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CONTENTS.

SIXTH REPORT ON THE FISHES OF THE IRISH ATLANTIC SLOPE.

THE FAMILIES *STOMIATIDAE, STERNOPTYCHIDAE* AND *SALMONIDAE*.[1]

BY

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Plates I and II.

Fam. *STOMIATIDAE*.

These are exclusively fishes of the deep sea, occurring in the Atlantic (including the Mediterranean) and Pacific Oceans, but apparently absent from both the North and South polar regions.

In general external features they may be distinguished from all other fishes of the same area, except some Gonostomatinae, by their very large mouths, in which the maxillae form a functional part of the upper jaw, and by the presence of photophores arranged in two regular linear series on the body, a lower extending from the isthmus to the base of the caudal fin and an upper reaching as far as the anterior ray of the anal fin. A hyoid barbel is frequently present, and the pectoral fins show a tendency to reduction, but the ventral fins are always present and often large. In form these fishes are elongate and sometimes eel-like, but usually compressed. Scales are usually absent, and, when present, embedded in the skin and not imbricated.

From the allied Gonostomatinae the species without hyoid barbels, and examples which have lost these barbels, may be best distinguished by the very large teeth in the premaxillae and front part of the mandibles, which are always much stouter and larger than the small and weak maxillary teeth. The frequent presence of a conspicuous suborbital photophore is also a character which is useful for purposes of identification.

[1] Zugmayer's account of the Fishes taken by the *Princesse-Alice* (Resultats des Campagnes Scientifiques du Prince de Monaco, XXXV, 1911) and the account of the Fishes taken by the *Michael Sars* (The Depths of the Ocean, Murray and Hjort, 1912) reached us during the progress of this paper through the press. We have, in consequence, only been able to make occasional references to them in the form of footnotes.

In addition to other organs of an apparently luminous function (which vary much in development in different genera), to the suborbital organ above alluded to, and to one or more smaller organs in the opercular region, the following series of photophores are present :—

(a) A series of *branchiostegals* overlying the branchiostegal rays,

(b) A *lateral* linear series running along the lower part of the sides from above the pectoral fins to opposite the anterior rays of the anal fin,

(c) A *marginal* linear series running from the isthmus along the ventral margin below the laterals to the origin of the caudal fin. This series is not differentiated into jugular, thoracic, ventral, anal, and caudal series as in some Sternoptychidae and in many Scopelidae; but the use of the latter terms is sometimes convenient in referring to the number of organs in front of, between, and behind the origins of the lower fins.

Genus *ASTRONESTHES*, Richardson.

Form elongate and somewhat compressed, head of moderate size, mouth very large. Premaxilla with a tooth of moderate size anteriorly, followed by a long curved tooth, behind which are several smaller straight teeth of different sizes; maxilla with a closely set series of small teeth. Mandible with a long curved tooth in front, followed by an irregular double series of smaller teeth. Small teeth on palatines. Hyoid barbel present. Body scaleless. Dorsal fin inserted above or behind ventrals and in advance of anal. A dorsal adipose fin present above the anal : a fold of skin resembling an adipose fin occasionally present on the ventrum in front of anus. Pectoral fins well developed with 8 or 9 rays, Ventrals with 7 rays. Suborbital photophore large and conspicuous; branchiostegals small; lateral and marginal series inconspicuous. Small photophores may be present on other parts of the body and on the paired fins.

This genus contains pelagic fishes of comparatively small size, which appear to be inhabitants of the upper strata of the deep sea; such little evidence as is available points to an ascent at times to the actual surface,[1] while the occurrence of an example in a halibut's stomach (*A. gemmifer*, Goode & Bean, 1895) indicates a descent to or nearly to the bottom in soundings of about 300 fathoms, possibly as the result of a movement into shallower water than normal.

Two species are known to occur in the North-eastern Atlantic :—

1. Dorsal with 11–13 rays, ending far in advance of origin of anal, *A. Richardsoni*, Poey.

[1] See also Murray and Hjort (1912).

2. Dorsal with 14–18 rays, ending opposite origin of anal, *A. niger*, Richardson.

The latter has not yet been taken in our area.

ASTRONESTHES RICHARDSONI, Poey.

A. abyssorum[1] (Koehler, 1896).

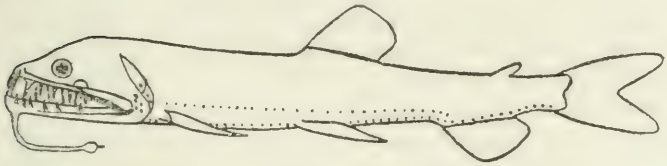

Fig. 1.—*Astronesthes Richardsoni*, young, 48 mm. without caudal fin.

Depth of body 6 to 7 times in total length (without caudal), head $4\frac{1}{4}$ to $4\frac{3}{4}$ times. Eye 5 to 7 times in head and about $\frac{3}{4}$ of length of snout. D. 11–13, originating above or a little behind ventrals and about midway between snout and origin of caudal. Adipose fin present. A. 13–15, originating some way behind distal end of dorsal. Suborbital photophore large, several small photophores on opercular bones. Photophores in lateral series about 30 and in marginal series about 45–50.

Colour uniform black.

Attains a length of about 190 mm. ($7\frac{1}{2}$ inches).

A. Richardsoni has been taken in the Western Atlantic off Cuba and in the Eastern Atlantic from off the South-west coast of Africa (Brauer, 1906) to the Irish Atlantic slope, where it has occurred twice :—

S. R. 231.—M.O.T., 1150 faths.—One, 48 mm. (without caudal).
S. R. 331.—Net on trawl, 680–610 faths.—One, 45 mm. (without caudal).

Genus *STOMIAS*, Cuvier.

Body very elongated and slightly compressed. Head small, eye of moderate size, mouth large. Premaxillae and mandibles with large teeth of unequal size, maxillae with numerous small teeth ; a large tooth on each side of vomer and smaller teeth on palatines. Hyoid barbel present. Dorsal and anal fins opposite to one another and very near caudal. Pectoral and ventral narrow and short, the former with 6, the latter with 5 rays. Scales thin and embedded in skin, forming a mosaic-like pattern. Suborbital photophore of moderate size ; branchiostegals small ; lateral and marginal series conspicuous. Small photophores are present on other parts of body. The body is covered with a colourless epidermis which is very readily stripped off.

[1] We suspect that Koehler's specimen had lost the posterior portion of its anal fin.

Brauer (1906) states that the eyes are larger in males than in females.

The members of this genus are pelagic fishes, inhabiting the open sea, and swimming at depths ranging from at least 750 fathoms to the surface. They are of predacious habits and we have found the remains of other fishes in the stomach of *Stomias boa.*

The larvae of *Stomias* have not been identified, but we suspect that some of the larval forms included by Brauer (1906) under "*Stylophthalmus paradoxus*" may be referable to this genus. Two very crushed and damaged larvae taken by the *Helga*, which bear a considerable resemblance to one of those figured by Brauer (1906, Plate V, fig. 7), may from their proportions and the position of the unpaired fins be larvae of *Stomias boa;* the only other diagnostic features which they show are a spathulate upturned snout, narrow in profile, somewhat projecting eyes, and a small amount of pigment on the head (see Pl. II, fig. 6). These larvae are about 29 and 36 mm. long respectively without their caudal fins, and, as *Stomias boa* may attain the general aspect of the adult at a length of little more than 30 mm., it would seem that in the latter stages of its metamorphosis there must be either no increase in the length of the body or an actual decrease, if our suggested identification is correct.

Brauer (1906, pp. 46, 47) gives a key to the nine species of Stomias which he recognises. They are probably all fishes of very wide distribution, but only one seems to have been recognised in the North-east Atlantic.

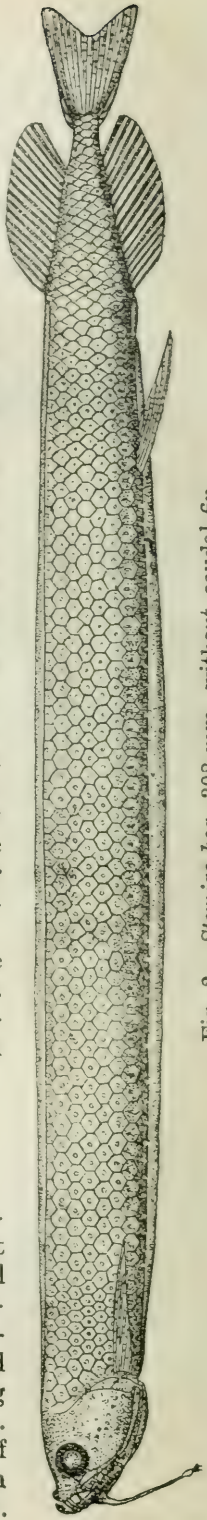

Fig. 2.—*Stomias boa*, 308 mm. without caudal fin.

STOMIAS BOA (Risso).

S. ferox, Reinhardt (see Lütken, 1892).

Body very elongated and slightly compressed. Head 9½ to 10½, depth of body about 13 to 20 times in total length without caudal fin. A tooth of moderate size (liable to disappear in old examples) on each side of premaxillary symphysis, followed by a large curved tooth and several smaller teeth of varying size; numerous minute teeth on maxilla. About three large curved teeth near front of mandible with several smaller teeth between and behind them. D. 16–20, A. 18–22.

Ventrals originating about three-quarters of the distance from snout to caudal origin. Scales mosaic-like, embedded in the skin, about 75–80 in a longitudinal series. Barbel about as long as head, ending in a slight swelling with a trifid tip. Photophores: opercular, one; branchiostegal, 12–16; jugular, 11–14; thoracic, 46–51; ventral, 10–13; anal and caudal, 16–18; lateral, 58–65. Each scale bears a central pigmented spot, apparently luminous in function.

Colour: sepia-brown, darker dorsally; the black lining of the body cavity can be seen through the overlying tissues. Scales and opercular integuments with a pearly lustre.

Attains a length of at least 308 mm. (12·2 in.) without the caudal fin.

The range of this species includes the Atlantic from North-west of the Hebrides (Collett, 1905) to the Cape of Good Hope (Brauer, 1906), and from Greenland to the New England coast; the Mediterranean; and the South Pacific (Peters, 1876).

S. boa is a pelagic fish, whose normal habitat appears to be the open sea, probably beyond the 600 fathom line. Vaillant's (1888) recorded capture of an example in a net which fished on the bottom in soundings not exceeding about 220 fathoms represents the most shoreward wandering known to us, and it has been taken in the Western Atlantic in very little deeper water. To judge from the number of examples taken by H.M.S. *Research* in the Bay of Biscay over soundings exceeding 750 fathoms, this species must be abundant in that area. In the area explored by the *Helga* it has only been met outside the 500 fathom line, and is probably more abundant over deeper soundings. Although the hauls taken were too few to permit of any generalisation we may note the failure of the *Huxley* (Byrne, 1907) to capture this species inside the 450 fathom line in the mouth of the English Channel.

So far as vertical distribution is concerned the absolute records are not numerous, but young and half-grown examples have been taken at night at the actual surface by the *Helga* and in nets fished open to the surface from 25, 50, 75, and 100 fathoms by H.M.S. *Research*. By day the *Research* took similar examples in closing nets fished between 300 and 200 fathoms and between 1000 and 750 fathoms.[1]

Over the Irish Atlantic slope it has not been captured at all frequently, but this may be in part due to the activity of the fish and their power of avoiding nets. The only large example was taken in a beam trawl, which, having failed to reach bottom, was functioning as a huge townet and took also a large *Xenodermichthys socialis*, another agile form which usually eludes the *Helga's* nets. The comparatively small size of the other examples of *S. boa* taken by the *Helga* seems to point to the species being a normal, if not very common, denizen of the

[1] See also Murray and Hjort (1912).

area explored, which is not improbably shoreward of its principal habitat.

The actual records are :—

S. R. 139.—Townet, 200 fathoms.—One, 40 mm.*
S. R. 193.—Townet, *ca.* 600 fathoms.—One, 84 mm.
S. R. 272.—M. O. T., 75 fathoms.—One, *ca.* 77 mm.
S. R. 299.—Trawl, *ca.* 500 fathoms.—One, 207 mm.*
S. R. 364.—Mq.-T., 620–695 fathoms.—One, 36 mm.
S. R. 439.—△, 0–5 fathoms.—One, 32 mm.*
S. R. 476.—M. O. T., 300 fathoms.—Two, 55 and 58 mm.
S. R. 484.—Trawl, 602–610 fathoms.—One, 308 mm.*
S. R. 485.—Trawl, 602–630 fathoms.—One, 46 mm.*
S. R. 496.—Mq. T., 473–500 fathoms.—One, 71 mm.
S. R. 499.—Sp. T., 666–778 fathoms.—One, 66 mm.
S. R. 503.—△, Surface.—One, 41 mm.
△, 70–80 fathoms.—One, 42 mm.
S. R. 589.—M. O. T., surface.—Three, 42–45 mm.
M. O. T., 550–600 fathoms.—Four, 30–38 mm.
S. R. 593.—M. O. T., surface.—Three, 56 mm.*
S. R. 805.—Trawl, 539–544 fathoms.—One, 180 mm.
S. R. 1237.—Townet, 50 fathoms.—One, 48 mm.

In the cases of specimens marked * the measurements are exclusive of the caudal fin.

The larvae referred to on p. 4 were taken at S. R. 449.—M. O. T., 700 fathoms.

The adult specimen from S. R. 484 is the largest of which we have seen a record. In the upper jaw it has a short curved tooth on each side of the symphysis, followed on the right side by a single large fang, and on the left side by a pair of large fangs, closely apposed, but neither obsolete nor loose. Posterior to them are three teeth of varying size in each jaw. In the lower jaw are a pair of short curved teeth on each side of the symphysis, followed by a rather large fang and four smaller teeth.

In the specimen from S. R. 299 there are only four conspicuous teeth on each side of the upper jaw, the second being the smallest. The central teeth appear to be wanting. In the mandible there are five rather large teeth on each side, with some small teeth centrally and others at the back of the larger side teeth.

The principal dimensions and characters of these two specimens are as follows :—

	S. R. 299.	*S. R.* 484.
Total length, without caudal fin ..	207 mm.	308 mm.
Length of head, without lower jaw ..	19 ,,	28 ,,
Length of barbel, including tentacles ..	23 ,,	26 ,,
Horizontal diameter of eye	5 ,,	6·5 ,,
Greatest height of body	10·5 ,,	23 ,,

	S. R. 299.	*S.R.* 484.
Height of caudal peduncle	4 mm.	4[1] mm.
Length of pectoral fin	17 ,,	25 ,,
Length of ventral fin	22 ,,	29 ,,
Length of base of dorsal fin	19 ,,	27 ,,
Length of base of anal fin	19·5 ,,	32 ,,
Dorsal rays	19	17 (? +)
Anal rays	21 or 22	19 (? +)
Scales of lateral line	79 or 80	
Scales in transverse row above lateral photophores	6	11
Jugular photophores	11	11
Thoracic photophores	49	49
Anal and caudal photophores	17	13 + ?
Lateral photophores	61	60 or 61

The larger specimen had lost its mucous epidermis. In the smaller specimen the epidermis was perfect, save for a small lesion (which also involved the dermis) on the back. Preserved in weak formalin, the epidermis formed a jelly-like sheath covering the whole animal, except the head and fins. Its thickness (which is not included in the measurements given above) was nearly 2 mm. on the back and about the same on the sides, becoming thinner at the ventrals and very thin on the caudal peduncle. On the ventrum it formed a keel, which attained a depth of 5 mm. midway between the pectorals and anal. Transferred to a solution of two parts alcohol and one part 5 per cent. formalin, the epidermis rapidly shrank and became opaque.

Genus *LAMPROTOXUS*, nov.

Form compressed and moderately elongate. A cord-like band of luminous tissue partially embedded in the skin forms a closed loop on the anterior part of each side of the body. Dorsal and anal with numerous rays opposite each other and near the caudal. Pectorals present, set very low. Ventrals set at about the middle of the total length without the caudal, but nearer to the head than to the caudal. Caudal with the dorsal lobe shorter than the ventral. Eye not longer than the snout. Teeth in the jaws widely separate and fang-like, an anterior fixed pair in each jaw followed by several smaller fixed teeth and by a few depressible teeth situate a little internally to the fixed teeth. Vomer toothless. Hyoid barbel very long and simple. Skin without scales. Suborbital photophore large, photophores of lateral and marginal series small.

This genus is evidently allied to *Grammatostomias*, but differs from it in possessing the singular luminous organ above described, and in the much longer barbel. We are not inclined to attach much weight to the latter character, but have ascertained from

[1] Without skin.

the authorities of the U.S. National Museum and Dr. Brauer that the type of *G. dentatus* and the material of closely allied forms taken by the *Valdivia* are sufficiently perfect to make it certain that none of them possessed any structure in the nature of the looped band of luminous tissue present in the Irish fish.

LAMPROTOXUS FLAGELLIBARBA (Holt & Byrne).

Grammatostomias flagellibarba, Holt & Byrne (1910).

Plate I.

Length of head about $5\frac{1}{2}$ in total length without caudal fin and a little greater than greatest height of body, which is about twice its greatest width. Eyes shorter than snout, about 8 in length of head and $2\frac{3}{4}$ in width of interorbital space.

Teeth slender and very sharp, their bases closely surrounded by the black epidermis. Those in upper jaw almost uniserial; a non-depressible tooth about as long as eye at each side of symphysis, this is followed by a much longer depressible tooth and one or two smaller depressible teeth on each side, all of which are in a line slightly internal to two smaller non-depressible teeth which lie in the intervals between the depressible teeth; the posterior end of the maxilla is rough with minute teeth in a single series. On the mandibles there are anteriorly and corresponding to the anterior teeth in the upper jaw a pair of long non-depressible teeth; behind these there are six depressible teeth diminishing somewhat in size backwards, and two non-depressible teeth lying in a line slightly external to the depressible teeth and situated behind the first and third teeth of the depressible series; the points of the non-depressible teeth are somewhat outwardly directed.

Hyoid barbel stout basally, produced into a slender filament many times longer than the body. Pectorals placed close together near the ventral margin, apparently devoid of any large detached ray; two of the rays short and fleshy, the remainder, of which one is anterior to the fleshy rays, slender.[1] Ventral with about 7 slender rays, set a little nearer to the snout than to the caudal fin, their length about equal to the height of the body at their point of insertion. Dorsal with about 20 rays. its base a little shorter than the greatest height of the body, Anal with about 22 rays, its base a little longer that the greatest height of the body; both fins with comparatively short rays set in rather conspicuous fleshy bases.

Height of caudal peduncle less than the length of the snout. Skin black, rather thick, with barely perceptible granulations.[2]

[1] The fleshy rays are at present colourless, but may have lost their integument. The original condition and number of the slender rays is beyond conjecture. They are now represented by a few hair-like processes, which may be either the true rays or portions thereof divided by fission.

[2] The faint vertical markings present in allied Stomiatids did not become apparent until the fish had been preserved in alcohol and formalin for some weeks.

A group of grey luminous organs (looking like fungoid growths) at the hind angle of the gill cover, and another group below the origin of the band mentioned below. Other and smaller grey luminous organs sporadically scattered over the lower parts of the cheeks and the fore part of the body. A thin band[1] (of tissue similar in appearance to the organs above mentioned and raised above the skin after the manner of a scar or cicatrix) forms a long loop with acute posterior angle,[2] extending beyond the vertical from the insertion of the ventrals, its lower limb wider and boldly sinuous at its origin, the rest narrow and feebly sinuous. A large photophore behind and slightly below the eye, occluded by skin save for a narrow slit. Very small photophores, hardly visible externally, are present in lateral and marginal series. Colour velvety black; looped band purplish grey; barbel grey.

Total length of type without caudal fin and lower jaw 172 mm. (6·8 in.). Sex, male.

The only extant specimen was taken in a shrimp-trawl fished from the *Helga* on 12th November, 1909, at Station S.R. 858, 51° 20′ N., 11° 56′ W., off the south-west coast of Ireland. The soundings were 736 fathoms, but the net never touched bottom, and probably did not go deeper than 700 fathoms.

Fam. *STERNOPTYCHIDAE.*

The members of this family show great diversity in external features, and especially in form, some species being very elongate and others extremely compressed and about as deep as long. In general terms it may be said that they agree with the Stomiatidae and differ from all other fishes in having the functional parts of the upper jaw chiefly formed by the maxilla and in possessing serially arranged photophores of a more or less complex type. They differ from the Stomiatidae externally in the arrangement of the teeth in the upper jaw; the Sternoptychidae never have the premaxillary teeth enlarged and more developed than the maxillary teeth as in the Stomiatidae; indeed the maxillary teeth of the Sternoptychidae are not infrequently larger than their premaxillary teeth. A further point of distinction may be found in the universal absence of a hyoid barbel in the Sternoptychidae.

The photophores vary much in different genera; in most of the forms usually placed in the sub-family Gonostomatinae these organs seem to differ but little in structure and arrangement from the similar organs of the Stomiatidae, while in many Sternoptychinae the photophores appear to approximate in structure to those of the Scopelidae, except that they are so placed as to throw their light downwards rather than directly outwards. The simple marginal series of the Stomiatidae and

[1] A description of the structure of these organs will be found in *Fisheries, Ireland, Sci. Invest.*, 1912, *II*, [1913], see below.

[2] On one side there is a short process posterior to the angle.

Gonostomatinae may in the Sternoptychinae be divided into well-marked Thoracic, Ventral, Anal, and Caudal series (see Holt & Byrne, 1911), often separated from one another by comparatively wide intervals.

In habits the members of this family seem to vary almost as much as in structure. Some are normal denizens of the upper strata of the deep sea, whose wanderings carry them sufficiently far into coastal waters to make them the occasional prey of shore fishes or to cause them to be cast upon the strand after storms; others may certainly descend to and perhaps normally live at very great depths.

The later larval forms of all the species of Sternoptychinae below described are well known; they are all characterised by the comparatively early appearance of an opercular photophore and also of close set series of branchiostegal and thoracic organs, features which give these larvae a very characteristic appearance.

No Gonostomatine larvae have been identified with certainty, but we think that there can be little doubt that the "Praescope" larvae taken in the Bay of Biscay and Mediterranean (Holt & Byrne, 1907, and Fage, 1910) are referable to some member of this sub-family. An early larva similar to and perhaps identical with the "Praescope" larva is shown on Pl. II, fig. 4; this is the only larva of this type which we have hitherto detected among the material collected by the *Helga*. The "Praescope" larva shows, at a length of about 15 mm., an opercular photophore and two closely apposed thoracic photophores which recall the similar structures in larval Sternoptychinae; it is also notable for the prominent and forwardly directed eyes which are apparent at all known stages, a feature which is characteristic but not necessarily diagnostic. Beyond the fact that considerations of size make it practically certain that *C. microdon* is not the parent form, nothing definite can be said as to its parentage.

Fage (1910) has described a Mediterranean larva which bears a considerable resemblance to the "Praescope" larva, but is smaller at all stages; as he justly remarks the presence and appearance of opercular, branchiostegal, and thoracic photophores at a length of 10 mm. give it a striking similarity to the larvae of *Maurolicus*. He refers this larva to *Cyclothone* and regards *C. signata*, Garman, as the probable parent; it might equally be the larva of *C. microdon*.

The following key includes all the genera at present recorded from our area:—

I. Body elongated; photophores small and inconspicuous, the marginal series continuous (Gonostomatinae).

  A. Premaxilla and maxilla with a continuous series of long pointed teeth set at fairly regular intervals and much smaller teeth in the intervals between them, *Gonostoma*.

  B. Premaxilla with few teeth, maxilla with a closely set

series of teeth of moderate size which increase in size from the front backwards and have slightly larger teeth at more or less irregular intervals, *Cyclothone*.

II. Body very short or of moderate length, compressed; photophores large and conspicuous, the marginal series more or less distinctly divided into groups (Sternoptychinae).

A. Depth of body more than 4 times in length without caudal, no projecting neural or dorsal rays, *Maurolicus*.

B. Depth of body not more than twice in length without caudal. Abdominal region passing more or less abruptly into caudal region.

i. About seven neural spines projecting in front of dorsal fin and connected by membrane. Maxilla very broad, *Argyropelecus*.

ii. Neural spines projecting in front of dorsal fin and fused into a thin bony plate terminating in a strong spine; a similar bony plate supported by projecting haemal spines fills the angle between the abdominal and caudal regions and bears the anal fin. Maxilla not very broad, *Sternoptyx*.

GENUS *GONOSTOMA*, Rafinesque.

GONOSTOMA BATHYPHILUM (Vaillant).

Neostoma bathyphilum, Vaillant (1888).

Cyclothone bathyphila, Goode & Bean (1895).

Fig. 3.—*Gonostoma bathyphilum*, 120 mm.

Body elongated and slender, its depth 7 to 9 times in total length (without caudal fin). Head $3\frac{1}{2}$ (in young) to $4\frac{1}{2}$ times in total length. Eye small and anterior in position, about $2\frac{1}{2}$ times in snout and 10 to 12 times in head. Cleft of mouth very wide; premaxilla with teeth of moderate and varying size, maxilla with large teeth set at fairly regular intervals and smaller teeth in the intervals between them; mandibular teeth similar to maxillary but smaller. D. 11–13, A. 21–23, originating opposite to one another. Adipose dorsal present. Scales absent. Photophores very small and inconspicuous in branchiostegal, lateral and marginal series; two conspicuous ventral photophores and one dorsal at base of caudal fin.

Colour deep velvety black. The skin is very adherent and is

retained by all the examples examined by us, even when very much damaged in capture.

Attains a length of about 6 inches (152 mm.). Young examples have a characteristically meagre appearance which is enhanced by the relatively large head.

Fig. 4.—*Gonostoma bathyphilum*, young, 50 mm. without caudal fin.

G. bathyphilum has been recorded from off the Azores, the Bay of Biscay, and the Irish Atlantic slope (Vaillant, 1888, and Holt & Byrne, 1907).

Available evidence points to the probability of this species being a bathypelagic fish which does not ordinarily occur shoreward of the 600 fathom line. Examples were taken by H.M.S. *Research* in the Bay of Biscay in closing nets fished from 1500 to 750 fathoms, and from 1500 to 1250 fathoms. Vaillant's examples were taken in nets fished open from the bottom to the surface from depths of about 780 fathoms and upwards. The examples taken by the *Helga* were in nets fished open to the surface, one from the bottom in 602–610 fathoms, one from the bottom over soundings of 670–692 fathoms, one from 650–750 fathoms over sounding of 860 fathoms, and one from about 700 fathoms over soundings of 950 fathoms. These records are :—

S. R. 224.—M.O.T. 650–750 faths.—One, badly broken.
S. R. 449.—M.O.T. 700 faths.—One, 30 mm. *ca.* without caudal.
S. R. 484.—Net on trawl, 602–610 faths.—One, 50 mm., without caudal.
S. R. 1242.—Trawl, 670–692 faths.—One, 30 mm. *ca.* without caudal.

Genus *CYCLOTHONE*, Goode & Bean.[1]

CYCLOTHONE MICRODON (Collett).

Gonostoma microdon (Günther).

Form elongated and slender; depth of body $7\frac{1}{2}$ to $8\frac{1}{2}$ times in total length (without caudal fin). Head $4\frac{1}{4}$ to 5 times in total length. Eye minute and anterior in position. Mouth very

[1] The absence of *C. signata*, Garm. (Brauer, 1906) from the collections made by the *Helga* is remarkable, especially in view of the recorded occurrences of that species in the Mediterranean and neighbouring parts of the Atlantic (Fage, 1910; Zugmayer, 1911; Murray & Hjort, 1912). In view of the possibility that we had failed to distinguish this species from the young of *C. microdon*, we submitted the smaller examples which we had referred to *C. microdon* to Dr. Brauer, who has been good enough to examine them and confirms our identification.

wide; premaxillae short, with several small teeth and one or two larger ones; maxilla with numerous small teeth closely set in a single series and increasing in size posteriorly; a few larger teeth at regular intervals.

Fig. 5.—*Cyclothone microdon* × 1½.

D. 11–14, A. 16–21, originating opposite to one another. Scales large, very thin, and exceedingly deciduous.

Photophores small and inconspicuous in adult, more conspicuous in young; Opercular, 2; Branchiostegals, about 9; Laterals, 7 or 8, the posterior separated by an interval from the others; Marginals, 15–18 in front of and 12–16 behind the origin of anal fin.

Colour of adult dark sepia (sometimes almost dull black) to dark chestnut-brown (var. *pallida*, Brauer). Young examples are semi-transparent, and the black lining integuments of the abdominal region show through their tissues. The skin is very delicate and generally more or less stripped off in the process of capture, leaving the fish semi-transparent (or yellowish after preservation) and sometimes spotted with pigment where small portions of the skin have adhered. Often skin and flesh alike have disappeared, leaving only the backbone and part of the head.

Attains a length of about 2½ inches (60 mm.) without caudal fin.

The young seem to have attained the general form and proportions of the adult at about 15 mm. (without caudal), but the dark pigment is later in making its appearance. Females between 30 and 35 mm. long (without caudal) taken during the late spring and summer contained well-developed ova.[1]

The range of *C. microdon* is practically world wide, so far as existing records enable us to judge. Its vertical distribution is dealt with below.

We doubt whether it can be properly regarded as a shoaling fish, although it must occur at times in very large numbers within a limited area.

G. microdon has been taken at the following stations:—

S. R. 113.—Townets on lead, 600 faths.—Two, 50 and 27 mm.
S. R. 139 —△, 1000 faths.—Five, 32–45 mm.

[1] This observation seems to conflict with those of Murray and Hjort as to the size at which *G. microdon* attains maturity. Our examples have, however, been submitted to Dr. Brauer, who confirms our identification (see footnote on p. 12).

S. R. 140.—△ and townet, 735 faths.—Two, 34 and 24 mm.
S. R. 175.—△, 600 faths.—Seven, 24–42 mm.
S. R. 197.—Townet, 300 faths.—One, broken.
Townet, 600 faths.—One, 31 mm.
△, 700 faths.—Four, 26–45 mm.
S. R. 224.—M.O.T., 650–750 faths.—Sixteen, 25–50 mm.
S. R. 231.—M.O.T., 1150 faths.—Thirty-four, 23–58 mm.
Townet, 600 faths.—One, 35 mm.
△, 750 faths.—Eight, 30–40 mm.
S. R. 270.—M.O.T. 350 faths.—Eleven, 23–38 mm.
S. R. 272.—M.O.T., 400 faths.—Three, 24–33 mm.
S. R. 282.—△, 700 faths.—Two, 34 mm.
S. R. 299.—Net on trawl, 500 faths.—Seven, 26–34 mm.
S. R. 328.—Net on trawl, 445–515 faths.—Two, 35 mm.
S. R. 330.—Net on trawl, 474–415 faths.—One, 28 mm.
S. R. 331.—Net on trawl, 610–680 faths.—One, 41 mm.
S. R. 336.—Net on trawl, 673–720 faths.—One, 38 mm.
S. R. 337.—M.O.T., 400–450 faths.—Four, 36 mm.
S. R. 352.—M.O.T., 700–750 faths.—Nineteen, 27–52 mm.
S. R. 363.—Nets on trawl, 695–720 faths.—Four, 30–45 mm.
S. R. 366.—M.O.T., 400 faths.—One, 30 mm.
S. R. 387.—Net on trawl, 530 faths.—Two, 42 mm.
S. R. 397.—Net on trawl, 537–646 faths.—Three, 39–45 mm.
S. R. 400.—Net on trawl, 525–600 faths.—One, 38 mm.
S. R. 401.—Nets on trawl, 600–660 faths.—Five, 39–44 mm.
S. R. 403.—△, 500 faths.—Two, 29 mm.
S. R. 439.—△, surface.—Two, 26 mm.
S. R. 449.—M.O.T., 700 faths.—Five, 25–45 mm.
S. R. 470.—M.O.T., 400–500 faths.—Two, 31–33 mm.
S. R. 476.—M.O.T., 300 faths.—Two, 38 mm.
S. R. 481.—M.O.T., 600–900 faths.—Two, 38–45 mm.
S. R. 484.—Nets on trawl, 602–610 faths.—Three, 40–54 mm.
S. R. 485.—Net on trawl, 602–630 faths.—Two, 33–43 mm.
S. R. 486.—Net on trawl, 600–660 faths.—Two, 30–42 mm.
S. R. 487.—Net on trawl, 540–660 faths.—Two, 40–52 mm.
S. R. 488.—△, 350–400 faths.—One, 30 mm.
S. R. 489.—Net on trawl, 720 faths.—One, 24 mm.
S. R. 494.—Net on trawl, 550–570 faths.—Two, 30–35 mm.
S. R. 496.—Nets on trawl, 473–500 faths.—Two, 28–43 mm.
S. R. 497.—Net on trawl, 775–795 faths.—One, 46 mm.
S. R. 498.—△, 500–600 faths.—Two, 38 mm.
S. R. 500.—Net on trawl, 625–666 faths.—One, 40 mm.
S. R. 502.—Net on trawl, 447–515 faths.—Three, 32 mm.
S. R. 589.—M.O.T., 550–600 faths.—Seven, 23–39 mm.
S. R. 593.—Net on trawl, 670–776 faths.—Two, 33–46 mm.
S. R. 851.—M.O.T., 900 faths.—Sixteen, 30–53 mm.
S. R. 1175.—M.O.T., 400 faths.—Eight, 30–35 mm.
S. R. 1237.—M.O.T., 450 faths.—Ten, 20–30 mm.
S. R. 1241.—Net on trawl,—Four, 35–30 mm.

As the above list indicates *C. microdon* is abundant and widely

distributed over the Irish Atlantic slope outside the 400 fathom line; shoreward of that line there is no record. It is worthy of remark that the species was not met with by the *Huxley* (Byrne, 1907) fishing inside the 450 fathom line at the mouth of the English Channel. The captures recorded in other parts of its range do not indicate any closer approach to land, with the exception of single examples taken by the *Ingolf* (Lütken, 1898) and *Investigator* (Alcock, 1899) over depths of between 250 and 300 fathoms.

The species may occur, though apparently very seldom, at the actual surface by night, and the records of both the *Valdivia* (Brauer, 1906) and the *Helga* show that it may occur in the superficial 500 or 600 fathoms of the open sea over much deeper soundings. The almost constant presence of small numbers of *C. microdon* in nets fastened to the back of the trawl in hauls taken in between 500 and 700 fathoms may either indicate its constant presence near the bottom in such soundings or its occurrence in such numbers at a higher horizon that a net hauled through such horizon inevitably meets a few examples; our own inclination is towards the former view. The negative evidence supplied by the *Helga* is probably, in view of the nets used, of no great value, but we may note that at S. R. 272 it was present in M.O.T. fished from 400 fathoms to the surface and absent in a similar net fished from 75 fathoms to the surface; at S. R. 282 it was present in △ fished from 700 fathoms to the surface and absent from a similar net fished from 200 fathoms to the surface; while at S. R. 337, 476, 498 and 1237 it was absent from surface hauls taken by nets similar to those in which it occurred. Notwithstanding the small size of the nets used the constant absence of *C. microdon* from nets fished by H.M.S. *Research* in the Bay of Biscay in the superficial 100 fathoms and its presence in one haul from 250 fathoms to the surface and in a closing net fished from 750 to 500 fathoms (see Holt & Byrne, 1907) seems worthy of remark.

On the whole, we think that the available evidence indicates that this fish is a normal denizen of depths of between about 800 and 300 fathoms,[1] ascending at times into higher horizons or even to the actual surface, and swimming in close proximity to the bottom at suitable soundings. Our inability to recognise the larvae of this species naturally calls for some remark; we can only suggest that they may normally swim at such considerable depths as to be unable to withstand the strain entailed by being dragged to the surface. Whatever the reason, their rarity in comparison with the larvae and young of *Scopelus glacialis* and *crocodilus*, *Maurolicus*, and *Argyropelecus* is most remarkable.

The larva figured on Pl. II was discovered among a mixed lot of *Maurolicus* larvae from various hauls, so its actual provenance cannot now be traced.

[1] Murray and Hjort (1912) arrive at a very similar conclusion from an examination of the large material taken by the *Michael Sars*.

MAUROLICUS PENNANTI, Wålbaum.

M. Mulleri (Gm. Linn).
M. borealis (Nilsson).
M. amethystino-punctatus, Cocco.

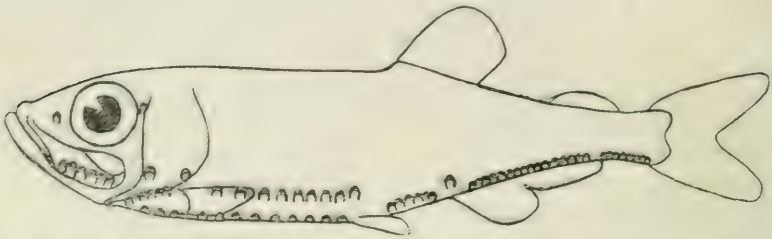

Fig. 6.—*Maurolicus Pennanti*, 37 mm. without caudal fin.

Depth of body $4\frac{1}{4}$ to $4\frac{3}{4}$ times in total length (without caudal); depth of caudal peduncle about $2\frac{1}{2}$ times in depth of body. Head $3\frac{1}{4}$ to $3\frac{3}{4}$ times in total length. Eye about 3 times in head and a little longer than snout. Premaxillae, maxillae, and mandibles with numerous small teeth. D. 9–12; adipose fin present; A. 8–11 + 15–18, originating under hinder part of dorsal, its rays divided into two groups. Photophores: Antorbital, 1; Postorbital, 1; Opercular, 2; Branchiostegal, 6; Jugular, 6; Thoracic, 11–12; Ventral, 6; Anal, 15–18, the anterior displaced dorsally; Caudal, 8–9; the latter three series each closely set and divided from one another by short intervals; Lateral, 9.

Colour silvery, back and top of head dark. Young examples or those which lose their integuments during capture are yellowish after preservation, but the photophores are adherent and do not readily strip off.

Attains a length of about 3 inches (76 mm.).

The smallest larvae collected by the *Helga* which appear to be referable to this species are not in a condition to admit of any useful description being given. At a length of about 7 mm. (without caudal) the developing thoracic photophores first appear (Pl. II, fig. 1) and thereafter provide a ready means of identifying the larvae.

By the time a length of 8 or 9 mm. (without caudal) has been attained the larvae present the general appearance shown in Pl. II, fig. 2. The marginal fin has disappeared except in the regions occupied by the unpaired fins of the adult and the developing rays of the dorsal and anal fins are visible; the ventral fins can usually just be detected. A closely set row of about 4 thoracic photophores is present and conspicuous, and the branchiostegal and one opercular photophore are also visible. Dark pigment is visible externally on the occiput, along the base of the anterior portion of the anal fin, and on the caudal peduncle; the roof of the air bladder is also darkly

pigmented. A larva at this stage has been figured by us (1907).

As development proceeds the thoracic photophores increase in number and the anal photophores begin to appear near the middle of the base of the anal fin; these are soon followed by the caudal and, a little later, by the ventral and jugular photophores.

By the time a length of about 11 mm. (without caudal) is attained (see Pl. II, fig. 3) the thoracic photophores as well as those on the head and operculum have almost attained their adult appearance, and the ventral, anal, and caudal series are represented by widely separated groups each containing a few closely set photophores. The anterior photophores of the lateral series begin to appear at about this stage, and there is a considerable increase in the dark pigment on the occiput and along the back between the dorsal and caudal fins.

The larvae at a length of 13 or 14 mm. (without caudal) have attained the general form of the adult; the majority of the lateral photophores have appeared, but the ventrals, anals, and caudals are still represented by smaller groups than in the adult, and these groups are separated from one another by very wide intervals.

At 15 mm. (without caudal) or even at a slightly smaller size traces of silvery pigment begin to appear, and by the time a length of about 20 mm. (without caudal) has been reached the photophores have attained the full adult number and positions.

The range of *M. Pennanti* includes the North Atlantic from Norway to the Azores and from Massachusetts to the Gulf of Mexico, and the Mediterranean. *M. australis*, Hector, seems to be at most a variety of the Atlantic species.

M. Pennanti appears to be a shoaling fish.

On the Irish Atlantic slope its range extends into comparatively shallow water, and the young have occurred in our collections shoreward of the 100 fathom line. Occurrences in nets fastened to trawls and in the trawl itself, as well as the large number taken on one occasion in a mid-water trawl fished almost on the bottom at depths of between 100 and 200 fathoms, may indicate a descent very nearly to the bottom at the shoreward boundary of its habitat. Young and half-grown examples may occur abundantly at the surface (Byrne, 1907), and larvae were taken in nets fished open by night from between 25 and 100 fathoms to the surface by H.M.S. *Research* in the Bay of Biscay. The finding of a large example in the stomach of a ling taken in a trawl beyond the 350 fathom line probably affords reliable evidence of a descent nearly to that depth. Records from deeper water are consistent with the view that *M. Pennanti* is normally a denizen of about the upper 400 fathoms of the open sea, and may occur on or near the bottom shoreward of the 400 fathom line. Comparatively frequently, however, as appears from the records collated by

Day (1880–84) and Smitt (1895), adults wander, even in some numbers, to the shores of North Europe, where they have often been found cast upon the beach.

This species has been taken by the *Helga* at the following stations:—

13. vii. 03.—Net on trawl, 120 faths.—Four, 9–18 mm.
S. R. 44.—Trawl and net on trawl, 116 faths.—Five, 11–15 mm.
S. R. 145.—Net on trawl, 112 faths.—Four, 20–27 mm.
S. R. 146.—Net on trawl, 181 faths.—Three, 13–15 mm.
S. R. 197.—△, 700 faths.—One, 31 mm.
Townet, 100 faths.—One, 23 mm.
S. R. 272.—M.O.T., 350 faths.—Ten, 12–22 mm.
S. R. 282.—△, 700 faths.—One, 15 mm.
S. R. 299.—△, 350–400 faths.—One, 22 mm.
S. R. 366.—M.O.T., 400 faths.—Three, 9 mm.
S. R. 383.—M.O.T., 143 faths.—About three hundred, 10–43 mm.
S. R. 386.—M.O.T., Surface.—Six, 25–34 mm.
S. R. 440.—Trawl, 350–390 faths.—One, 55 mm.[1]
S. R. 470.—M.O.T., 400–500 faths.—Sixty eight, 9–19 mm.
S. R. 476.—Townet, 50 faths.—One, 18 mm.
M.O.T., 300 faths.—Over a thousand, 6–18 mm.
S. R. 481.—M.O.T., 600–900 faths.—Four, 15–20 mm.
S. R. 484.—Net on trawl, 602–610 faths.—Eighteen, 11–20 mm.
S. R. 485.—Net on trawl, 602–630 faths.—Two, 11–17 mm.
S. R. 488.—△, 350–400 faths.—Twenty-six, 14–19 mm.
S. R. 489.—Net on trawl, 720 faths.—Two, 14–16 mm.
S. R. 498.—△, 500–600 faths.—One, 15 mm.
S. R. 585.—Townet, 84 faths.—One, 10 mm.

Genus *ARGYROPELECUS*, Cocco.

Keys to all the described species of the genus have been recently given by Brauer (1906) and Regan (1908). Two species only are known to occur over the Irish Atlantic Slope, and these may be distinguished as follows:—

1. Preopercular spine single and directed downwards; abdominal spines two, both slender, one directed downwards and one downwards and backwards. Teeth in mandible, some large and some small. Greatest depth of body about $\frac{2}{3}$ length[2] (without caudal). *A. Olfersi.*

2. Preopercular spines two, one directed downwards and one backwards; abdominal ridge ending in a long, backwardly-directed, serrated spine, with a small backwardly directed spine above it. Teeth in mandible small and of nearly uniform size.

[1] In stomach of a ling (*Molva abyssorum*).

[2] Perhaps less in very large examples (over 60 mm. without caudal fin).

Greatest depth of body only slightly exceeding $\frac{1}{2}$ length (without caudal). *A. hemigymnus.*

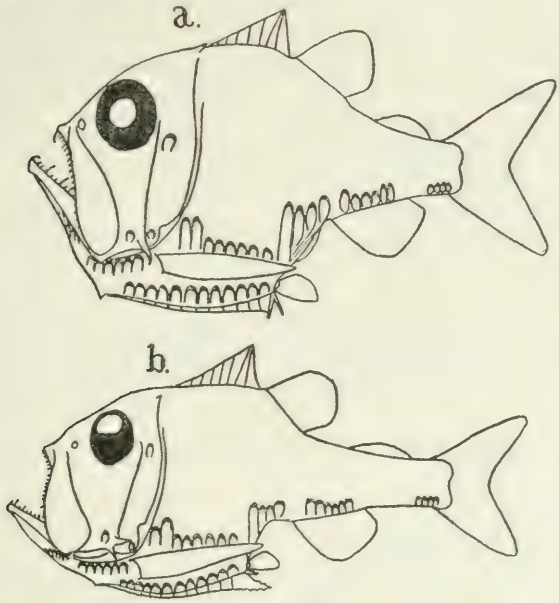

Fig. 7.

a.—*Argyropelecus Olfersi*, young, 26 mm. without caudal fin.
b.—*Argyropelecus hemigymnus*, young, of the same length.

Like the *Scopeli* (see Holt & Byrne, 1911), all known species of *Argyropelecus* appear to be truly oceanic fishes, pelagic in habit, and normally living in the upper strata of the deep sea. Unlike the *Scopeli*, however, the adults do not seem from their structure to be adapted for very rapid movement; and it is not improbably as a consequence of this structural difference that they are more frequently found floating at the surface in a dead or dying condition or cast ashore after stormy weather. At times *A. Olfersi* may wander, voluntarily or otherwise, into sufficiently shallow water to be devoured by cod or coalfish (Smitt, 1895; Collett, 1896). Günther (1887) was the first to suggest that members of this genus may rise towards the surface by night and sink into deeper water by day, and this suggestion has generally been accepted as reasonable: there is some evidence of a diurnal fall and nocturnal rise in the case of pelagic fish-larvae and crustaceans, and we may well suppose that such predacious fishes as *Argyropelecus* conform to the movements of their prey. Adults have been taken in a living condition at the actual surface (Günther, 1889; Collett, 1896) and in a closing townet between 100 fathoms and the surface, also by night (Holt & Byrne, 1907); we are aware of nothing which points to the depth to which they normally descend, but should assume that this would not ordinarily exceed about 200 fathoms.[1]

[1] See also Murray and Hjort (1912). The bulk of their individuals occurred in nets lowered to between 80 and 275 fathoms.

We are aware of nothing which points to a shoaling habit in these fishes, but they may undoubtedly occur in considerable numbers within a limited area. Assuming the correctness of the view already expressed by us (1911) that photophores are to be regarded primarily as recognition marks during the breeding season, it may well be that the upwardly directed eyes and the photophores so arranged as to be best visible from below may be correlated in *Argyropelecus* and its allies with normal movements in a vertical rather than a horizontal plane.

What little is known of their food points to their being essentially predacious fish; Collett (1896) mentions finding a *Maurolicus* about 50 mm. long in the stomach of an *A. Olfersi*, and we have found the remains of a small fish in an *A. hemigymnus* of a little over an inch in length. The resemblance in external form which they bear to *Zeus* (the John Dory) suggests that, like that fish, the *Argyropeleci* may hunt by stealth.

ARGYROPELECUS OLFERSI, Cuvier.

Length of body to ventral fins more than half total length (without caudal fin); depth of body at first dorsal spine about double its depth at origin of anal fin, and $1\frac{1}{2}$ to $1\frac{3}{5}$ times in total length (without caudal). Head about three times in total length (without caudal). Eye $2\frac{1}{4}$ to $2\frac{1}{2}$ times in head. A single fang-like tooth at angle of premaxilla, remaining teeth on premaxilla and maxilla small; a few teeth of large size on mandible with smaller teeth between them. Preopercular spine single and directed downwards. Two spines at posterior angle of abdomen, one directed downwards and one downwards and outwards. D. 9, A. 11. Adipose dorsal present. Photophores: Antorbital, 1; Postorbital, 1; Opercular, 2; Branchiostegal, 6; Jugular, 6; Thoracic, 12; Ventral, 4; Anal, 6; Caudal, 4, separated from the anals by an interval not exceeding $\frac{2}{3}$ of the length of the latter group; Laterals, 8, the two anterior higher than the others.

Dorsum, upper part of head, lower part of body in caudal region, and base of caudal fin dark sepia, colour elsewhere silvery in large examples. In small examples a greater or less extent of the caudal region is colourless and semitransparent (as in *A. hemigymnus*) and there is a colourless band on the caudal peduncle up to a length of about 30 mm. (without caudal).

Attains a total length of at least 99 mm. or about 3·9 in. (82 mm. without caudal), at which size the female is mature (see Collett, 1896).

Presumably the larvae of this species are in general similar to those of *A. hemigymnus*, but, as remarked in dealing with that species, the smallest larvae which we can refer to a definite species are about 8 mm. long (without caudal); at a length of 13 mm. the young *A. Olfersi* can already be identified by the character of the preopercular and abdominal spines.

The range of *A. Olfersi* includes the Atlantic from the Cape of Good Hope to Norway and off the New England coast, and it

has also been taken in the open ocean between the Canaries and Brazil (Brauer, 1906). The *Valdivia* found this species in the Indian Ocean, and *A. caninus*, Garman, from the Pacific coast of Central America, is regarded by Regan as not entitled to specific distinction. We are unaware of any record from the Mediterranean, and it is possible that this species is more truly oceanic in habit than *A. hemigymnus*, and that its occasional appearances over the Irish Atlantic Slope are the results of storms or abnormal currents and in no way indicative of its constant presence in that area.

The *Helga* records are as follows :—

S. R. 188.—Net on trawl, 380 faths.—One, 13 mm.
S. R. 197.—△, *ca.* 700 faths.—One, 26 mm.
S. R. 498.—△, 500–600 faths.—One, 14 mm.
S. R. 1243.—Trawl, 670–690 faths.—One, 48 mm.

[The measurements are exclusive of caudal fin.]

ARGYROPELECUS HEMIGYMNUS, Cocco.

Length of body to ventral fins about half total length (without caudal fin); depth of body at first dorsal spine about 2½ times its depth at origin of anal fin, and about twice or slightly less in total length (without caudal). Head about 3 to 3½ times in total length (without caudal). Eye 2¼ to 3 times in head. Teeth on premaxilla and maxilla small, on mandible very slightly larger and somewhat variable in size. Preopercular spines two, one directed downwards and the other backwards and outwards. Abdominal ridge ending in a long backwardly directed serrated spine, with a small spur-like spine above it. D. 7–8 A. 11. Adipose dorsal present. Photophores as in *A. Olfersi*, the Caudals separated from the Anals by an interval greater than the length of the latter group.

Upper part of head and abdominal region dark sepia; remainder of abdominal region of body and head silvery. Caudal region of body colourless and semi-transparent except for a dark band at base of caudal fin and a dark patch (sometimes with silvery pigment) above anal fin. In smaller examples the silvery pigment is less developed and the colourless area comparatively larger.

Attains a length of about 50 mm. (2 in.) including caudal fin. The female is mature at a length of 40 mm. (Fage, 1910).

The larvae of *Argyropelecus* have already been described and figured by Lo Bianco (1903), ourselves (1904), Brauer (1906), and Fage (1910). Larvae between 5 and 6 mm. long, figured by Brauer, already show signs of the demarcation between the abdominal and caudal regions of the body, which is so characteristic of the adult, and have a single conspicuous photophore in the opercular region.

As growth proceeds other photophores appear and the abdominal and caudal portions of the body become more distinct;

as in *Maurolicus* the thoracic photophores appear at a comparatively early stage, and at about the same time the second opercular and the branchiostegal and jugular series become visible, and these are shortly followed by the anal and later by the caudal series, each of which are represented by two or three closely apposed photophores.

At a length of 6·5 to 7 mm. (without caudal fin) all the abovementioned photophores, and sometimes the anterior organs of the lateral series, can be detected. The marginal fin-fold still persists, but the dorsal and anal fin-rays are visible.

Fig. 8.—*Argyropelecus hemigymnus*, young. 8 mm. without caudal fin.

At a length of 8 to 8½ mm. (without caudal fin) the marginal fin-fold has disappeared except above the ventral fins (which are now visible) and the projecting neural spines have made their appearance. The thoracic photophores have attained their full number and one or two of the ventral series are visible; the two anterior laterals only are present and the anals and caudals are still few in number and widely separated from each other and from the developing ventrals. Faint vestiges of silvery pigment can be detected in the opercular region. The abdominal spines are visible but the lower one is not relatively nearly so large as in the adult and shows no sign of any serrated expansion (Fig. 8).

Larvae at this stage are the smallest which we can identify with any reasonable certainty as referable to this species.

At a length of 10 mm. (without caudal) the serrations of the larger abdominal spine are visible, and the characters both of this spine and of the preopercular spine provide a means of identifying the larvae, which are now rapidly attaining the proportions and appearance of the adult.

At a length of about 15 mm. (without caudal) the little fish have practically attained the proportions of the adult.

A. hemigymnus is found in the Mediterranean and the Eastern Atlantic from the Azores to Norway; in the Western Atlantic from the Caribbean Sea to the longitude of Cape May (Goode & Bean, 1895). It also occurs in the Indian Ocean (Brauer, 1906) and Bay of Bengal (Alcock, 1899), while Regan (1908) does not consider *A. Heathi*, Gilbert, from the Sandwich Islands, as specifically distinct.

The larvae taken by H.M.S. *Research* (H. & B., 1907) in the

Bay of Biscay were all taken in nets fished open to the surface from depths which in no case exceeded 250 fathoms.

The *Helga* records are as follows :—

S. R. 193.—△, *ca.* 700 faths.—Five, 9–15 mm.
S. R. 197.—△, *ca.* 700 faths.—Two, 8 mm.
S. R. 212.—Net on trawl, 375–411 faths.—One, 15 mm.
S. R. 231.—M.O.T., 1150 faths.—One, 7·5 mm.
S. R. 270.—M.O.T., *ca.* 350 faths.—Several under 10 mm.
S. R. 272.—M.O.T., *ca.* 400 faths.—Several small and three, 24, 22, and 21 mm.
S. R. 277.—Dredge, 550 faths.—One, 21 mm.
S. R. 321.—Net on trawl, 208–480 faths.—One, 23 mm.
S. R. 328.—Net on trawl, 445–515 faths.—One, 15 mm.
S. R. 337.—M.O.T., 400–450 faths.—One, 9 mm.
S. R. 366.—M.O.T., 400 faths.—Seven, 22 to 30 mm. and four, 8 mm. and under.
S. R. 401.—Net on trawl, 600 faths.—One, 7 mm.
S. R. 488.—△, 350–400 faths.—Two, 9–10 mm.
S. R. 494.—Net on trawl, 550–570 faths.—One, 13 mm.
S. R. 497.—Net on trawl, 775–795 faths.—One, 11 mm.
S. R. 851.—M.O.T., 900 faths.—One, 26 mm.
S. R. 858.—Shrimp trawl, 700 faths.—Two, 23–26 mm.
S. R. 1175.—M.O.T., 400 faths.—One, 17 mm.
S. R. 1237.—M.O.T., 450 faths.—One, 26 mm.

[The lengths are in all cases exclusive of the caudal fin.]

These records appear to indicate that *A. hemigymnus* is a normal denizen of the Irish Atlantic Slope outside the 400 fathom line.

STERNOPTYX DIAPHANA, Hermann.

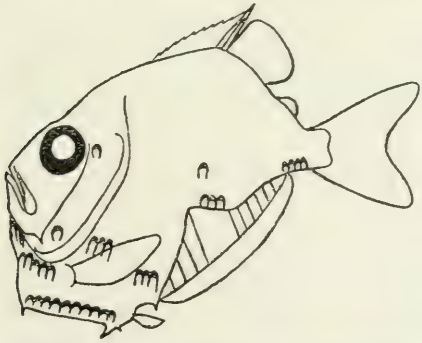

Fig. 9.—*S. diaphana*, about 50 mm. without caudal fin, somewhat diagrammatic.

Greatest depth of body slightly less than total length (without caudal fin) ; length of head about 3 times in total length (without caudal). Eye about twice in head. Premaxilla, maxilla, and mandible with numerous very small teeth. Preopercular spine single and directed downwards. Two spines at posterior

angle of abdomen, a larger pointing downwards and forwards and a smaller pointing downwards and backwards. D. 9–11, A. 13–14. Photophores: Postorbital, 1; Opercular, 1; Branchiostegal, 3; Jugular, 5; Thoracic, 10; Ventral, 3; Anal, 4, the anterior higher than the others; Caudal, 4; the three latter groups widely separated from each other; Lateral, 3.

Colour silvery, upper part of head, dorsum, lower part of body in caudal region, and base of caudal fin sepia.

Attains a length of about 50 mm. (2 ins.). The larvae of this species have been described and figured by Brauer (1906); in general features and development they resemble those of *Argyropelecus*, but the abdominal region is relatively deeper, and the ventral bony plate appears at an early stage.

In habits *S. diaphana* probably resembles *Argyropelecus;* it has on occasion been taken at the actual surface and "possibly it may descend to or beyond the 100 fathom[1] line during the daytime" (Günther, 1887). It has been found in almost all warm seas, but we are not aware of any record from the Mediterranean. In all probability our area is considerably to the north of its normal range, and we are not aware of any other example taken north of 46° N. in the Eastern or about 44° N. in the Western Atlantic (Collett, 1896). The single example taken by the *Helga* was 45 mm. long without caudal and occurred at the very south of the area fished at S. R. 481.—M.O.T., 600–900 faths., soundings, 920–1064 faths.

Fam. *SALMONIDAE.*

BATHYLAGUS EURYOPS, Goode & Bean (1895).

Bathylagus atlanticus, Holt & Byrne (1906) *nec* Günther.

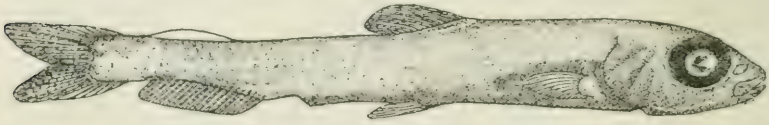

Fig. 10.—*B. euryops*, young, 25 mm. without caudal fin.

The *Helga* collections include a number of specimens of *Bathylagus* measuring from about 18 to 158 mm. These we originally referred to *B. atlanticus*, Günther (1887), a species only known from the South Atlantic type, a damaged specimen measuring 6½ in. (165 mm.) without the caudal fin. Compared with *Helga* examples, it is of rather robust form, but may probably have shrunk considerably in length as a result of preservation in alcohol. In the First Report of this series (1906, Pl. I., figs. 3, 4) we described and figured the largest specimen then in our possession, 54 mm. without caudal fin, and

[1] We suspect that "200 fathom line" would be more accurate. See Murray and Hjort (1912).

in Fig. 10, above, we have depicted one of the smallest, which serves well enough to illustrate the youngest stages known to us.

Our largest specimen, 158 mm. without caudal, is in bad condition, having lost nearly all its skin and much of its fins, but it is clearly considerably more slender in form than the type of *B. atlanticus*, which is not very much longer.

A specimen of 137 mm. is in somewhat better preservation: its measurements are as follows:—

Total length without caudal fin	137 mm
Length of head	31·5 ,,
,, ,, snout	6 ,,
Horizontal diameter of eye	12 ,,
Width between eyes	10 to 7 ,,
,, ,, orbital ridges	8 to 3 ,,
Snout to dorsal fin	60 ,,
,, ,, adipose ,, ...	118·5 ,,
,, ,, ventral ,, ...	69 ,,
,, ,, anal ,, ...	103 ,,
Height of body at insertion of pectoral fins ..	25 ,,
Width ,, ,, ,, ,, ,, ,, ,, ..	11·5 ,,
Height of body at middle of anal fin, including basal ridge of fin	13·5 ,,
Height of caudal peduncle..	8 ,,

The scale formula is illegible, except that six transverse rows cross the lateral line on the part of the body (immediately behind the head) equal to the length of the head. There are 9 rays in the dorsal and 17 (including a minute spine in front) in the anal fin. Günther counted only 13 anal rays in the type of *B. atlanticus*. Our specimen of 54 mm. has 15. In this character, as in the height of body relative to length and to length of head and the position of the dorsal fin, our specimens seem to agree with *B. euryops* rather than with *B. atlanticus*, and the bad condition of the skin in all prevents any valid estimate of scale formula. Goode & Bean's figure shows the head obviously distorted by projection of the hyoid apparatus. The natural shape is probably throughout life much as in our figure in the First Report (1906). Comparing the proportions shown in that figure with the dimensions of the specimen of 137 mm. it appears that as growth proceeds the postanal region becomes shorter relative to the length of the head, and in the position of the anus the specimen last named agrees with the diagnosis of *B. euryops*.

So far as we know 158 mm. ($6\frac{1}{4}$ in.) without caudal fin is the greatest length recorded for the species. The colouration appears to be uniform indigo-black when the skin is perfect. Frayed specimens are mostly grey.

B. euryops is known from the American side of the North Atlantic from specimens taken in open nets at soundings ranging from 600 to over 1,300 fathoms.

On our coast it has occurred, as appears below, in open nets fished at depths of 400 to 900 fathoms ; as most of the captures were made in mid-water nets, its habit would seem to be pelagic.

List of captures by *Helga* :—

S. R. 282.—△, 700 fms.—One, 54 mm.
S. R. 363.—Net on trawl, 695–720 fms.—One, 137 mm.
S. R. 449.—M.O.T., 700 fms.—One.
S. R. 470.—M.O.T., 400–500 fms.—Two, 18 and 106 mm.
S. R. 481.—M.O.T., 600–900 fms.—One, 20 mm.
S. R. 484.—Net on trawl, 602–610 fms.—Two, 18 and 106 mm.
S. R. 489.—Trawl, 720 fms.—One, 158 mm.
S. R. 498.—△, 500–600 fms.—One, 21 mm.
S. R. 589.—M.O.T., 550–600 fms.—One, 20 mm.
S. R. 593.—Net on trawl, 670–770 fms.—Two, 15 and 22 mm.

MICROSTOMA sp.

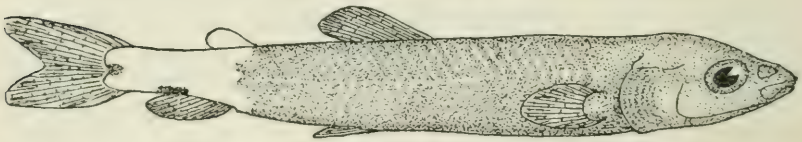

Fig. 11.—*Microstoma* sp., 14·5 mm. without caudal fin.

The occurrence of specimens of *Microstoma,* too small for specific determination, was noticed in the Second Report of this series (1908, p. 53). Figure 11, above, represents a perfect example.

NOTE ADDED IN PRESS.

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These memoirs, which reached us too late for reference in the text, should be consulted as to the larvae of *Stomias* and *Gonostoma.*

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EXPLANATION OF PLATES.

Plate I.

Fig. 1.—*Lamprotoxus flagellibarba.*

Fig. 2.— ,, ,, , to show relative length of barbel.

Plate II.

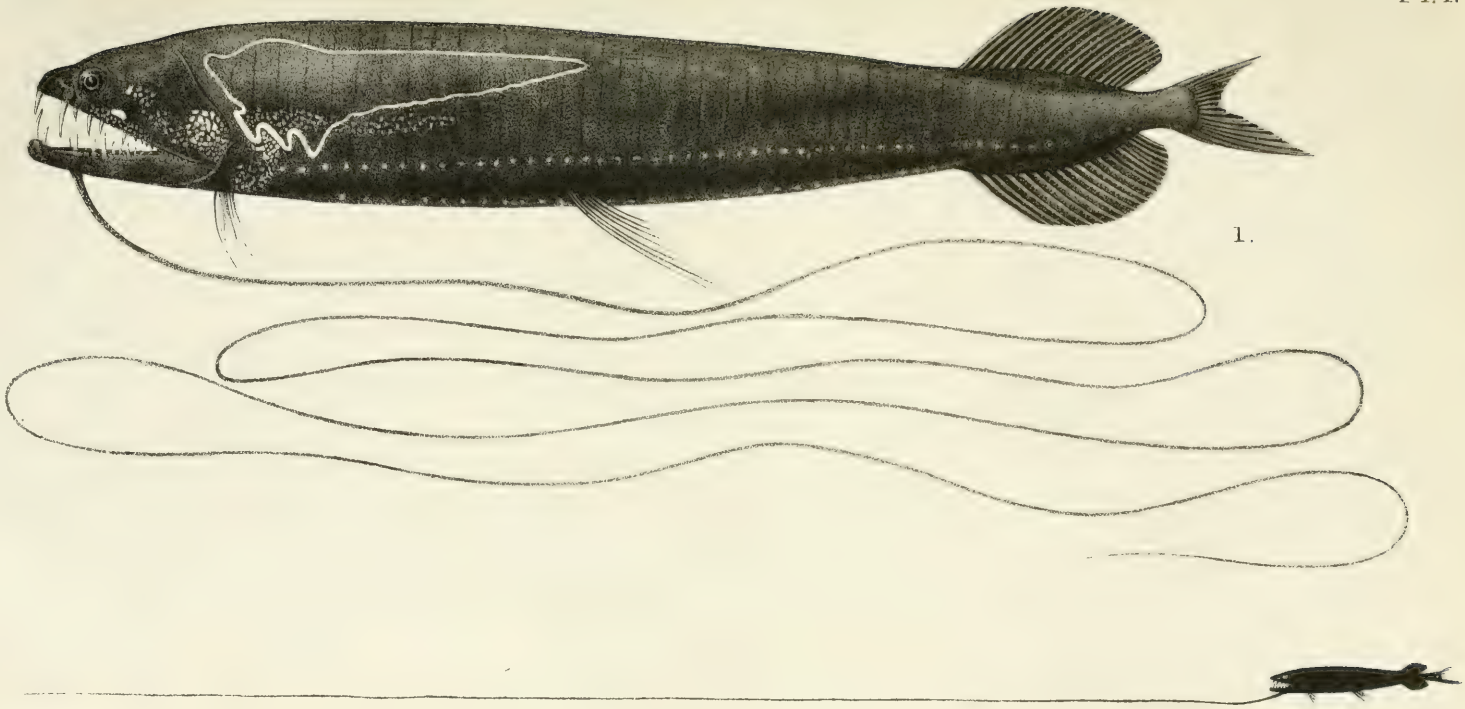
Fig. 1.—*Maurolicus borealis*, 7·5 mm. long without caudal.

Fig. 2.— ,, ,, 9 ,, ,, ,, ,,

Fig. 3.— ,, ,, 11·5 ,, ,, ,, ,,

Fig. 4.—Gonostomatine larva "II.1" (possibly *C. microdon*), *ca.* 8 mm. without caudal.

Fig. 5.—Stomiatid larva "II.3" (possibly *S. boa*), 36 mm. without caudal.



J. Green del. Huth, Lith^r London.

Lamprotoxus flagellibarba.

1.

2.

3.

4.

5.

Huth, Lith. London

Figs. 1 3, Maurolicus borealis.
Fig. 4, Gonostomatine larva "H 1".
Fig. 5, Stomiatid larva "H. 3".

THE LUMINOUS ORGANS OF *LAMPROTOXUS FLAGELLIBARBA.*

BY

C. L. BOULENGER.

Plate I.

Sections cut from a portion of the skin of this fish showed parts of the "looped band" as well as a number of the smaller "grey specks" which are described[1] as sporadically scattered over the fore part of the body. Both kinds of organs present features similar to those described by v. Lendenfeld, Brauer, and other authors as 'luminous' and are most probably light-producing in function.

The sections of the grey specks show these to be luminous organs of a very simple type, without lens or reflectors. They vary somewhat in size and shape; the majority are oval and are sunk into the skin for about half their height. The transparent cuticle of the body is continued over the outer face of the organ to form a cornea-like covering, whilst the embedded surface is backed by a dark pigment-layer continuous with that of the skin.

Each organ is of the nature of a small gland consisting of a small number of relatively large cells of pyramidal shape, arranged radially with their narrower ends meeting in the centre. There seems to be no central cavity. The protoplasm of the cells is filled with granules, the nucleus has an approximately central position.

The grey specks therefore seem to be luminous organs very similar to those described in many of the *Stomiatidae*, e.g., *Idiacanthus fasciola* Pet. (Cf. Brauer, *Die Tiefsee Fische*, II, Wiss. Ergebn. Tiefsee-Exp. Bd. 15, 1908, p. 67, and Pl. XXVI, figs. 18–20.)

The "looped band" situated laterally on the anterior part of the body, although very different in shape, has a histological structure not very unlike that of the smaller organs which I have just described. The organ has the form of a long cord partially embedded in the skin and presenting an oval cross-section. It consists of a layer of tall epithelial cells and, as in the case of the small grey specks, is covered externally by transparent cuticle, internally by the pigment layer of the skin.

The layer of cells is somewhat folded so that when a transverse section is examined the latter do not occupy a perfectly radial position in all parts.

[1] Holt & Byrne, *Fisheries, Ireland, Sci. Invest.*, 1912, *I*, [1912], p. 9.

Each cell is narrow and of considerable height, whilst the basal part contains the nucleus and deep-staining clear protoplasm, the more proximal parts scarcely stain at all and are filled with secretion products. Towards the centre of the organ the cell limits are impossible to make out, and I am unable to say whether the cells meet or whether a small cavity, filled with secretion, is present.

The shape of this organ seems quite peculiar, although its structure resembles that of certain of the luminous organs described by Brauer, e.g., the band shaped organ which occurs below the eye in *Dactylostomias ater*. A. Br. This organ possesses a similar folded epithelium of glandular cells which in this case surround a distinct cavity. (Cf. Brauer, l.c., pl. XXVIII, fig. 5.)

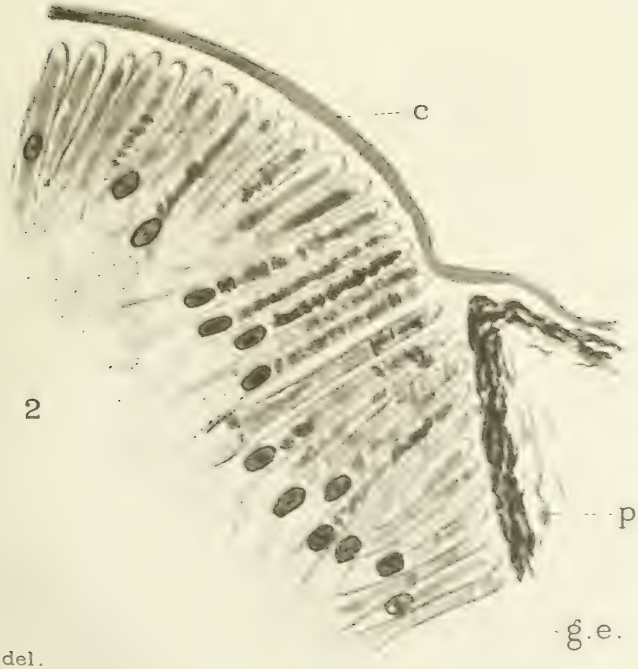
EXPLANATION OF PLATE I.

Fig. 1.—Section of small luminous organ. The cavities at *x* are due to breakage of the section.

Fig. 2.—Part of transverse section of the looped band.

c., Cornea like covering of cuticle.
g.c., Gland cell.
g.e., Glandular epithelium.
p., Pigment layer.

Wt.P.335—S.50. 750. 8/12. B. & N., Ltd.



C.L.B.del.

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Malby&Sons,Lith

Luminous organs of
LAMPROTOXUS FLAGELLIBARBA

GEPHYREA OF THE COASTS OF IRELAND,

BY

R. SOUTHERN, B.Sc.

Plates I—VII.

No attempt has been made in recent times to deal with the British Gephyrea as a whole. Forbes (**6**) describes eight species known in 1841. In 1896, Shipley (**26**, p. 449) enumerates twelve species, of which one—*Golfingia Macintoshi*, Lankester—I regard as synonymous with *Phascolosoma vulgare*, Blv. Two other species, *Aspidosphon Mülleri*, Diesing (= *Phascolosoma radiata*, Alder), and *Onchnesoma squamatum* (Kor. & Dan.) had been previously recorded from the British Area, but were overlooked by Shipley, so that in 1896 the British list included thirteen species. In 1897 Herdman added *Thalassema Lankesteri*. Two species since recorded, viz., *Phascolosoma pellucidum*, Kef. (Shipley **28**, p. 189), and *Phascolosoma teres*, Hutton (**9**, p. 29) are synonymous with *P. elongatum*, Kef.

The collection described in the present paper includes 23 species. All the previously recorded British species have been found except the northern *Phascolosoma eremita*, Sars, and *Echiurus Pallasi*, Guérin, and I do not think that either of these species is likely to be found in Ireland. The latter species was recorded in Thompson's MSS. (**38**, p. 445) from 'the North of Ireland,' but I am very doubtful whether this record can be relied upon.

Of the eleven species here added to the British fauna, all with the exception of a doubtful specimen of *Bonellia viridis*, Rolando, are from deep water. Of these, six have not been previously described.

The number of species belonging to the genus *Phascolosoma* now known from deep water in the North Atlantic is very large, and owing to short and imperfect descriptions, often based on a single specimen, it is becoming increasingly difficult to name specimens with the desirable degree of accuracy. The criteria adopted for specific diagnosis are the presence or absence of hooks and tentacles on the proboscis, papillae on the skin, the number of retractor muscles, the vascular system, and the relative proportions of the body. These structures are frequently of great, but imperfectly known variability, and for this reason I have attached great importance to the study of the structure of the body-wall, as shown in serial sections. It has yielded distinct and apparently constant

specific characters of great importance. For instance, in the two forms of *Phascolosoma mutabile* (p. 19), differing considerably in appearance and in the presence or absence of hooks on the proboscis, specific identity was clearly shown by the structure of the body-wall.

The present collection includes the following species[1]:—

Sipunculoidea.

Sipunculus nudus, L.
Sipunculus norvegicus, Kor. & Dan.
Physcosoma granulatum, Leuckart.
Physcosoma abyssorum, sp. n.
Phascolosoma vulgare, Blainville.
Phascolosoma elongatum, Kef.
Phascolosoma rugosum, sp. n.
Phascolosoma mutabile, sp. n.
Phascolosoma muricaudatum, sp. n.
Phascolosoma bulbosum, sp. n.
Phascolosoma procerum, Mobius.
Phascolosoma constrictum, sp. n.
Phascolosoma abyssorum, Kor. & Dan.
Phascolosoma Johnstoni (Forbes).
Phascolion strombi (Montagu).
Aspidosiphon Mülleri, Diesing.
Onchnesoma Steenstrupi, Kor. & Dan.
Onchnesoma squamatum (Kor. & Dan.).

Echiuroidea.

Echiurus abyssalis, Skorikow.
Thalassema Lankesteri, Herdman.
Thalassema Neptuni, Gaertner.
? *Bonellia viridis*, Rolando.

Priapuloidea.

Priapulus caudatus (Lamarck).

Geographical Distribution.

One of the most interesting facts which the present study has brought to light is the presence of a species of *Physcosoma* in deep water in the Atlantic. The centre of radiation of this genus is supposed to be near the Malay Archipelago, where the largest number of species is found, and they are now characteristic members of the tropical shallow-water faunas. Selenka (**24**, p. 2), commenting on the presence of *Physcosoma granulatum* in the Mediterranean, says that it probably found its way there from the Red Sea. However, as it is now known from the Azores, France, Norway, and the west and north

[1] See complete list, including synonyms, on p. 41.

coasts of Ireland, this contention has lost its force. Moreover, it cannot be a species having a rapid power of dispersal, or how are we to explain the remarkable fact of its absence from the south-west coast of England, where its present distribution would lead us to expect to find it. Six other species of this genus are known from the Atlantic, but four of them also occur in the Pacific, and the other two are in the West Indian Islands. Of the six Atlantic species, five are present in the West Indian Islands, thus indicating their affinity with the Pacific fauna, and they probably passed to their present homes during a geologically recent submergence of the Central American region. The discovery of a species living in 700 fathoms off the coast of Ireland, a species which has very distinctive characters, though undoubtedly belonging to this genus, is, however, strongly against the theory of recent radiation from the Pacific. The members of this genus seem to have a strong preference for a habitat rich in lime. *Physcosoma granulatum*, the commonest Gephyrean on the west coast of Ireland, is especially abundant in limestone regions, or in *Lithothamnion*, whilst the new deep-sea species was found associated with the coral *Lophohelia prolifera*. It seems to me most probable that the genus is old, and of world-wide distribution, and that conditions of life in the coral islands of the tropical Pacific have been favourable to a secondary outburst of specific evolution. It is obvious that a high temperature is not essential for this genus, as the new species from 700 fathoms was living in water at a temperature, probably quite uniform throughout the year, of 7·19° C. The minimum temperature endured by *Physcosoma granulatum* on our west and north coasts must be often lower than this in the winter.

The range of *Echiurus abyssalis*, Skorikow, previously known from three specimens found in the Mediterranean, has now been extended to the Atlantic. One hundred and eighty specimens of this species are included in the present collection.

The remaining species in the collection are such as might be expected to occur in the British area, though in some cases their range has been considerably extended. Besides the new species described, the following 5 species are added to the British fauna :—

Sipunculus norvegicus, Kor. & Dan.
Phascolosoma abyssorum, Kor. & Dan.
Onchnesoma Steenstrupi, Kor. & Dan.
Echiurus abyssalis, Skor.
? *Bonellia viridis*, Rolando.

Bathymetrical Distribution.

In the following notes, I am dealing only with facts elucidated by the study of the present collection of Irish specimens. Some former records of shallow water forms from great depths need verification in the light of our present ideas of specific values.

Bathymetrical Range of the Irish Gephyrea.

	Physcosoma granulatum.	Phascolosoma vulgare.	Phascolosoma elongatum.	Thalassema Neptuni.	Priapulus caudatus.	Phascolion strombi.	Phascolosoma procerum.	Sipunculus nudus.	Thalassema Lankesteri.	Bonellia viridis.	Phascolosoma Johnstoni.
High-water Mark ..	.	.	.	.	.	.	.	.	.	.	.
	.	.	.	.	.	.	.	.	.	.	.
	×	×	×	×	.	.	.	.	.	.	×
Low-water Mark ..	×	×	×	×	×	.	.	.	.	.	×
	¦	×	×	×	¦	×	.	.	.	.	¦
	¦	×	×	×	¦	×	×	.	.	.	¦
	¦	×	×	×	¦	×	×	.	×	.	×
10 fathoms.. ..	¦	×	×	×	¦	×	¦	.	¦	.	¦
	×	¦	×	×	¦	×	×	.	¦	.	¦
	¦	¦	¦	×	×	×	¦	¦	¦	.	¦
	¦	¦	¦	×	.	×	×	¦	¦	.	¦
20 fathoms.. ..	¦	¦	¦	×	.	×	¦	×	¦	.	¦
	×	¦	¦	×	.	×	¦	¦	×	.	¦
	¦	¦	¦	.	.	×	¦	¦	.	.	¦
	.	¦	¦	.	.	¦	¦	.	.	.	¦
30 fathoms.. ..	.	¦	×	.	.	¦	¦	.	.	.	¦
	.	¦	¦	.	.	¦	¦	.	.	.	¦
	.	×	×	.	.	¦	×	.	.	×	¦
	.	×	¦	.	.	¦	¦	.	.	.	×
50 fathoms.. ..	.	×	¦	.	.	×	¦	.	.	.	¦
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100 fathoms.. ..	.	.	.	.	.	¦	.	.	.	.	×
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200 fathoms.. ..	.	.	.	.	.	.	.	.	.	.	¦
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300 fathoms.. ..	.	.	.	.	.	.	.	.	.	.	¦
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400 fathoms.. ..	.	.	.	.	.	.	.	.	.	.	×
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500 fathoms.. ..	.	.	.	.	.	.	.	.	.	.	×
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700 fathoms.. ..	.	.	.	.	.	.	.	.	.	.	¦
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800 fathoms.. ..	.	.	.	.	.	.	.	.	.	.	.
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	.	.	.	.	.	.	.	.	.	.	.
900 fathoms.. ..	.	.	.	.	.	.	.	.	.	.	.

Bathymetrical Range of the Irish Gephyrea.

	Aspidosiphon Müllerí.	Echiurus abyssalis	Onchnesoma Steenstrupi.	Onchnesoma squamatum.	Phascolosoma muricaudatum.	Phascolosoma abyssorum.	Sipunculus norvegicus.	Phascolosoma mutabile.	Phascolosoma bulbosum.	Phascolosoma rugosum.	Phascolosoma constrictum.	Physcosoma abyssorum.
High-water Mark	·	·	·	·	·	·	·	·	·	·	·	·
	·	·	·	·	·	·	·	·	·	·	·	·
Low-water Mark	·	·	·	·	·	·	·	·	·	·	·	·
	·	·	·	·	·	·	·	·	·	·	·	·
	·	·	·	·	·	·	·	·	·	·	·	·
10 fathoms ..	·	·	·	·	·	·	·	·	·	·	·	·
	×	·	·	·	·	·	·	·	·	·	·	·
20 fathoms ..	ǀ	·	·	·	·	·	·	·	·	·	·	·
	ǀ	·	·	·	·	·	·	·	·	·	·	·
	ǀ	·	·	·	·	·	·	·	·	·	·	·
30 fathoms ..	ǀ	·	·	·	·	·	·	·	·	·	·	·
	ǀ	·	·	·	·	·	·	·	·	·	·	·
	ǀ	·	·	·	·	·	·	·	·	·	·	·
50 fathoms ..	ǀ	·	·	·	·	·	·	·	·	·	·	·
	ǀ	·	·	·	·	·	·	·	·	·	·	·
	×	·	·	·	·	·	·	·	·	·	·	·
75 fathoms ..	ǀ	·	·	·	·	·	·	·	·	·	·	·
	×	·	·	·	·	·	·	·	·	·	·	·
	ǀ	·	·	·	·	·	·	·	·	·	·	·
100 fathoms ..	×	·	·	·	·	·	·	·	·	·	·	·
	ǀ	·	·	·	·	·	·	·	·	·	·	·
	×	·	·	·	·	·	·	·	·	·	·	·
200 fathoms ..	×	·	·	·	·	·	·	·	·	·	·	·
	ǀ	·	·	·	·	·	·	·	·	·	·	·
	×	ǀ	·	·	·	·	·	·	·	·	·	·
	×	ǀ	·	·	·	·	·	·	·	·	·	·
300 fathoms ..	ǀ	ǀ	·	·	ǀ	·	·	·	·	·	·	·
	×	×	·	·	ǀ	·	·	·	·	·	·	·
	ǀ	ǀ	×	×	ǀ	·	·	·	·	·	·	·
	×	ǀ	ǀ	ǀ	ǀ	·	·	·	·	·	·	·
400 fathoms ..	ǀ	×	ǀ	ǀ	×	·	·	·	·	·	·	·
	×	ǀ	ǀ	ǀ	×	×	·	·	·	·	·	·
	ǀ	ǀ	ǀ	ǀ	ǀ	·	·	·	·	·	·	·
	ǀ	ǀ	ǀ	ǀ	ǀ	·	·	·	·	·	·	·
	×	×	×	×	×	·	×	·	·	·	·	·
500 fathoms ..	·	×	×	×	×	·	×	·	·	·	·	·
	·	×	·	ǀ	ǀ	·	ǀ	×	ǀ	·	·	·
	·	ǀ	·	ǀ	ǀ	·	ǀ	ǀ	ǀ	·	·	·
	·	ǀ	·	×	×	·	×	ǀ	×	·	·	·
600 fathoms ..	·	×	·	ǀ	ǀ	·	·	ǀ	ǀ	·	·	·
	·	ǀ	·	·	·	·	·	ǀ	·	ǀ	·	·
	·	×	·	·	·	·	·	ǀ	·	×	ǀ	ǀ
700 fathoms ..	·	×	·	·	·	·	·	ǀ	·	ǀ	ǀ	ǀ
	·	·	·	·	·	·	·	ǀ	·	ǀ	×	×
	·	·	·	·	·	·	·	ǀ	·	·	ǀ	ǀ
	·	·	·	·	·	·	·	×	·	·	·	·
800 fathoms ..	·	·	·	·	·	·	·	ǀ	·	·	·	·
	·	·	·	·	·	·	·	ǀ	·	·	·	·
	·	·	·	·	·	·	·	ǀ	·	·	·	·
900 fathoms ..	·	·	·	·	·	·	·	ǀ	·	·	·	·

The table on pp. 4 and 5 shows at a glance the bathymetrical range in Irish waters of all the species I have examined. The depths at which specimens have been obtained are indicated by crosses. In cases where the depth at the beginning differed considerably from that at the end of the haul, as frequently happens when dredging or trawling in deep water, the cross indicates the mean of the two figures, and the possible extremes at which the specimens may have been captured are indicated by vertical lines.

The species obviously fall into two groups. The first group ranges from the littoral region down to about 100 fathoms, becoming rarer as this limit is reached. The second group appears at about 300 fathoms and ranges down to unknown depths. The first or shallow water group is definitely associated with the sea-weed zone, and the varied nature of the sea-floor in proximity to the coast. In the area investigated, the bed of the sea in the zone from 100 to 300 fathoms is almost exclusively formed of clean sand, poor in species and individuals. This stretch of sand forms an effective barrier between the two faunas. It seems probable that depth is in itself a factor of only secondary importance, the range of species being determined chiefly by the nature of the sea-bottom. There is no evidence that bathymetrical range is influenced by such factors as the temperature and salinity of the sea-water, at any rate within the limits of their variation in the area investigated.

Below 300 fathoms, the sea-floor changes, and once more supplies a favourable habitat for a diversified fauna. Deposits of mud and ooze predominate, whilst widespread associations of corals and sponges afford shelter and a solid foundation for a large number of species, which here attain the upper limit of their range.

A comparison of the number of specimens obtained, with the number of hauls of the trawl and dredge, indicates that the Gephyrean fauna, in the depths between 400 and 700 fathoms, is at least quite as rich in numbers as that found in shallow waters, and probably much richer in species.

The two species having the greatest amplitude, and passing from the shallow region to deep water, are *Phascolosoma Johnstoni* (*Petalostoma minutum*, Kef.) ranging from mid-tide mark down to 720 fathoms, and *Aspidosiphon Mülleri*, from 13 to 450 fathoms. In the sandy zone, these two species live in Gasteropod shells or in crevices of limestone, a habit specially fitting them for a wide bathymetrical range. It is also of interest to note that these two species are extremely variable, and have given rise to great confusion and numerous synonyms.

Six species have been found between tide-marks, though none of them are confined to this region. Two of these, *Physcosoma granulatum* and *Thalassema Neptuni* are absent from the east coast, but are very common and characteristic members of the fauna of the western littoral.

Faunistic Notes.

It is only possible to classify very roughly the various types of habitat occupied by the Gephyrea, since they do not appear to be so sensitive to their immediate surroundings as some other groups are. Beginning with the region between tide-marks, one finds that Gephyrea are almost completely absent from the extensive stretches of clean sand. At the base of rocks, or near masses of *Sabellaria alveolata*, a few specimens of *Phascolosoma vulgare* may be found in the sand. If, however, there is any admixture of mud or coarse gravel, *P. vulgare*, *P. elongatum*, and *P. Johnstoni* are frequent. In shelly sand and gravel, *P. elongatum* occurs. In the sand of *Zostera* beds *P. elongatum* often occurs in vast numbers, accompanied by *P. vulgare* and occasionally by *Priapulus caudatus*, if there is an admixture of mud.

Under stones on a rocky shore, one finds *P. vulgare*, *P. elongatum*, *P. Johnstoni*, and *Physcosoma granulatum*. By breaking open pieces of limestone or schist, *Thalassema Neptuni* and *Physcosoma granulatum* are generally found on the west coast. These species, together with *P. vulgare* and *P. Johnstoni* are abundant in the massive growths of *Lithothamnion*. *P. Johnstoni* is common in the roots of *Laminaria*, at low water.

In the partially submerged peat at Valencia Harbour, *Thalassema Neptuni* is very common. Small specimens of *P. elongatum* may be found in the sand-binding seaweeds which occasionally cover the rocks.

Dredging over fine sand yields very poor results, an occasional specimen of *P. procerum* being the only capture. On this type of ground, however, shells and pieces of limestone are frequently occupied by *Thalassema Neptuni*, *Phascolion strombi*, *Aspidosiphon Müllerí*, and *P. Johnstoni*. Shallow-water deposits of mud yield *P. vulgare*, *P. elongatum*, *P. procerum*, and *Thalassema Lankesteri*. Below 300 fathoms, there is generally a zone of muddy sand, passing downwards into ooze, both formations containing a large proportion of tests of *Foraminifera*. In these deposits, a large number of species flourish, including the following :—

P. muricaudatum
P. rugosum
P. mutabile
Onchnesoma squamatum
Echiurus abyssalis.
P. bulbosum
P. constrictum
Sipunculus norvegicus
Onchnesoma Steenstrupi.

The two species *Physcosoma abyssorun* and *Aspidosiphon Mülleri* were found associated with the coral *Lophohelia prolifera* in deep water.

Several specimens of *P. constrictum* were found hiding between the sponge *Pheronema* and *Ascidia tritonis*, large specimens of the latter being firmly attached to the sponge.

A specimen of *Physcosoma granulatum* was found living inside the sponge *Clione celata*.

I am greatly indebted for the loan of specimens to the Rev. Canon Norman, the Directors of the Museums at Bergen, Stockholm, Berlin, Hamburg, Paris, Monaco, and the Stazione Zoologica, Naples. Professor Sluiter, Dr. Hutton and Mr. Arnold Watson have also assisted me with advice or material.

The present collection, including the type-specimens, will be placed in the Irish National Museum.

No attempt has been made in the Systematic Part to give the full synonymy of the species described. Several references have been given to standard works, so as to fix the identity of the species.

The numbers in Clarendon type refer to the List of References on p. 42.

SIPUNCULOIDEA.

Sipunculus nudus, L.

1884. Selenka, **25**, p. 92.
1896. Shipley, **26**, p. 412.

A single specimen was taken in Galway Bay. It was 140 mm. long.

Distribution.—English Channel, North Sea, France, Florida, Mediterranean, Adriatic, Red Sea, Indian Ocean, Philippines, Bismarck Archipelago, Japan. This species was taken by the "Porcupine" in 1869 in 1263 fms., south of the Rockall Bank.

Locality.—A. 122—5 VI '05. Galway Bay, soundings 12–25 fms. Temperature at 25 fms., 12·3° C. Beam trawl, 12–25 fms.—One specimen.

Sipunculus norvegicus, Koren and Danielssen.

Pl. V, fig. 7.

1877. *S.n.* + *S. priapuloides*, Koren and Danielssen, **13**, p. 123 and 126.
1883. *Phallosoma n.* + *P.p.*, Levinsen, **17**, p. 268.
1896. *S.p.*, Roule, **21**, p. 473.
1899. *S.p.*, Shipley, **27**, p. 158.
1900. *S.n.*, Sluiter, **30**, p. 17.
1905. *S.n.* + *S.p.*, Théel, **34**, p. 52 and 54.
1906. *P.p.*, Roule, **22**, p. 65.

The 15 specimens of this species included in the collection vary from 12–83 mm. in length. They are very transparent, especially the smaller ones. The characteristic ridge which separates the smooth 'glans' at the posterior end of the body is well marked in the larger forms, but in the small ones it is indistinct or absent. The longitudinal muscles are in 22–23

bands. The retractor muscles are attached to only one or two of the longitudinal bands.

On the rectum the two racemose glands and the spherical diverticulum are quite easily seen. (Pl. V, fig. 7, b.)

The spindle muscle in front is connected by several roots to the same longitudinal strand of the body-wall to which the rectum is attached. It runs along the rectum and is connected with it by numerous delicate muscular fibres. The rectum is expanded near the anus, and just below the swollen part are attached two very slender muscle fibres which are fixed at their other ends to the bases of the two dorsal retractor muscles. The two racemose glands envelop these muscles where they join the rectum. Behind these glands there is a small spherical diverticulum on the rectum. The relation of these structures is plainly shown in fig. 7. The intestine is attached to the body-wall by numerous muscle fibres. One specimen, taken in November, had several eggs in the body-cavity. They are large and spherical, ·45 mm. in diameter, with thick, finely reticulate walls.

I am inclined to agree with Théel (**34**, p. 56) and Roule (**22**, p. 95) in uniting the two species of Koren and Danielssen. The characters given by these observers as distinguishing the two forms are either non-existent or of doubtful diagnostic value. The chief characters which distinguish *S. priapuloides* from *S. norvegicus* are the greater size, the furrow on the ventral face of the 'glans' together with the interruption of the annular fold separating the 'glans' from the trunk, and the presence of a small diverticulum and a pair of racemose glands on the rectum. As regards the latter character, I have found that the diverticulum and glands are present in all the specimens which I have examined. The structure of the 'glans' is very variable. The ventral groove is certainly not due to bad preservation, as Théel suggests, since it is more clearly seen in the best preserved specimens. The annular fold is very inconspicuous or absent in small individuals, and sometimes, when present, is entire and not accompanied by any ventral groove. These structures seem to develop as the animal approaches maturity, and I am of the opinion that *S. norvegicus* represents an immature stage of *S. priapuloides*. It is unfortunate that the former name has priority, as it is somewhat misleading. Moreover, fully developed specimens agree much better with the original description of *S. priapuloides*. These cannot, however, be considered sufficient reasons for disregarding the law of priority, as Roule (**22**, p. 95) has done. He used the name *Phallosoma priapuloides* as being the most appropriate, although his specimen agreed with *S. norvegicus*, in having a smooth 'glans' and uninterrupted annular fold. The diverticulum on the rectum was absent, but the two racemose glands were seen. He maintained that the two species were synonymous. Sluiter (**30**, Pl. I, fig. 7) figures a specimen under the name *S. norvegicus*, showing the

distinct groove on the 'glans' and an interrupted annular fold characteristic of *S. priapuloides.*

Distribution.—North Atlantic, in deep water; Loyalty Islands (Shipley).

Localities.—

S. R. 172—5 XI '04., 52° 2′ N., 12° 8′ W., soundings 454 fms., fine mud. Dredge.—One specimen.

S. R. 502—11 IX '07. 50° 46′ N., 11° 21′ W., soundings 447–515 fms. Temperature at 500 fms., 8·8° C., salinity, 35·37 °/₀₀. Sprat net on trawl, 447–515 fms. —One specimen.

S. R. 752—17 V '09. 51° 48′ N., 12° 11′ 30″ W., soundings 523–595 fms., ooze. Temperature at 500 fms., 8·9° C., salinity 35·43°/₀₀. Midwater-trawl, 523–595 fms.—Thirteen specimens.

Physcosoma granulatum (Leuckart).

1828. *Phascolosoma granulatum*, Leuckart, **16**, p. 22.
1840. *Sipunculus papillosus*, Thompson, **37**, p. 101.
1841. *Syrinx papillosus*, Forbes, **6**, p. 247.
1845. ? *Syrinx granulosus*, McCoy, **18**, p. 272.
1877. *Phascolosoma Lovénii*, Koren and Danielssen, **13**, p. 128.
1884. *Phymosoma granulatum* + *P. Lovénii*, Selenka, **25**, p. 57 and 79.
1905. *Physcosoma Lovénii*, Théel, **34**, p. 50.
Non *Phascolosoma papillosum*, Koren and Danielssen (**13**, p. 138), Sluiter (**30**, p. 19), or Théel (**34**, p. 60).

This is the most characteristic littoral Gephyrean of the west coast of Ireland. It is very abundant under stones, in crevices of the rocks, and in *Lithothamnion.* It has not been found in the Irish Sea, but ranges along the whole west coast from Valencia Harbour on the south to Portstewart on the north coast of Co. Derry, where I found it in 1910 in large numbers. It has a characteristic Lusitanian distribution though it appears not to have been recorded from the south-west coast of England nor the west of Scotland. On the Norwegian coast a single specimen of this species was found by Koren and Danielssen at Bergen Fiord, at a depth of 50 fathoms, and named by them *Phascolosoma Lovénii.* According to Théel (**34**, p. 50), who has re-examined this specimen, the original description erred in several important points, such as the absence of hooks on the proboscis. Théel says: "The idea is not altogether precluded, that a closer examination may prove that the animal in question is identical with another form of *Physcosoma* already known, e.g., the *P. granulatum* of Leuckart, which seems to have a very wide distribution in the Mediterranean and the Atlantic." A close comparison of *P. granulatum* with the description of *P. Lovénii* fails to yield any differences of specific

value. There is a general agreement in the internal anatomy, and in the structure of the skin, with its papillae and hooks.

This species seems almost confined to the region between tide marks, and only on two occasions was it taken below low-water mark (W.68, in 19–25½ fms., and W.204, in 11 fms.). The former specimen was a young one, 15 mm. long when expanded, and the longitudinal muscles of the body-wall appeared to form a continuous sheath, and were not collected into distinct bands. This is probably a juvenile character, as it also occurred in other small specimens. One specimen was found (M.L. XVIII) which had only two retractor muscles. Mature females, with the body cavity full of eggs, were found in October and November.

Théel refers the *Phascolosoma papillosum* of Koren and Danielssen to *P. vulgare*, Blv., apparently with good reason. He also considers the species of that name described by Thompson and Forbes (tom. cit.) from the west coast of Ireland as consisting of old and deeply coloured specimens of P. *vulgare*. After considering the description of these writers, and the distribution of their species on the west and north coasts of Ireland, I am convinced that they were dealing with specimens of *Physcosoma granulatum*, which is by far the commonest littoral Gephyrean from that district. Moreover, Thompson and Forbes were well acquainted with the appearance of *P. vulgare* (their *Syrinx Harveii*). This contention is supported by the fact that specimens in the British Museum, labelled *Phascolosoma papillosum*, belong to *Physcosoma granulatum*.

The *Phascolosoma papillosum*, Thompson, of Sluiter (**30**, p. 19) is *P. vulgare*.

The *Syrinx granulosus*, described by McCoy (**18**, p. 272), from Roundstone, on the west coast of Ireland, may be either *Physcosoma granulatum* or *Phascolosoma vulgare*, Blv.

Distribution.—West coast of Ireland, Norway, France (Roscoff, Morgat), Azores, Mediterranean, Adriatic, Zanzibar ?

Localities.—

Valencia Hbr., common. Ballyvaughan and Milltown Malbay, Co. Clare. Shores of Galway Bay (A. 87 ; A. 99 ; A. 103 ; Arran Islands, A. 120). Dogs Bay, Roundstone, in *Lithothamnion*.

Ballinakill Harbour (M.L. XVIII ; L 297 ; L. 326).

Clare Island, in *Lithothamnion*. Dorinish Isd., Clew Bay.

W. 68—22 v '09. Clew Bay. Beam trawl, 19–25½ fms.—One small specimen.

W. 204—20 VIII '11. Clew Bay. Dredge, 11 fms.—One specimen in sponge *Clione celata*.

Blacksod Bay, shores of Mullet ; very common, found on 17 occasions.

Broadhaven Bay, one specimen. Doonecry and Inishmurray, Co. Sligo. Portstewart, Co. Derry, common.

Physcosoma abyssorum, sp. n.

Plates I and II, fig. 1.

All previously described species of this genus have been found either in the littoral region or in comparatively shallow water The deepest records do not go below about 50 fathoms. A single specimen of a new species of this genus was taken in 627–728 fathoms off the south-west of Ireland. The temperature of the water ranged from 8·22° C. at 600 fms., to 7·19° C. at 700 fms. The members of the genus *Physcosoma*, which has its headquarters near the Malay Archipelago, are usually confined to shallow warm water. *P. granulatum*, Leuckart, which is found in the north of Ireland and in the Bergen Fiord (as *P Lovénii*) is obviously able to endure a winter temperature very little above freezing point, but its summer temperature is considerably above that which *P. abyssorum* has to endure permanently. The present species, like so many others of the genus, was found in association with coral (*Lophohelia prolifera*) and it is probable that it, or other species of the genus, will be found in the coral associations in shallower water, which will link it bathymetrically to the other members of the genus.

The single specimen (Pl. I, fig. 1A) is greyish brown in colour. The trunk is cylindrical, tapering gradually towards the proboscis, whilst the posterior end is rounded. The total length of the body is 47 mm. The length of the trunk is 19 mm., of the proboscis 28 mm., of which a portion 9 mm. long is invaginated. The skin is very thick, and transversely wrinkled, and is covered with large and conspicuous papillae. The base of the proboscis is darker than the rest of the body, more wrinkled, and with more numerous papillae. Towards the tip of the proboscis the papillae decrease in size. On the mid-body they are paler in colour, and more scattered. On the tail, the papillae (Fig. 1C) are large and almost hemispherical, embedded in rugose layers of dark rust-coloured granules. They are composed of large gland cells which converge to the tip of the papilla, where the common pore is surrounded by a ring of granules. If the cuticle is stripped off, the ectoderm can be plainly seen as a delicate layer of flat cells lying on the circular muscles (Fig. 1K). In this layer are embedded numerous large oval unicellular glands (Fig. 1D, a, fig. 1K, a) arranged in a regular manner. The tentacular disc, which is invaginated and difficult to examine, bears about 25 tentacles of various sizes. Beneath the disc is a smooth region, bounded below by a fold or collar. The proboscis bears 21 regular rows of hooks. The anterior and posterior rows are not so complete as those in the middle. The hooks are triangular, with long curved sharp points (Pl. II, figs. 1H, 1J). The upper corner of the base is rounded into a knob shaped process. At the lower corner of the base there are several granules. Alternating with the rows of hooks are rows of glands (Fig. 1H, a). These are deeply embedded in the

skin and are granular in appearance. A duct passes from them to the surface of the cuticle, where it appears like a circle or oval, containing 2–4 granules disposed in a ring. On the proboscis the skin is very rugose, having transverse wrinkles of fine rust-coloured granules alternating with rows of glands.

A longitudinal section of the body-wall on a level with the anus is shown in Fig. 1D. The total thickness varies from ·45–·6 mm. The muscular layer is from ·175–·215 mm. thick, so that the greater half of the body-wall is formed by the cuticle. The latter has an outer layer which takes the stain deeply, and probably consists of hardened mucus. Beneath the cuticle is the ectoderm, a single layer of flattened cells (Fig. 1D, b, Fig. 1K), amongst which are seen a number of large unicellular gland cells (a). The layer of longitudinal muscles is twice as thick as the layer of circular muscles. The skin is bounded internally by a peritoneal epithelium (Fig. 1D, f).

The large papillae are seated with a broad base on the circular muscles (Fig. 1D) and are enveloped in a fold of the ectoderm. The gland cells forming the papilla are large and elongated, with more or less granular contents. They open into a small cavity near the tip of the papilla.

The grouping of the longitudinal muscles into separate strands which is so characteristic of this genus is not very well marked in this species, and is concealed by the thick and shining peritoneal epithelium. When the latter is stripped off, the muscles are seen to be collected into about 18 longitudinal strands, which are most evident near the posterior end. In the proboscideal region, they form an almost continuous layer.

The intestine (Fig. 1B) forms about 30 loops. Its wall is transparent and has about 14 longitudinal rows formed by masses of glandular cells (Fig. 1E). These rows have a wavy outline, and frequently anastomose. There is no diverticulum on the rectum. A thick spindle muscle is present, which is attached to the body-wall at the posterior end, and in front of the intestine (Fig. 1B, a, Fig. 1G, a). The rectum is firmly attached by spreading sheets and strands of muscles.

The retractor muscles of this species are of considerable interest. Apparently only two are present, as in *Physcosoma Rüppellii* (Grube), *P. Weldoni*, Shipley, and many species of *Phascolosoma*, etc. In these cases it is always stated that the two retractors are the ventral pair. An examination of the present species shows, however, that in the oesophageal region two pairs of muscles are present (Fig. 1F., and that each muscle posteriorly is formed by the union of a dorsal and ventral retractor on each side. The two muscles are attached posteriorly to the body-wall rather behind the mid-line between the anus and the tail. Each muscle is attached to two of the longitudinal strands of the body-wall. In the oesophageal region the ventral muscles are considerably thicker than the dorsal ones. Just before the intestine emerges from the muscles, the dorsal and ventral muscles of each side fuse to form a single strand, which

afterwards shows no sign of its double origin, even where it joins the body-wall except that it is attached to two longitudinal strands.

There is a large pair of eyes on the brain. The vascular system (Fig. 1F, a) is very reduced and shows as a slender yellow vessel on the dorsal side of the oesophagus.

There is a single pair of nephridia, of a deep rust colour. The basal portion is inflated, and attached by muscle-fibres to the body-wall. The distal portion is slender, and quite free. The internal opening is surrounded by a folded membrane. The external openings are situated in front of the anus.

There are no structures in this species which can be definitely correlated with its environment in deep water. The reduction of the retractor muscles to a single pair, and the simplicity of the vascular system, are on the whole, however, more frequent in deep water species than in those from shallow water.

Locality.—

S. R. 504—12 IX '07. 50° 42′ N., 11° 18′ W. Temperature at 600 fms., 8·22° C., salinity 35·53°/$_{00}$; at 700 fms., 7·19° C. Beam trawl, 627–728 fms.—One specimen, with coral.

Phascolosoma vulgare, Blainville.

1841. *Syrinx Harveii*, Forbes, **6**, p. 249.
1845. ? *Syrinx granulosus*, McCoy, **18**, p. 272.
1877. *Phascolosoma papillosum*, Thompson, Koren and Danielssen, **13**, p. 138.
1885. *Golfingia McIntoshi*, Lankester, **15**, p. 469.
1892. *Phascolosoma Sanderi*, Collin, **4**, p. 177.
1900. *Phascolosoma papillosum*, Thompson, Sluiter, **30**, p. 19.
1905. *P. vulgare* + *P. papillosum*, Théel, **34**, p. 60.

This species is commonly distributed all round Ireland, ranging from the middle littoral region down to 60 fathoms. Young specimens, and those from deep water, are frequently very transparent. There is great variation in the size of this species, the largest attaining a length of 150 mm., whilst a female specimen from Tralee, with the body cavity full of eggs had a trunk only 9 mm. long. A specimen dregded in 60 fms. (S. R. 1153), 27 mm. long, had a very transparent skin. The proximal hooks were very small, whilst those at the tip of the proboscis were unusually large.

This species is frequently to be found in the lower half of the littoral zone, in the sand of zostera beds, and in sand and gravel with a certain admixture of mud. It is also frequently dredged in mud.

Sexually mature specimens were found in April.

This species presents such wide diversity in its external appearance that it is not surprising to find a long list of synonyms. It was first recorded from the British Isles by Forbes (**6**, p. 249)

as *Syrinx Harveii*. In 1885, Lankester (**15**, p. 469) described a specimen dredged in 10 fathoms in St. Andrew's Bay, for which he created a new genus *Golfingia*. From a consideration of the text and figures, I have no doubt that the specimen is only a strongly contracted form of *Phascolosoma vulgare*. The corneous rings surrounding the base of the proboscis and on the tail, are always present in this species in a more or less developed condition, as may be seen in many of the published figures (Forbes, **6**, p. 249; Théel, **35**, Pl. I, fig. 1). I have examined several specimens closely resembling in this respect the figures given by Lankester. The so-called pinnate tentacles are formed either by the unequal contraction or the unequal growth of the tentacular disc and crown, which causes it to be thrown into folds. In all other characters, such as the structure of the skin, hooks, and internal organs, *Golfingia* corresponds closely with *P. vulgare*. The 'corneous spike' on the tail, is merely the contracted posterior part of the body-wall. The type of *Golfingia* is now in the Natural History Museum, London, where I had the opportunity of examining it. Unfortunately it is in a very fragmentary condition, but, so far as I could see, it showed no differences from certain forms of *P. vulgare*. The systematic position of *Golfingia elongata*, Verrill (**39**, p. 670), is only vaguely defined by the brief description of the author. It might possibly be a species of *Aspidosiphon*.

The *Phascolosoma Sanderi* described by Collin (**4**, p. 177) also appears to be the form of *P. vulgare* with similar well-developed corneous areas at the base of the proboscis and on the tail. The types of this species were kindly submitted to me by the Director of the Berlin Museum, and they showed no differences of importance from typical specimens of *P. vulgare*.

Théel has shown (**34**, p. 62) that the *P. papillosum*, Thompson, of Koren and Danielssen (**13**, p. 138) is really *P. vulgare*, and Sluiter tells me (in lit.) that the specimens he named *P. papillosum*, Thompson (**30** p. 19), also belong to this species.

The *Syrinx granulosus* of McCoy (**18**, p. 272) is most probably this species, though it may possibly be *Physcosoma granulatum*, Leuck.

Distribution.—British Isles; European shores of the Atlantic; Greenland; Azores; Mediterranean; Red Sea; Singapore

Localities.—

Killary Harbour, 15 fms., 12 VII '90. R.D.S. Exp. St. 73.
Lough Swilly, 1900. Off Bray Head, Co. Wicklow.
Bofin, CLXXXIII—11 VIII '00—One specimen.
Bofin, CCXXXIV—9 X '00. Sh. coll.—Two large specimens.
M.L. VIII—5 II '01, Ballinakill Hbr., Sh. coll.—One specimen.
M.L. LIIa—22 VII '01, Ballinakill Hbr., Dredge, 1½–2 fms.—One specimen.

On oysters from Tralee, 6 IV '03—One small specimen.
L. 283—19 I '04, Ballinakill Hbr., Sh. coll.—Two specimens.
L. 326—1 IV '04, Ballinakill Hbr., Sh. coll.—Six specimens.
A. 120—20 V '05, Aran Is., Sh. coll.—Two specimens.
S. 363—20 II '06, 18½ miles S.W. by W. of Isle of Man; Beam trawl, 35–36 fms., in mud.—One specimen.
R. 30—17 VIII '06, 9½ miles S.E. by S. of Mine Head; Sand grab, 39 fms.—One specimen.
S. 553—16 VIII '07, 10 miles E. of Bailey Lt.; Trawl, 41–52 fms.—Two specimens.
S. 597—6 II '11, off Co. Wexford; Dredge, 7½–8 fms. Common in old oyster shells and masses of *Sabellaria spinulosa*.
S. R. 1153—13 V '11. 30 miles S. of Co. Cork; Dredge, 60 fms.—One specimen in sandy mud.
Annagh Is., Westport Bay, 19 VIII '09., Sh. Coll.—Three specimens.
W. 108—25 VIII '09. Clew Bay; Dredge, 4 fms.—One specimen.
W. 146—16 VIII '10. Inishlyre Roads, Clew Bay; Dredge, 2–4 fms.—One specimen, in corallines.
Blacksod Bay, shores of Mullet. Collected on nine occasions, 1909–1911.
W. 248—3 III '12. Lough Swilly.—Three specimens in coarse sand.
W. 263—23 VIII '12. Valencia Harbour, off Cable station. Dredge, 2½–4½ fms., mud.—One specimen.

Phascolosoma elongatum, Keferstein.

1845. *Syrinx Forbesii* + *S. tenuicinctus*, McCoy, **18**, p. 273.
1853. *Sipunculus punctatissimus*, Gosse, **7**, p. 125.
1900. *Phascolosoma pellucidum*, Kef. Shipley, **28**, p. 189.
1903. *P. teres*, Hutton, **9**, p. 29.
1905. *P. e.*, Théel, **34**, p. 62.

In certain places this species occurs in very large numbers. It is especially abundant in the sand of zostera beds, where it is the characteristic Gephyrean. It is also frequent in muddy sand. There are very few records of this species on the east coast of Ireland.

In 1900, Shipley (**28**, p. 189) recorded *Phascolosoma pellucidum*, Kef., as occurring abundantly in zostera beds. A number of the specimens were sent to me by Dr. Allen. They are typical examples of *Phascolosoma elongatum*, Kef.

In 1903, Dr. Hutton (**9**, p. 29) described a new species, *Phascolosoma teres*, from two specimens dredged in 60 fathoms in the Firth of Clyde. These specimens have been placed at my disposal for examination by Dr. Hutton. They appear to be small and strongly contracted specimens of *P. elongatum*.

They agree with the latter species in having (1) no papillae, but only flat glands on the skin, (2) a similar number of tentacles, about 15, (3) hooks of a similar structure and arrangement on the proboscis, (4) four retractor muscles. Hutton says that the right nephridium is much larger than the left one. In the specimen I examined, the difference between the two nephridia is small, and probably due to unequal contraction. The sharply delimited posterior portion of the body and the arrangement of the intestine are also characters produced by the intense contraction of the circular muscles of the body-wall. I have examined numerous specimens of *P. elongatum* showing a similar condition, and it is very common in individuals of this species which are killed quickly.

The two species *Syrinx Forbesii* and *S. tenuicinctus* described by McCoy (**18**, p. 273) from the west coast of Ireland, almost certainly belong to this species. They have both smooth cylindrical bodies, without papillae. I have examined specimens in the British Museum, labelled '*Phascolosoma tenuicinctus*,' and they undoubtedly are referable to *P. elongatum*. The *Phascolosoma Forbesi* of Baird was referred to this species by Selenka (**25**, p. 24) after examination of a specimen in the British Museum. He expresses doubts whether McCoy's species belong to *P. elongatum* or *P. vulgare*, but the absence of papillae points to *P. elongatum*. There seems to be nothing to distinguish the *Sipunculus punctatissimus*, Gosse (**7**, p. 125), from this species.

This species ranges in Irish waters, from the littoral region down to about 60 fathoms.

Distribution.—This species has a somewhat restricted range. It has been recorded from the British Isles, Sweden, North Sea, north and west coasts of France, and the Mediterranean.

Localities.—

Roundstone, 7 VI '90.—One specimen.

Mulroy Bay.—Four specimens.

A. 17—28 VI '04. Galway Bay. Dredge, 1–1½ fms.—Two specimens.

R. 30—17 VIII '06. 9½ miles S.E. by S. of Mine Head. S. Grab, 37½–39 fms.—One specimen.

R. 31—17 VIII '06. 6 miles S.E.S. of Mine Head. S. Grab, 29 fms.—Two specimens.

W. 147—16 VIII '10. Inishlyre Roads, Clew Bay. Dredge, 5 fms., in mud.—Two specimens.

S. 594—6 IX '10. Dundrum Bay. Shrimp trawl, 10¾–12 fms., in sand and shells.—One specimen.

W. 175—16 II '11. Valencia Hbr. shore collecting in sand of zostera bed.—Very common.

S. R. 1153—13 V '11. 30 miles S. of Co. Cork; Dredge, 60 fms., in sandy mud.—Two specimens.

Blacksod Bay, shores of Mullet. Collected on 8 occasions, 1909–1911.

W. 256—6 III '12. Lough Swilly, shore collecting.—Four specimens in sand-binding seaweeds.

W. 263—23 VIII '12. Valencia Harbour, off Cable station. Dredge, $2\frac{1}{2}$–$4\frac{1}{2}$ fms., mud.—One specimen.

Phascolosoma rugosum, sp. n.

Plate II, fig. 2.

Two specimens of this new species were obtained. The description is drawn up from the larger and earlier one (S. R. 331), and afterwards those points are noted in which the second specimen differs.

The proboscis is invaginated for a distance of 2 mm., and its total length from the anus to the tentacular crown is 8·5 mm. From the anus to the posterior extremity is only 5 mm., giving a total length of 13·5 mm. The backward position of the anus and the breadth of the proboscis are very characteristic. The body is rounded behind (Fig. 2A), somewhat rectangular in outline behind the anus. In front of the latter, it gradually grows narrower, but the width of the proboscis still remains about $\frac{1}{3}$ of that of the trunk. The colour of the animal in life, and also after being in spirit, is a very light grey, and the delicate transverse and longitudinal ridges and furrows of the cuticle give it a rugose appearance, hence the specific name.

The papillae on the skin are inconspicuous and not very numerous. They arise from a large oval base which lies on the outer muscular layer of the body-wall (Figs. 2C, D, E). They vary considerably in shape, as shown by the figures. The long slender ones are especially numerous on the tip of the tail, but they also occur sparsely on the trunk (Fig. 2D). In sections of the body-wall (Fig. 2E) the papillae are seen to be flask shaped. The papillae near the tip of the proboscis are of quite a different appearance (Fig. 2C). They seem to terminate distally in a flat disc which shows concentric striations.

Behind the tentacles the proboscis is studded with a number of small hooks, which are not arranged in rows. These hooks are curved, with broad bases and sharp points (Fig. 2C). They decrease in size from the front backwards. Papillae are scattered amongst the hooks. The proboscis is retracted, and the tentacles can only be seen with difficulty. They are about 12 in number.

There are four slender retractor muscles (Fig. 2B). The dorsal pair are attached just behind the anus, the ventral pair about half way between the anus and the tail. The intestine is free behind. It forms an irregular spiral consisting of 13–16 loops. The end of the rectum is enveloped in a meshwork of muscular fibres. No vascular system could be seen.

The two nephridia open to the exterior in front of the anus.

In transverse section the body-wall is very thin (Fig. 2E), varying from ·035–·060 mm. The muscular layer is only ·015–·020 mm. thick. The cuticle is about $2\frac{1}{2}$ times as thick as the

muscular layer. Under the cuticle can be distinctly seen the epidermal layer, the nuclei of which stain deeply. The longitudinal muscular layer is thicker than the circular layer, and is bounded internally by the delicate peritoneal epithelium. The papillae are flash-shaped, with flat bases, and the neck projects beyond the cuticle.

The second specimen obtained (S. R. 1004) is rather smaller, and the skin is a little darker, otherwise it resembles the first specimen in appearance. The papillae of the skin are a little longer and more bulbous. The hooks on the proboscis are more numerous, larger, and with sharper points. The internal structure agrees closely with that of the first specimen.

This species belongs to the '*vulgare*' group, characterised by the possession of four retractor muscles, hooks on the proboscis, and papillae on the skin. It is distinguished from all other species by the structure of the skin and papillae, the general aspect and shape of the body, the posterior position of the anus, etc.

Localities.—

S. R. 331—9 v '06. 51° 12′ N., 11° 55′ W. Mosquito-net on trawl, 610–680 fms., ooze.—One specimen.

S. R. 1004—12 VIII '10. 51° 22′ 30″ N., 11° 44′ 30″ W., soundings 641–636 fms., fine sand and coral. Temperature at 630 fms., 7·12° C., salinity 35·46°/₀₀. Beam trawl, 641–636 fms.—One specimen.

Phascolosoma mutabile, sp. n.

Plate III, fig. 4.

Four specimens of this species were found at two stations in deep water, off the south-west coast of Ireland. As they differ in several respects, it will be preferable to describe them separately.

The type-specimen (S. R. 335) is broadly fusiform in outline (Fig. 4A), with bluntly rounded posterior end. The trunk merges gradually into the proboscis. The total length is 43 mm., of which the proboscis comprises 20 mm. The skin is thick and opaque, covered with fine wrinkles, and the cuticle is deeply coloured with dark brown pigment. The anal and nephridial pores are plainly indicated by pale areas. Papillae are scattered over the whole skin, but, except on the tail, they are short and almost spherical (Fig. 4C), and are only visible under high magnification. They are most numerous at the posterior end, where they are 4–6 times as long as broad. Some distance behind the tentacular crown there is a narrow band of scattered and inconspicuous hooks (Fig. 4E). They are narrow, pointed, and deeply grooved in front view. There are only about 80 of them altogether.

The tentacles are well developed, about 52 in number. As the disc in the type-specimen is invaginated and difficult to see,

the figure and description of the tentacles are drawn from one of the other specimens (see below).

Fig. 4G shows a longitudinal section of the body-wall from the posterior end of the body. The cuticle is nearly twice as thick as the muscular layer. Its outer rugose layer is thick, and full of dark granules of pigment. The internal layer of longitudinal muscles is only a little thicker than the external circular muscles. The glands are flask-shaped, with rounded bases and long slender necks, which project well beyond the cuticle.

The inner surface of the body-wall has a pearly lustre. The intestine (Fig. 4B) is slender, consisting of about 24 closely wound loops. It is free behind. The rectum has no diverticulum and is covered near its terminus with a flat sheet of muscle. It is also attached to the body-wall by a long slender muscle which has two roots. Two other slender muscles originate from the middle of the intestine and are attached to the two ventral retractor muscles. These are shown in Fig. 4B. A few other slender strands of muscle connect the intestine to the body-wall and ventral retractors.

There are four retractor muscles of approximately equal thickness. The anterior pair are attached to the body-wall at about a quarter of the distance from the anus to the posterior end. The ventral pair are attached about half-way between the dorsal pair and the posterior end. The space between the two pairs of retractors is much greater than in *P. vulgare*. The two nephridia are attached to the body-wall only near their external openings, which are situated some distance in front of the anus.

The three other specimens obtained from an adjacent locality (S. R. 334) differ from the type, and agree with each other in several points, so that it is probable that they represent the typical condition. The skin is pearly grey in colour, and not pigmented. The closest search failed to reveal any hooks on the proboscis. The absence of hooks in these specimens cannot be held as a character of specific value, when one considers how few they are in the type.

Sections of the skin reveal exactly the same structure as shown in Fig. 4G, whilst the internal anatomy is in close agreement. These specimens agree with *P. margaritaceum* (Sars), in having four retractor muscles, no hooks, and well-developed tentacles, but differ markedly in the structure of the body-wall. For comparison, I give a figure of a longitudinal section of the skin from the posterior end of the body of a specimen of *P. margaritaceum* from Greenland (Pl. II, fig. 3). It will be seen that the proportion of the various layers in the body-wall, and the structure of the papillae, are quite different.

One of the specimens from station S. R. 334 had its tentacles fully expanded (Fig. 4F). The structure of the tentacular disc agrees closely with one of the figures given by Théel for *P. margaritaceum* (Théel, **34**, Pl. XIV, fig. 194). There are about

54 tentacles of various sizes. Beneath the tentacular crown is a smooth area, below which is a prominent fold, or collar.

This species belongs to the '*vulgare*' group. It resembles *P. profundum*, Roule, in many points, but differs in having more numerous and better developed tentacles, in the structure of the body-wall, the disposition of the retractor muscles, etc. It differs from *P. approximatum*, Roule, in the two latter characters. It is distinguished from *P. rugosum* (p. 18) by the structure of the papillae, the thicker body-wall, the thicker and shorter retractors, and the more numerous tentacles.

Localities.—

S. R. 334—10 v '06. 51° 35′ 30″ N., 12° 26′ W. Temperature at 500 fms., 9·2° C. Beam trawl, 500–520 fms.—Three specimens.

S. R. 335—12 v '06. 51° 15′ N., 12° 17′ W. Temperature at 700 fms., 6·84° C. Sprat net on trawl, 893–673 fms.—One specimen.

Phascolosoma muricaudatum, sp. n.

Plate IV, fig. 5.

This species might easily be mistaken at first sight for *Phascolosoma flagriferum*, Selenka, which it resembles in having a filiform tail. A closer examination shows, however, that it has no real affinity with that species, from which it differs in having four retractor muscles instead of two.

The present species is represented by 56 specimens of various sizes. The largest specimen is 48 mm. long, the proboscis being 16 mm., and the trunk 32 mm., of which the filiform tail comprises 6 mm. The small, fully-expanded specimen figured (Fig. 5A) is 21 mm. long, the proboscis being 8 mm., the trunk and tail 13 mm., and the tail alone 4 mm. There is thus considerable variation in the relative proportions. The body is cylindrical, passing anteriorly gradually into the proboscis, posteriorly abruptly into the slender tail. In most of the specimens the skin is pale brown in colour, very thin and transparent, except when strongly contracted. It is delicately wrinkled, and a low magnification shows that it is regularly dotted with small glands. At the base of the tail the skin is thicker, more wrinkled, and the papillae are placed on small hemispherical projections (Fig. 5B) caused by the contraction of the skin in this region. In a few cases the skin is grey and opaque, and much more wrinkled, but this is probably due to the specimens being preserved in spirit, the transparent ones being in formalin. The tail is covered with slender papillae (Fig. 5B, C). The large flat papillae on the base of the tail, so marked in *Phascolosoma flagriferum*, are quite absent. The tail varies considerably in length, but is always abruptly separated from the trunk, and must be considered as of the nature of an appendage, since the nerve-cord does not penetrate into it. Its

function is probably sensory. In small and immature specimens, the proboscis just behind the tentacles is dotted with powerful hooks, not arranged in any definite order. In several fully grown animals, the hooks are quite absent, thus adding another instance to prove the unreliability of this character as a specific criterion. Mingled with the hooks are papillae of quite a different appearance to those found elsewhere on the body. Fig. 5E shows the appearance of these papillae and hooks in a contracted specimen. The skin is divided into irregular oval areas, each corresponding to a single gland, from which rises a low, rounded papilla. In Fig. 5F they are shown in side view. The hooks project from between these papillae. Fig 5D shows part of the tip of the proboscis of the fully-expanded specimen shown in Fig. 5A. The end of the proboscis is dilated and transparent. The hooks are sharply pointed, with the lateral edges infolded, and of a common type. The papillae are seen in outline as broadly cylindrical. Beneath the zone of hooks, the papillae change completely, and are now seen to be slender, with bulbous tips. Further behind, they become quite cylindrical, and have the same appearance in all other parts of the body (Fig. 5G, a, b, c). They are from two to six times as long as broad.

The small fully-expanded specimen (Fig. 5A) had twelve slender tentacles. Adult specimens have 25–30 well-formed tentacles.

A longitudinal section of the skin is shown in Fig. 5J. The cuticular layer is comparatively thin, being about equal to the layer of circular muscles, whilst the layer of longitudinal muscles is considerably thicker. The cells composing the glands have large deeply staining nuclei. The glands are roughly flask-shaped.

The intestine (Fig. 5H) is formed of about 30 closely coiled loops. A single delicate strand of muscle attaches its anterior part to the body-wall. There is a large spindle muscle which is attached in front by numerous strands round the anus, but is quite free behind.

No trace of a vascular system could be seen.

There are four retractor muscles. The dorsal pair are much thinner than the ventral pair, and are attached just behind the level of the anus, though in some specimens they extend further back. There is considerable variation in this character. The ventral pair of muscles are attached in front of the middle line between the anus and the base of the tail.

The nephridia are small, and are attached to the body-wall in front of the anus.

Ripe eggs were found in the body cavity of many of the specimens.

This species is clearly distinguished from all forms having four retractor muscles by the filiform tail. Another very distinctive character is the appearance of the papillae on the tip of the proboscis.

Localities.—

S. R. 164—3 XI '04. 52° 6′ N., 12° 0½′ W., soundings 375 fms., mud and sand. Temperature at 320–350 fms., 9·78° C. Dredge, 375 fms.—Two specimens.

S. R. 172—5 XI '04. 52° 2′ N., 12° 8′ W. Townet on dredge, 454 fms.—One specimen.

S. R. 353—6 VIII '06. 50° 38′ N., 11° 32′ W., soundings 250–542 fms., mud and sand. Temperature at 500 fms., 8·58° C. Mosquito net on trawl, 250–542 fms.—One specimen.

S. R. 590—3 VIII '08. 51° 51′ 30″ N., 12° 8′ W., soundings 480 fms., ooze. Temperature at 480 fms., 9·28° C. Midwater trawl, 480 fms.—Four specimens.

S. R. 752—17 V '09. 51° 48′ N., 12° 11′ 30″ W., soundings 523–595 fms., ooze. Temperature at 500 fms., 8·9° C. Midwater trawl, 523–595 fms.—Fifty specimens.

Phascolosoma bulbosum, sp. n.

Plate V, fig. 6.

Eight specimens of this new species were taken in the same haul with fifty specimens of *Phascolosoma muricaudatum* sp. n., a species with which they have a superficial resemblance. The peculiarity of shape from which it derives its specific name is common to all the specimens. The anterior portion of the trunk is thin-walled, often transparent, and swollen. Behind, it passes into a long slender thick-walled tail. This latter portion, however, is really a slender portion of the trunk, and not an appendage in the same sense as is the tail of *P. muricaudatum.* This is evident from the fact that the nerve-cord traverses it to the tip (Fig. 6D), whilst in *P. muricaudatum* it does not enter the tail. It is probable that the bulbous character of the anterior part of the trunk is not a specific character, but is due to unequal expansion. The filiform nature of the posterior portion of the trunk, is, however, characteristically shown by all the specimens, and is probably the normal condition. No papillae are visible to the naked eye.

The skin is buff-coloured, often rusty red in places. It is very delicately marked with granular wrinkles. The largest specimen had a total length of 55 mm., of which the trunk forms 43 mm., and the proboscis 12 mm. No hooks could be found on the proboscis, either in large or small specimens. The papillae on the proboscis (Fig. 6B) are small and few in number. On the body and tail they are numerous, but small (Fig. 6C), cylindrical in shape, 2–6 times as long as thick, and surrounded by a delicate granular ridge.

Fig. 6E shows a longitudinal section of the skin from near the base of the tail, where it is strongly contracted. The two muscular layers are approximately equal in thickness, and the

cuticle is also thick, and deeply ridged. The glands are small and flask-shaped, resembling those of *P. mutabile* (Pl. III, Fig. 4G), from which species, however, it is quite distinct.

The tentacles are moderately long, 16–18 in number.

The intestine (Fig. 6D) is comparatively short, composed of about 20 loops. There is a powerful spindle-muscle (b), which divides into numerous fibres round the rectum. It is not attached behind. In addition there are three delicate muscular strands (a) passing from the intestine near the rectum to the muscles joining the oesophagus to the retractors.

There are two slender retractor muscles, to which the oesophagus is attached throughout the greater part of its length. They join the body-wall behind, midway between the anus and the posterior end. At their bases are seen the genital festoons. No trace of a vascular system could be seen. The nerve-cord passes to the extreme tip of the tail, showing that the latter is only the attenuated posterior portion of the trunk.

The two nephridia are long and slender, and their openings are distinctly visible in front of the anus.

This species is closely related to *P. flagriferum*, Selenka. It differs in having no large papillae on the base of the tail, in the position of the retractors, and in the tail being only the attenuated posterior portion of the body.

It also agrees closely with *P. Catharinae*, Müller, but differs in shape, in having fewer tentacles, and in the absence of a vascular system.

Locality.—

S. R. 752—17 v '09. 51° 48′ N., 12° 11′ 30″ W., soundings 523–595 fms., ooze. Temperature at 500 fms., 8·9° C. Midwater trawl, 523–595 fms.—Eight specimens.

Phascolosoma procerum, Mobius.

1905. *P. p.*, Théel, **34**, p. 70.

This species, which has not previously been recorded from Irish waters, has only been found in small numbers, and is comparatively rare. This is possibly because of its restriction to a definite habitat. It has generally only been found in mud, or in muddy sand. The proboscis, when fully extended, greatly exceeds the trunk in length. One small specimen, 10 mm. in total length, had a proboscis measuring 7·7 mm.

It ranges from low-water mark down to about 100 fathoms.

Distribution.—North Sea, West Coast of Sweden, Kattegat, West Coast of Norway. This is a very typical Celtic distribution.

Localities—

Donegal Bay, 1896.

A. 81—13 IX '04. Galway Bay Dredge, 12 fms.—One specimen.

W. 21—22 XI '04. Galway Bay. Soundings 16½ fms., muddy sand. Temperature at bottom 12° C. Dredge. —One specimen.

W. 108.—25 VIII '09. Clew Bay. Dredge, 4 fms.—Six specimens.

W. 147—16 VIII '10. Inishlyre Roads, Clew Bay. Dredge, 5 fms., in mud.—One specimen.

S. R. 1153—13 V '11. 30 miles S. of Co. Cork. Dredge, 60 fms., sandy mud.—One specimen.

W. 225—22 VIII '11. Killary Harbour. Dredge, 17½ fms., soft mud—Six specimens.

W. 226—22 VIII '11. Killary Harbour. Dredge, 7 fms., soft mud.—Four specimens.

S. R. 1254—9 XI '11. 30 miles E. of Carlingford, Irish Sea. Townet on bottom, 40 fms., soft mud.—One specimen, 4 mm. long.

W. 259—19 VIII '12. Off the coast of Kerry. Soundings 78 fms., sand. Dredge—One specimen.

Phascolosoma constrictum, sp. n.

Plates VI and VII, fig. 10.

Four specimens of this species were taken altogether, on two different occasions, in deep water off the south-west of Ireland. The description is from the first specimen obtained (S. R. 363).

The proboscis is not fully everted, though the hooks are visible at the tip. The body is about 35 mm. long, of which the proboscis comprises 8 mm. The division between the trunk and proboscis is shown externally and internally by a deep constriction, behind which is the anal aperture (Pl. VI, fig. 10A). This constriction is present in all the specimens, and seems to be a specific character. The trunk is widest in its posterior third. In front of this, it gradually attenuates, whilst behind it is rapidly rounded off to a terminal papilla. The colour of the cuticle is pale grey, through which shines the deep flesh colour of the muscle layers. The papillae on the skin are of a translucent amber colour. The proboscis and anterior region of the trunk are somewhat rugose, and the papillae are concealed by the ridges on the cuticle. The posterior region is roughly marked out into rectilinear areas by irregular folds of the cuticle. The body is thickly dotted with large papillae, except in the anterior region. They vary greatly in shape and size in different regions of the body. They are largest on the mid-body, where they are shaped like a button, with a rounded papilla in the middle of the upper surface (Figs. 10 C, G, H). On the proboscis the papillae are all narrow and cylindrical (Fig. 10F). Below the anus they are still cylindrical, but are gradually getting stouter and flatter, in some cases with a swelling in the middle, but no stalk.

Towards the middle of the body the stalk appears, and gradually elongates. These papillae resemble saucers, with inverted cups standing in them. Near the tail, the papillae increase in length and diminish in width, till finally, on the pointed tail, they are long and cylindrical, resembling those found on the proboscis. On all parts of the body small papillae are mixed with the large ones. Fig. 10 H shows in schematic outline the various forms of papillae.

The hooks on the proboscis are in about 12 very ill-defined rows, mixed with papillae, which have globular heads and short stalks (Fig. 10J). The hooks are irregularly conical, with sharp or blunt points, and incurved bases. The skin between them is very granular.

The body-wall is fairly stout in the proboscis and anterior region of the body, but behind, it is thin and transparent, especially on the dorsal side of the mid-body. The tentacles are invaginated, and so contracted that it is not possible to see them clearly in this specimen. The tentacular fold bears a number of short thick lobes crowded together in an irregular manner.

The intestine (Fig. 10B) is twisted in a complex spiral composed of about 16 irregular loops. The end of the rectum is swollen and covered with transverse muscle fibres. A few delicate muscular strands connect the intestine to the body-wall, and the intestinal loops are bound together by fibres, but no spindle muscle is present.

No vascular system could be seen.

Two retractor muscles are present, and are attached to the body-wall mid-way between the anus and the tail. Two delicate sac-like nephridia are present, opening to the exterior just behind the anal aperture. In the great majority of species of the genus *Phascolosoma*, the nephridia open in front of the anus. Other exceptions to this rule are *P. sabellariae*, Théel, *P. improvisum*, Théel, and *P. reconditum*, Sluiter.

The nerve cord terminates in a series of slender branches some distance from the posterior end of the body.

Fig. 10G shows a longitudinal section of the skin taken from near the middle of the body. The longitudinal muscular layer is about twice as thick as the circular layer, and is composed of broad fibres. The cuticle is thick and finely striated, with a dark granular external layer. The papillae consist of a slender core, composed of cells with large nuclei, which stain deeply. Round the distal part of the core is a button-shaped mass of a cuticular nature. The central core is based on the circular muscles, and is enveloped in the epidermal layer, which is very distinct.

Three other specimens of this species were obtained, whilst examining a number of specimens of *Ascidia tritonis*, which were attached to the sponge *Pheronema*. They were partly embedded in the test of the Ascidian in the area of attachment, together with a large number of Polychaetes.

These three specimens are smaller than the one already described, but resemble it in general appearance. The large papillae are, however, concentrated in the posterior third of the body. The internal anatomy is very similar, with the exception that the retractor muscles are attached to the body-wall further back, in the posterior third. One of the specimens, 18 mm. long, has the body cavity full of eggs.

This species belongs to the '*abyssorum* group' characterised by the reduced tentacles and vascular system, and by having two retractor muscles. It is easily distinguished from all other species by the structure of the papillae.

Localities.—

S. R. 363—10 VIII '06. 51° 22′ N., 12° 0′ W. Temperature at 600 fms., 7·92° C. Trawl, 695–720 fms., ooze. —One specimen.

S. R. 500—11 IX '07. 50° 52′ N., 11° 26′ W. Temperature, at 600 fms., 8·22° C. Trawl, 625–666 fms.—Three specimens.

Phascolosoma abyssorum, Koren and Danielssen.

1905. *P. a.*, Théel, **34**, p. 78.

A single specimen, which I refer with some hesitation to this species, was dredged in 388 fathoms. Its body was smooth, transparent, and cylindrical, in shape like that of a small specimen of *P. elongatum*. No papillae could be found on the skin. The total length was 19 mm., of which the proboscis measured 9 mm. Round the mouth were 14–16 slender and fairly long tentacles. There are two free nephridia of a brick-red colour. The two retractor muscles, separate for the greater part of their length, are attached to the body-wall about midway between the anus and the tail. The glands of the skin closely resemble those figured by Théel (tom. cit.), as do the hooks on the proboscis, though the latter are few in number, and some of them are more pointed in side view. From this description it will be seen that the specimen resembles *P. abyssorum* in having a smooth, semi-transparent cylindrical body, with glands in the skin, but no papillae; in having two well-separated retractor muscles, and in having hooks on the proboscis. The chief differences are slight, such as the possession of fewer and longer tentacles, fewer rows of hooks, absence of generative products, and these may be due to the immaturity of the specimen. In the present state of our knowledge, it is better to leave the specimen under this species for the present.

Distribution.—West Coast of Norway (200–300 fms). Spitzbergen.

Locality.—S. R. 151—27 VIII '04. 54° 17′ N., 11° 33′ W. Temperature at bottom 9·15° C. Dredge, 388 fms., stone and rock.—One specimen.

Phascolosoma Johnstoni (Forbes).

Plate V, fig. 9.

1841. *Sipunculus Johnstoni*, Forbes, **6**, p. 254.
1862. *Phascolosoma minutum*, Keferstein, **11**, p. 40.
1865. *Petalostoma minutum*, Keferstein, **12**, p. 438.
1884. *Petalostoma minutum*, Selenka, **25**, p. 129.
1905. *Phascolosoma sabellariae*, n. sp. + *P. improvisum*, n. sp., Théel, **34**, p. 81.
1908. *Petalostoma minutum*, Kef., Southern, **32**, p. 171.
1909. *Petalostoma minutum*, Kef., Paul, **20**, p. 1.
1911. *Phascolosoma minutum*, Kef., Théel, **36**, p. 31.
1912. *Phascolosoma minutum*, Kef., Sluiter, **31**, p. 10.

This diminutive species seems to be common round the Irish coast, as I have found it wherever I have looked closely. It lives under stones and in crevices of the rocks between tide marks, amongst the tubes of *Sabellaria alveolata* (L.), and is very common in Laminaria roots. A number of small specimens dredged in deep water, down to about 700 fathoms, are also indistinguishable from the common littoral form. Sluiter (**31**, p. 10) records the species from 950 fathoms. Two specimens from deep water (S. R. 590) were found living in the test of a Foraminiferon (*Saccamina sphaerica*, Sars) composed of large quartz grains. The proboscis of one specimen protruded from the mouth of the test; the other specimen was contracted altogether within the test (Figs. 9A, 9B).

This species is extremely variable and has given rise to much confusion, as the list of synonyms given above will show. I regret that the rule of priority compels me to discard the well-known name of *Phascolosoma minutum*, Kef., in favour of that first given to the species by Forbes. In 1841, Forbes (**6**, p. 254) described under the name *Sipunculus Johnstoni*, a species found by Dr. Johnston at Berwick. The latter wrote to Forbes as follows: "It is not uncommon sometimes at the roots of corallines, lurking in the sand, the colour of which it resembles. It is rarely, I should think, half an inch long, contracts and lengthens itself, as is usual with the tribe, draws in the anterior end, and extends it as a snail doth its horns, *and when it is fully extended there is an appearance of two minute papillae at the orifice*." The latter character proves almost beyond doubt that Dr. Johnston was examining the species since called *Petalostoma minutum*. The latter has been recorded from the neighbouring coast of Scarborough by Watson, who kindly sent me examples. The description of Forbes is illustrated by a drawing made by Mrs. Johnston, in which the animal appears with a bunch of well-developed, but imaginary, tentacles.

The littoral specimens of this species usually do not have hooks on the proboscis. However, occasionally the hooks are present, and I recently obtained large numbers of specimens in Laminaria roots from Howth, Co. Dublin, all of which had

hooks on the proboscis. All the specimens from deep water were provided with hooks. The papillae on the skin are also variable, those specimens from deep water having larger and longer papillae than the littoral forms. However, the extreme forms are joined by a complete series of intermediate stages, and it is impossible to distinguish more than a single species.

Théel has recently recorded *Phacolosoma minutum* from the Falkland Islands, so that the species has a bipolar distribution.

The specimens from deep water are usually found in small Gasteropod shells, or in tests of Foraminifera.

Distribution.—British Isles (Plymouth, Scarborough, Dublin Bay), West Coast of Sweden, Norway, North Sea, France, Falkland Islands.

Localities.—

Helga, CXX—24 VIII '01. 77 miles W.N.W. of Achill Head. Townet on trawl, 382 fms.—One specimen.

W. 7—24 III '04. 27 miles W. by N. ¼ N. of Bray Head, Valencia. Soundings 100 fms., sand. Temperature at 100 fms., 9·8° C. Townet on trawl, 100 fms.—One specimen, mature.

S. R. 486—3 IX '07. 51° 37′ 30″ N., 12° 0′ W. Townet on trawl, 600–660 fms.—Six specimens.

S. R. 489—4 IX '07. 51° 35′ N., 11° 55′ W. Townet on trawl, 720 fms.—Five specimens.

S. R. 590—3 VIII '08. 51° 51′ 30″ N., 12° 8′ W. Soundings 480 fms., ooze. Temperature at 480 fms., 9·28° C. Midwater trawl, 480 fms.—Two specimens.

W. 73—22 V '09. Clare Island, shore collecting.—Two specimens.

W. 142—13 VIII '10. Valencia Harbour. Dredge, 4–7 fms.—One specimen, mature, in limestone.

W. 191—14 V '11. Crookhaven. Shore collecting—Very common in Laminaria roots.

Blacksod Bay; collected on ten occasions on the shores of the Mullet, 1909–1911.

Portstewart, Co. Derry; common on the shore, and in Laminaria roots.

Dublin Bay (Balscadden Bay, Stella Maris Bay, Sandycove).

Lough Swilly, in Lithothamnion (W. 256; W. 258).

S. R. 1358—6 V '12. 12 miles S. by W. ½ W. of Chicken Rock, Isle of Man. Dredge, 35 fms., gravel and shells.—Several specimens.

Phascolion strombi (Montagu).

1905. *Phascolion strombi* (Mont.), Théel, **34**, p. 86.

This species is common all round Ireland. It usually lives in small Gasteropod shells, especially those of *Turitella*. It is also

common in shells of *Dentalium*, and on one occasion was found in cowrie shells, and in tubes of *Hydroides norvegica*. Frequently it is accompanied in the shell by the Polychaete worm *Syllis cornuta*, Rathke. Brumpt (**3**, p. 493) gives some particulars of the association of a Syllid with *Phascolion*, but says that Malaquin, to whom he submitted specimens, was of the opinion that it was closely allied to *Syllis hyalina*, Grube. I think it highly probable that it is the same species as the one I have found. I have also found *Syllis cornuta* accompanying *Aspidosiphon Mülleri* in the shell of *Aporrhais pes-pelicani*, and sharing a tube with the ploychaete *Pectinaria auricoma* (Müller).

A specimen of *Phascolion* was found sharing a *Turitella* shell with a small Hermit Crab (*Eupagurus bernhardus*). The *Phascolion* occupied the upper whorls of the shell, and its proboscis emerged from a round hole in the middle of the shell.

Sexually mature specimens were found in August and September. Occasionally examples were found without hooks on the proboscis, as Théel describes in the variety *spetzbergensis* (**34**, p. 89).

The bathymetrical range of this species is from low-water mark down to about 100 fathoms, though it has been recorded from 1,000 fathoms in the Atlantic. It is very abundant in depths of 10–30 fathoms. It was found on the Porcupine Bank in 91 fathoms, though it has not been found in the intervening deep channel.

Distribution.—British Isles, shores of East Atlantic, Arctic Ocean, Newfoundland, Eastern shores of Canada and the United States. Mediterranean. Between South Georgia and the Falkland Islands, Théel (**36**, p. 31), who comments on the bipolar distribution of the species.

Localities.—

Dublin Bay, in various localities.

Bofin, XXXVII—28 VI '99. Outside Bofin Harbour. Dredge, 15–16 fms.—Common in cowrie shells, etc.

Helga, LXXVIId—29 VI '01. Porcupine Bank. Dredge, 91 fms.—Two specimens.

L. 13b—14 I '02. Ballinakill Hbr. Townet on bottom, 2–6 fms.—Four specimens.

L. 18—16 I '02. Ballinakill Hbr. Shrimp trawl, 10–12 fms.—Five specimens.

A. 5—1 VI '04. Galway Bay. Dredge, 6 fms.—Eight specimens.

A. 6—6 VI '04. Galway Bay. Dredge, 7 fms.—Two specimens.

A. 81—13 IX '04. Galway Bay. Dredge, 12 fms.—One specimen.

S. 553—16 VIII '07. 10 miles E. of Bailey Light. Trawl, 41–52 fms.—One specimen.

Clew Bay, 1909–1911. Dredged on ten occasions in various parts of the bay, at depths of 2–25 fathoms.

Blacksod Bay, 1909–1911. Dredged on ten occasions in various parts of the bay, at depths of 2–10 fathoms.

W. 243—9 II '12. Dingle Bay. Dredge, 22 fms., gravel and stones.—Common in shells.

W. 244—9 II '12 Dingle Bay. Dredge, 25 fms., stones. —Common in shells.

S. R. 1358—6 V '12. 12 miles S. by W. ½ W. of Chicken Rock, Isle of Man. Dredge, 45 fms., gravel and shells.—Two specimens.

S. R. 1444—19 VIII '12. Off the coast of Kerry. Dredge, 142 fms., sandy mud.—One specimen.

Aspidosiphon Mülleri, Diesing.

Plate V, fig. 8.

1860. *Phascolosoma radiata*, Alder, **1**, p. 75.
1875. *Aspidosiphon mirabilis*, Théel, **33**, p. 17.
1881. *Aspidosiphon armatus*, Koren and Danielssen. **14**, p. 4.
1883. *A. Mulleri* + *A. mirabilis* + *A. armatus*, Selenka, **25**, p. 120.
1895. *A. Mülleri*, Fischer, **5**, p. 18.
1905. *A. mirabilis* + *A. armatum*, Théel, **34**, p. 91.
1912. *A. Mulleri*, Sluiter, **31**, p. 19.

This is the commonest Gephyrean found in deep water off the west coast of Ireland. It is most commonly found living in the dead shells of Gasteropods, but it occurs also in tubes of *Protula* and *Serpula*, in corals like *Lophohelia prolifera*, and in limestone. Whether it burrows in the latter, or occupies tunnels already made, I cannot say, though it usually fits the hole very accurately. When it withdraws its proboscis into the shell or tunnel in which it lives, the anterior shield serves as a very effective operculum. *Aspidosiphon Mülleri* does not diminish the entrance to the shell in which it lives by cementing sand round it, as *Phascolion strombi* does. The aperture of the shell is often choked up with mud or ooze, through which the proboscis projects, but this seems to be quite accidental, and the mud is not strengthened with cement or mucus. Each individual is usually accompanied in its tube by a specimen of the Polychaete worm *Syllis cornuta*, Rathke, which is also found with *Phascolion Strombi*.

This species is at present known under various names, which have been given usually as the result of erroneous descriptions. The material I have examined comes from the following localities :—

(1.) A large collection from the west coast of Ireland.
(2.) A number of specimens of *A. Mülleri* from Naples.
(3.) The type-specimen of *A. mirabilis*, Théel, from the west coast of Sweden (Swedish State Museum).
(4.) The type-specimen of *A. armatum*, Kor. and Dan., from the west coast of Norway (Bergen Museum).

(5.) One specimen of *A. Mülleri* from south of the Azores and one from the Bay of Biscay, named by Sluiter (**30**, p. 14), from the Oceanographical Museum, Monaco.

(6.) Four specimens of *A. Mülleri* from Accra, West Africa, named by Fischer (**5**, p. 18), from the Hamburg Museum.

All these specimens agree closely except on one point, viz., the shape of the hooks on the proboscis (vide infra).

The length varies considerably, the Atlantic specimens being usually the largest. The anterior shield is more or less clearly grooved, showing considerable variation in this respect. The proboscis is covered throughout its length with rows of hooks. No diverticulum could be found on the rectum, though one is said to be present in the Mediterranean specimens. The rectum is swollen and thick-walled. There are 11–15 muscular tendons under the anterior shield. The longitudinal muscles of the body-wall are more or less collected into strands, especially in the anterior region, behind the shield. The spindle muscle is conspicuous, and is attached to the posterior shield opposite the base of the retractor muscles, on the dorsal side. The nephridia are attached to the body-wall by muscular strands throughout their whole length. The cutaneous glands are well figured by Théel (**34**, Pl. 8, figs. 115–119).

The proboscis is covered with hooks throughout its whole length. In the Mediterranean specimens the 14 distal rows of hooks are two-pointed, as figured by Oscar Schmidt (**23**, Taf. 1, figs. 3–6). In the 12th–14th rows the lower point is getting smaller and there are some single-pointed hooks present. Further behind, the hooks are all single-pointed. In all the Atlantic specimens I have examined I failed to find any bifid hooks. Sluiter, however, in his latest communication (**31**, p.19) comments on the great variation in this respect, and says that, in addition to the typical form, he has seen specimens, some having all the hooks bifid, some with no hooks bifid, and some with no hooks at all. This character, then, is too variable to have any specific value.

Théel's description of *Aspidosiphon mirabilis* (**34**, p. 91) is incorrect in several respects. Hooks are present throughout the whole length of the proboscis, and not only in its anterior part as he says. Posteriorly they are hidden by a brown incrustation, and so have escaped his notice. The retractor muscles are attached to the ventral sides of the posterior shield, and not to its centre. The nephridia, instead of being free, are attached throughout their whole length by delicate muscles to the body-wall.

Only a few fragments remain of the type specimen of *Aspidosiphon armatum*, described by Koren and Danielssen. Fortunately they include the two shields. The figures of these structures (**14**, Taf. II, figs. 7, 8, 14) are very inaccurate. I have had them redrawn (Pl. V, fig. 8), and they show the normal structure of *A. Mülleri*. There are only about 11 well-defined

muscular tendons under the anterior shield, and not 21, as shown by Koren and Danielssen in fig. 14.

The West African specimens of *A. Mülleri*, named by Fischer (5, p. 18), have single-pointed hooks all over the proboscis and are quite normal in structure.

I am indebted to the Rev. Canon Norman for drawing my attention to a long overlooked paper by Alder (1, p. 75) containing a description of a new species which he calls *Phascolosoma radiata*, dredged near the Shetlands. This is undoubtedly our *A. Mülleri*, and is the first record of this species outside the Mediterranean. Canon Norman says also that he took this species himself in the Shetlands in 1863 and 1868, and also in Norway.

Distribution.—Arctic Ocean; Atlantic, from shallow water down to 700 fathoms; Mediterranean; Red Sea; West Coast of Africa; Pacific.

Localities.—

Helga, LXXVIId.—29 VI '01. 53° 24′ 30″ N., 13° 36′ W., soundings 91 fms., gravel and sand. Temperature at bottom 12·9° C. Dredge, 91 fms.—Two specimens, in shells.

Helga CXXIXd.—11 IX '01. 40 miles W.N.W. of Cleggan Head, soundings 76½ fms., stones. Temperature at bottom 9·3° C. Dredge, 76½ fms.—One specimen, in limestone.

S. R. 164—3 XI '04. 52° 6′ N., 12° 0½′ W. Dredge, 375 fms.—Two specimens.

S. R. 399—5 II '07. 51° 28′ N., 11° 33′ 30″ W. Townet on dredge, 342 fms., mud and stones.—Four specimens.

W. 83—25 V '09. Clew Bay. Dredge, 13 fms.—One specimen in shell of *Apporhais pes-pelicani*.

S. R. 1005—12 VIII '10. 51° 22′ N., 11° 30′ 30″ W. Dredge, 249 fms., fine sand.—Numerous specimens living in limestone and schist.

S. R. 1153—13 V '11. 30 miles south of Co. Cork. Dredge, 60 fms., sandy mud.—Common in shells and tubes of *Serpula*.

S. R. 1173—19 V '11. 51° 50′ N., 11° 37′ 30″ W. Eel-trawl, 275 fms., fine sand.—One specimen.

S. R. 1176—22 V '11. 51° 26′ 30″ N., 11° 2′ W. Dredge, 100 fms., sand.—Common in various shells.

S. R. 1177—22 V '11. 51° 21′ N., 11° 24′ W. Dredge, 152½ fms., sand.—Very common in shells and *Lophohelia prolifera*.

S. R. 1178—22 V '11. 51° 20′ N., 11° 30′ W. Townet on trawl, 212–229 fms.—One specimen.

S. R. 1179—22 V '11. 51° 20′ N., 11° 35′ 30″ W. Dredge, 456 fms., mud and stones—One specimen, in coral.

S. R. 1391—14 V '12. Off the coast of Co. Kerry. Dredge, 149 fms., sand.—Numerous specimens.

S. R. 1444—19 VIII '12. Off the coast of Co. Kerry. Dredge, 142 fms., sandy mud.—One specimen.

Onchnesoma Steenstrupi, Kor. and Dan.

1905. *Onchnesoma Steenstrupii*, Kor. and Dan., Théel, **34**, p. 93.

Twelve specimens of this small and distinct species were obtained. They were all rust-coloured, especially at the posterior end. The area where they were found, usually on a bottom of mud or ooze, lies about 50 miles off the coast of Kerry.

Distribution.—Arctic and North East Atlantic; Skager-Rack; Gulf of Lyons ?; Mediterranean ?

Localities.—

S. R. 5—14 II '03. 50 miles W.N.W. of Tearaght. Dredge, 312 fms., fine mud and sand.—Four specimens.

S. R. 172—5 XI '04. 52° 2′ N., 12° 8′ W. Townet on trawl, 454 fms., fine mud.—Two specimens.

S. R. 590—3 VIII '08. 51° 51′ 30″ N., 12° 8′ W., soundings 480 fms., ooze. Temperature at 480 fms., 9·28° C., salinity 35·46°/₀₀. Midwater trawl, 480 fms. —Five specimens.

S. R. 592—6 VIII '08. 50° 39′ N., 11° 25′ W. Trawl, 400–510 fms., ooze.—One specimen.

Onchnesoma squamatum (Kor. and Dan.).

1905. *Onchnesoma squamatum* (Kor. and Dan.), Théel, **34**, p. 96.

Large numbers of this species were obtained in deep water off the west coast of Ireland. It has been found at various stations in the western part of the North Atlantic, usually at considerable depths, ranging from 100–700 fathoms.

Distribution.—North-west Atlantic, between the latitudes of Lofoten and Brest.

Localities.—

S. R. 31—7 VIII '03. 50 miles W.N.W. of Tearaght. Temperature at 300 fms, 10° C. Townet on dredge, 306 fms., fine mud and sand.—Two specimens.

S. R. 172—5 XI '04. 52° 2′ N., 12° 8′ W. Townet on dredge, 454 fms., fine mud.—Twenty specimens.

S. R. 502—11 IX '07. 50° 46′ N., 11° 21′ W. Bottom temperature 8·8° C. Mosquito net on trawl, 447–515 fms.—Three specimens.

S R. 590—3 VIII '08. 51° 51′ 30″ N., 12° 8′ W., soundings 480 fms., ooze. Bottom temperature 9·28° C. Midwater trawl, 480 fms.—One hundred and sixty specimens.

S. R. 752—17 v '09. 51° 48′ N., 12° 11′ 30″ W., soundings 523–595 fms., ooze. Temperature at 500 fms., 8·9° C. Midwater trawl, 523–595 fms.—One hundred specimens.

ECHIUROIDEA.

Echiurus abyssalis, Skorikow.

Plate VII, fig. 11.

1903. *Echiurus Pallasi*, Guerin, Lo Bianco, **2**, p. 265.
1906. *Echiurus abyssalis*, Skorikow, **29**, p. 217.
1912. *E. a.*, Sluiter, **31**, p. 23.

This species was taken in large numbers in deep water off the west coast of Ireland, about 180 specimens being altogether obtained.

They are of a grey colour, and the trunk varies from 3–12 mm. in length. The body is cylindrical and the width is usually about half the length, though there is great variation in this feature, according to the extent of contraction (Pl. VII, fig. 11A). The proboscis also varies greatly. In small specimens it may be three or four times as long as the body, but in the largest specimens it is from half to two-thirds of the body length. It is probably highly contractile in life. In the specimen figured (Fig. 11C) the proboscis was 11 mm. long. In its most commonly occurring shape, it is massive and tubular at the base, becoming ribbon shaped and narrow towards the tip, where it broadens, and is distinctly bilobed, the angles being prominent. All the specimens are in a bad state of preservation, and the cuticle, which is very thin and delicate, is frequently missing. The body is surrounded by 15 rows of prominent papillae, with rows of smaller ones between. The rings of large papillae correspond to swellings on the nerve-cord, which can be plainly seen, and probably each denotes a segment of the body. The papillae are cylindrical, or like truncated cones. They are hyaline, and not encrusted, as the rest of the skin is. The cuticle has a markedly reticular structure, owing to the openings of the numerous glands in the skin.

The setae are all of the same delicate pinkish-brown colour. The ventral (anterior) setae, which correspond in position with the second row of large papillae, have strongly curved tips (Fig. 11D) which are flattened like a spoon, and narrow in side view. The posterior setae are gently curved towards the tip. All are striated, both longitudinally and transversely, especially the posterior setae. The latter are disposed in two rings, the anterior row containing 6–10, the posterior one 5–7, setae. There is a wide gap in these rings on the ventral side, which is proportionately larger in the anterior ring. These rows of setae correspond to the two posterior rings of large papillae.

The internal anatomy is very simple. The intestine is only slightly folded (Fig. 11B). Two very delicate anal vesicles (c) are present, but the state of preservation is too bad to allow their intimate structure to be ascertained. They are unbranched, and probably of the same structure as those of *Echiurus Pallasi*, Guerin. The vascular system is also of the normal type.

The four nephridia are very small. In immature specimens the funnel is as large as the tube, but in those containing eggs (Fig. 11E) the latter part is expanded. In the specimens I examined, the funnel is not so distinctly separated from the tube as Sluiter shows in his figures (**31**, Fig. 14), but this may be due to stronger contraction of the skin in my specimens.

The Irish specimens were in such a bad state of preservation that the study of sections did not yield much information. Fig. 11F shows a longitudinal section through the posterior end. The body-wall is composed of the usual strata of circular, longitudinal, and oblique muscular layers. Underneath each papilla there is a small pear-shaped cavity. The section figured passes through the rectum, showing its thickened walls, and the numerous muscles which fasten it to the body-wall. This thickened portion of the rectum probably acts as a sphincter muscle.

I submitted several examples of this species to Sluiter, who was strongly of the opinion that they agreed with *Echiuris abyssalis*, Skorikow. This species, of which only three specimens have previously been obtained in the Mediterranean, differs from the common littoral and shallow-water *E. Pallasi*, Guerin, in its smaller size, greater simplicity in its internal characters, and in the structure of the nephridia. In *E. Pallasi*, the funnel of the nephridium is attached wholly to the tube, whilst in *E. abyssalis* it is more or less separated from it. The Irish specimens seem to be intermediate in this respect between the two species, but that may be due to the great contraction of the skin. I have no doubt that the two species are distinct.

Distribution.—Deep water in the Mediterranean.

Localities.—

Royal Irish Academy Expedition, 1886. Log 48—Five specimens.

Royal Irish Academy Expedition, 1886. Log 59—Eight specimens.

S. R. 172—5 XI '04. 52° 2′ N., 12° 8′ W. Townet on dredge, 454 fms., fine mud.—Twenty-nine specimens.

S. R. 212—6 V '05. 51° 54′ N., 11° 57′ W. Soundings 411 fms., fine mud and sand. Temperature at 350 fms., 9·82° C. Townet on trawl, 375–411 fms.—Two specimens.

S. R. 331—9 V '06. 51° 12′ N., 11° 55′ W. Townet on trawl, 610–680 fms., ooze.—One specimen.

S. R. 334—10 V '06. 51° 35′ 30″ N., 12° 26′ W. Sound-

ings 500–520 fms., ooze. Temperature at 500 fms., 10·8° C. Townet on trawl.—Eleven specimens.

S. R. 397—2 II '07. 51° 46′ N., 12° 5′ W., soundings 549–646 fms., ooze. Temperature at 500 fms., 8·71° C. Townet on trawl, 549–646 fms.—One specimen.

S. R. 440—16 V '07. 51° 45′ N., 11° 49′ W., soundings 350–389 fms. Temperature at 300 fms., 9·93° C. Townet on trawl, 350–389 fms.—Ten specimens.

S. R. 447—18 V '07. 50° 20′ N., 10° 57′ W., soundings 221–343 fms., fine sand. Temperature at 300 fms., 9·87° C. Townet on trawl, 221–343 fms.—Thirty-two specimens.

S. R. 479—28 VIII '07. 51° 20′ N., 11° 41′ W., soundings 468–560 fms. Temperature at 550 fms., 8·34° C. Townet on trawl, 468–560 fms.—Twelve specimens.

S. R. 486—3 IX '07. 51° 37′ 30″ N., 12° 0′ W. Townet on trawl, 600–660 fms.—Thirty-seven specimens.

S. R. 490—7 IX '07. 51° 57′ 30″ N., 12° 7′ W., soundings 470–491 fms., ooze. Temperature at bottom, 8·68° C. Townet on trawl.—Eight specimens.

S. R. 491—7 IX '07. 51° 57′ 30″ N., 12° 13′ W., soundings 491–520 fms. Temperature at bottom, 8·53° C. Townet on trawl.—One specimen.

S. R. 502—11 IX '07—50° 46′ N., 11° 21′ W., soundings 447–515 fms. Temperature at bottom 8·8° C. Townet on trawl.—Thirty specimens.

S. R. 506—12 IX '07. 50° 34′ N., 11° 19′ W., soundings 661–672 fms., ooze. Temperature at 600 fms., 8·22° C. Townet on trawl.—Two specimens.

S. R. 590—3 VIII '08. 51° 51′ 30″ N., 12° 8′ W., soundings 480 fms., ooze. Temperature at bottom 9·28° C. Midwater trawl, 480 fms.—Three specimens.

Thalassema Lankesteri, Herdman.

1897. *T. L.*, Herdman, **8**, p. 367.
? 1852. *Thalassema gigas*, M. Müller, **19**, p. 14.

Two specimens of this species are included in the collection. The first was taken in the Irish Sea (S. 517), not far from where Herdman found his specimens. Unlike these, it is an entire specimen. When alive, it was of an intense green colour, but the pigment was soluble in dilute formalin.

The total length is 170 mm., the trunk being 95 mm. long and the proboscis 75 mm. The width of the body varies from 10–20 mm., and the proboscis is 16 mm. at its widest part near the tip. The end of the proboscis is smoothly rounded. The specimen is a mature female, with eggs in the nephridia. The second specimen was obtained by the Royal Dublin Society Expedition in 1890. It was found in the stomach of a Dab

(*Pleuronectes limanda*) in Kenmare River. This specimen has a total length of 260 mm., the trunk being 160 mm. and the proboscis 100 mm. in length. The width of the trunk is 6–13 mm., of the proboscis 15 mm. at its widest part in the proximal third. The tip of the proboscis is bluntly bilobed. The whole body is longer and thinner than that of the first specimen, which is more strongly contracted. It is also a mature female with eggs in the nephridia. In their internal anatomy both specimens agree closely with Herdman's description.

Through the kindness of Professor Cori and Dr. Scharff, I obtained a specimen of *Thalassema gigas* from the Gulf of Trieste. The body was very swollen and almost oval, and the proboscis was comparatively small. Its tip was damaged, but, so far as I could see, it was not clearly trilobed. At any rate, the general shape of the body and proboscis varies so much in these animals according to the state of contraction and expansion that it supplies no reliable diagnostic characters. The warty appearance of the skin closely resembles that of *T. Lankesteri*, and there is close agreement in the internal anatomy. The anal vesicles agree in being plume-shaped, consisting of a main stem with simple lateral branches. In the Trieste example, the nephridia were larger than in the Irish specimens, but this character, again, cannot be considered of specific value. There is as much difference between the two Irish specimens as there is between either of them and the one from Trieste.

In view of the close resemblance of these specimens I am of opinion that the two species are synonymous. However, as the available material was so scanty and not very well preserved, I think it advisable to leave them separate for the present. A study of the proboscis and body-wall in well-preserved specimens would be necessary to settle the question definitely. The occurrence of the same species in two such widely separated localities as Ireland and Trieste would not be very remarkable, as there is a close affinity between the marine fauna of the Adriatic and that of the British Isles.

In neither species have any males been found up to the present, and it is probable that these species will resemble others of the Echiuroidea in having dwarf males. I examined the nephridia closely, but was unable to find any trace of them.

Distribution.—Irish Sea. Trieste ?

Localities.—

Kenmare River, in stomach of a Dab, taken in the trawl, in 7 fms., 8 v '90, by the Royal Dublin Society Exp.—One specimen.

S. 517—26 IV '07. 9½ miles E.S.E. of Clogher Head. Trawl, 22–23 fms., muddy sand. Bottom temperature 7·15° C.—One specimen.

Thalassema Neptuni, Gaertner.

1899. *T. N.*, Jameson, **10**, p. 535.

Distribution.—This species has a typically Lusitanian distribution. It is found on the west coast of Ireland, south-west coast of England, France, and the Mediterranean.

Localities.—

Dungarvan; Valencia Harbour, common in submerged peat, and in crevices of the rocks; also dredged in 7 fms.

Clew Bay, dredged on eight occasions, 1909–1911, in 5–20 fms., usually in limestone.

Blacksod Bay, on two occasions, single specimens in crevices of the schist, 1910.

A. 5—1 VI '04. Galway Bay. Dredged in 6 fms., in limestone.—Two specimens.

A. 69—27 VIII '04. Galway Bay. Dredged in 9 fms.—One specimen.

W. 243—9 II '02. Dingle Bay. Dredge, 22 fms., in limestone.—Very abundant.

Bonellia viridis, Rolando.

1906. *B. v.* Théel, **35**, p. 23.

This species, which is widely distributed in the Atlantic, Mediterranean, and Pacific, has not yet been recorded from British waters, though it is almost certain, from its known distribution, that it occurs round our coasts. The specimen which I refer doubtfully to is in such a bad state of preservation that it is impossible to name it with any certainty. According to observations made at the time of capture, the specimen was of a bright green colour, gelatinous and transparent. The proboscis and setae were missing. The skin is wrinkled as in *Bonellia viridis*. The sand in the intestine is in the form of oval pellets, and the fragments of the specimen closely resemble a similar badly preserved specimen of *Bonellia* in the Irish National Museum.

Distribution.—Scandinavia; Mediterranean; Azores; Indian and Pacific Oceans.

Locality—R. 30—17 VIII '06. 9½ miles S.E. by S. of Mine Head, Co. Waterford. Sand grab, 37½ fms., sand and gravel.—One specimen.

PRIAPULOIDEA.

Priapulus caudatus (Lamarck).

1845. *Priapulus hibernicus*, McCoy, **18**, p. 272.
1906. *P. c.* Théel, **35**, p. 15.

Distribution.—British Isles, Northern and Arctic Seas. According to Théel (**36**, p. 18) this species is bipolar, as a closely related form is found at various places in the Antarctic region.

Localities.—

Kenmare River, in stomach of a Dab, 8 v '90, by the Royal Dublin Society Expedition.—One specimen.

S. 56—15 IV '02. Off Ireland's Eye, Co. Dublin. Trawl, 13 fms., in stomach of a Plaice.—One specimen.

Ballinakill Hbr., in stomach of *Scyllium caniculum*, 13 × '03.—One specimen.

L. 283—19 I '04. Ballinakill Hbr., shore collecting.—Six specimens.

L. 288—3 II '04. Ballinakill Hbr., shore collecting.—Three specimens.

W. 254—5 III '12. Whale Head, Lough Swilly. Digging in Zostera.—One specimen.

LIST OF GENERA AND SPECIES.

Names not adopted in this paper are in brackets.

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EXPLANATION OF PLATES I–VII.

Plate I.

Fig. 1.—*Physcosoma abyssorum*, sp. n.

1 A.—The entire animal, × 2. a = anus.
1 B.—Internal anatomy. a = spindle muscle.
1 C.—Papillae on tail. × 44.
1 D.—Longitudinal section of body-wall, on a level with the anus. × 100. a = unicellular gland in epidermis; b = epidermis; c = cuticle; d = outer layer of circular muscles; e = inner layer of longitudinal muscles; f = peritoneal epithelium.
1 E.—Part of the intestine, showing the rows of gland cells.
1 F.—Oesophageal region from the dorsal side showing the fusion of the dorsal (c) and ventral (d) retractor muscles on each side. a = contractile vessel; b = oesophagus.
1 G.—Rectum, showing the attachment of the spindle muscle (a).

Plate II.

Fig. 1, *Physcosoma abyssorum*, sp. n.—continued.

1 H.—Glands and hooks on the proboscis. a = basal portion of gland. × 215.
1 J.—Hooks on the proboscis, × 215.
1 K.—Skin with cuticle removed, showing epidermis and unicellular gland (a), × 215.

Fig. 2, *Phascolosoma rugosum*, sp. n.

2 A.—The entire animal, × 5.
2 B.—The internal anatomy.
2 C.—Papilla near the anus, × 215.
2 D.—Papillae from the posterior end, × 215.
2 E.—Transverse section of the body-wall, near the posterior end, × 100.

Fig. 3, *Phascolosoma margaritaceum* (Sars).

Longitudinal section of the body-wall near the posterior end of a specimen from Greenland, × 44.

Plate III.

Fig. 4, *Phascolosoma mutabile*, sp. n. All figures except 4 F from type (S. R. 355).

4 A.—The entire animal, × $1\frac{3}{4}$.
4 B.—Internal anatomy.
4 C.—Papillae. a, on the proboscis; b, on a level with the anus; c, on the posterior end, × 215.
4 D.—Portion of the skin from near the posterior end, × 100.

4 E.—Hooks on the proboscis, × 215.
4 F.—Tentacular crown. (S. R. 334.)
4 G.—Longitudinal section of body-wall from the posterior end, × 100.

Plate IV.

Fig. 5, *Phascolosoma muricaudatum*, sp. n.

5 A.—The entire animal, drawn from a small fully-expanded specimen, × 4. a = the anus.
5 B.—Tail of a more contracted specimen.
5 C.—Tip of the tail, × 60.
5 D.—Part of the proboscis of the specimen shown in Fig. 5 A, showing the hooks (h), papillae (p), and tentacles (t), × 110.
5 E.—Portion of the proboscis of a strongly contracted specimen, showing the appearance of the hooks and peculiar papillae, × 270.
5 F.—Same papillae in side view, × 270.
5 G.—Papillae; a, from the middle of the proboscis; b, from the middle of the trunk; c, from the tail, × 250.
5 H.—Internal anatomy. a = termination of nerve-cord.
5 J.—Longitudinal section of the body-wall near the base of the tail. Stained with Eosin and Haematoxylin, × 100.

Plate V.

Fig. 6, *Phascolosoma bulbosum*, sp. n.

6 A.—The entire animal, × 2½.
6 B.—Papillae on proboscis, × 360.
6 C.—Papilla on the level of the anus, × 250.
6 D.—Internal anatomy. a = the three muscular strands fastening the intestine to the junction of the oesophagus and retractor muscles; b = the spindle muscle.
6 E.—Longitudinal section of the body-wall from near the base of the tail, × 180.

Fig. 7, *Sipunculus norvegicus*, Kor. and Dan., showing the rectum and its appendages. a = the spindle-muscle; b = the racemose glands; c = base of retractor muscle; d = the diverticulum; e = the position of the anus.

Fig. 8, *Aspidosiphon Mülleri*, Diesing. These two drawings were made from the type-specimen of *Aspidosiphon armatum*, Kor. and Dan.

8 A.—Anterior shield.
8 B.—Posterior shield.

Fig. 9, *Phascolosoma Johnstoni* (Forbes).

9 A.—Test of the Foraminiferon *Saccammina sphaerica*, M. Sars, inhabited by two specimens of *P. Johnstoni*. (S. R. 590).
9 B.—Section of the test to show the disposition of the two specimens.

Plate VI.

Fig. 10, *Phascolosoma constrictum*, sp. n.

10 A.—The entire animal, × 2½.
10 B.—Internal anatomy.
10 C.—Large and small papillae from the middle of the trunk, × 215.
10 D.—Papillae near the posterior end, × 215.
10 E.—Papillae from just below the anus, × 215.
10 F.—Papillae from the middle of the proboscis, × 215.
10 G.—Longitudinal section of the body-wall from just behind the anus, × 215.
10 H.—Diagrammatic outlines of the various types of papillae. 1, on the proboscis; 2 and 3, near the anus; 4, on the mid-body; 5, just before the posterior end; 6, on the posterior end.

Plate VII.

10 J.—*Phascolosoma constrictum*, sp. n.—continued.
Glands and hooks on the proboscis, × 215.

Fig. 11, *Echiurus abyssalis*, Skorikow.

11 A.—Entire animal from the ventral side, × 12.
11 B.—Internal anatomy. a = blood-vessel; b = nephridia. c = anal vescicles.
11 C.—Proboscis fully expanded, × 6.
11 D.—One of the two ventral hooks, × 24.
11 E.—Nephridium, containing eggs.
11 F.—Longitudinal section through the posterior end, showing the thickened walls of the rectum, × 44.

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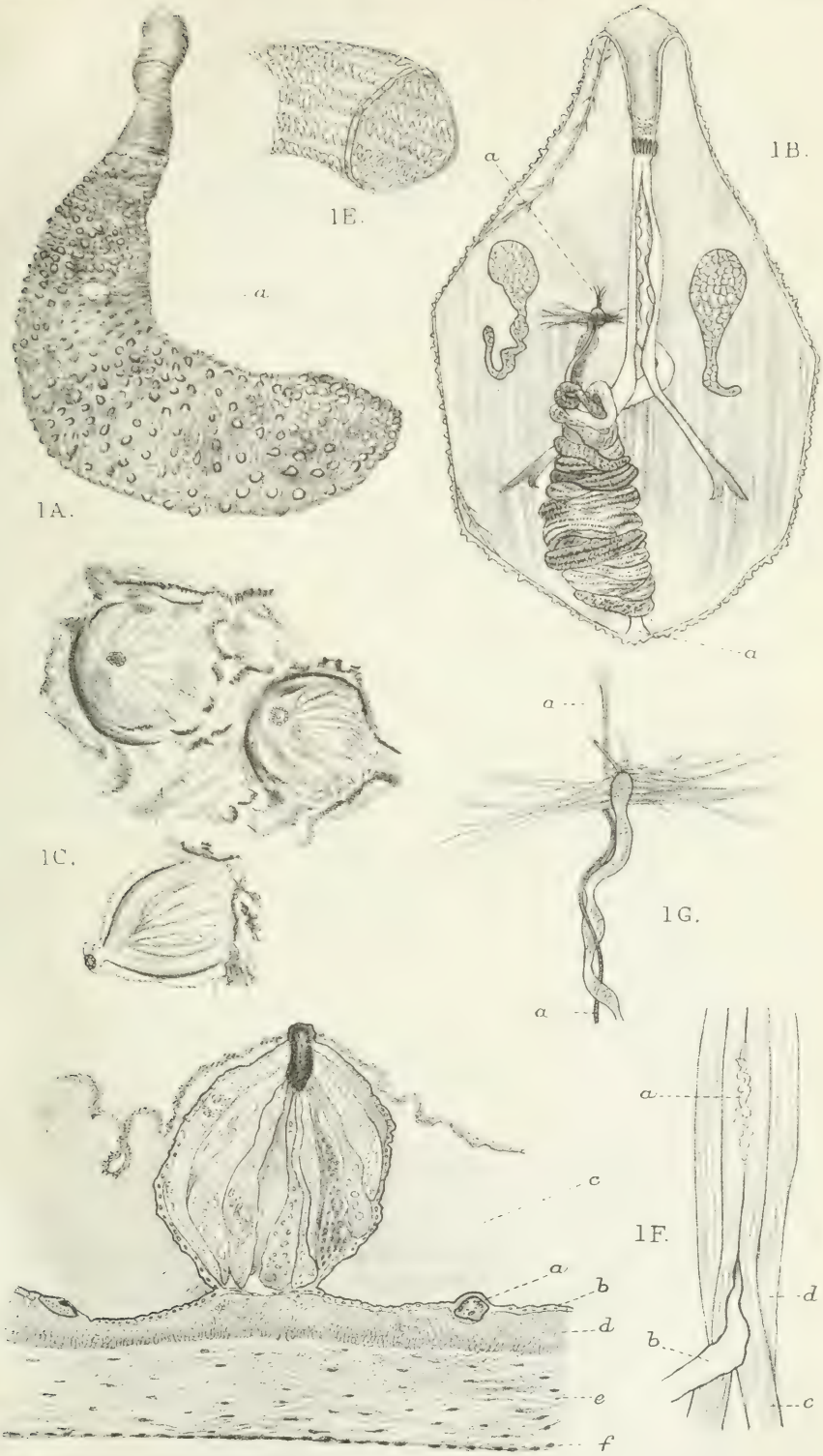


R. S. del.

Huth, Lith.f London.

Fig. 1, Physcosoma abyssorum, *sp. n.*

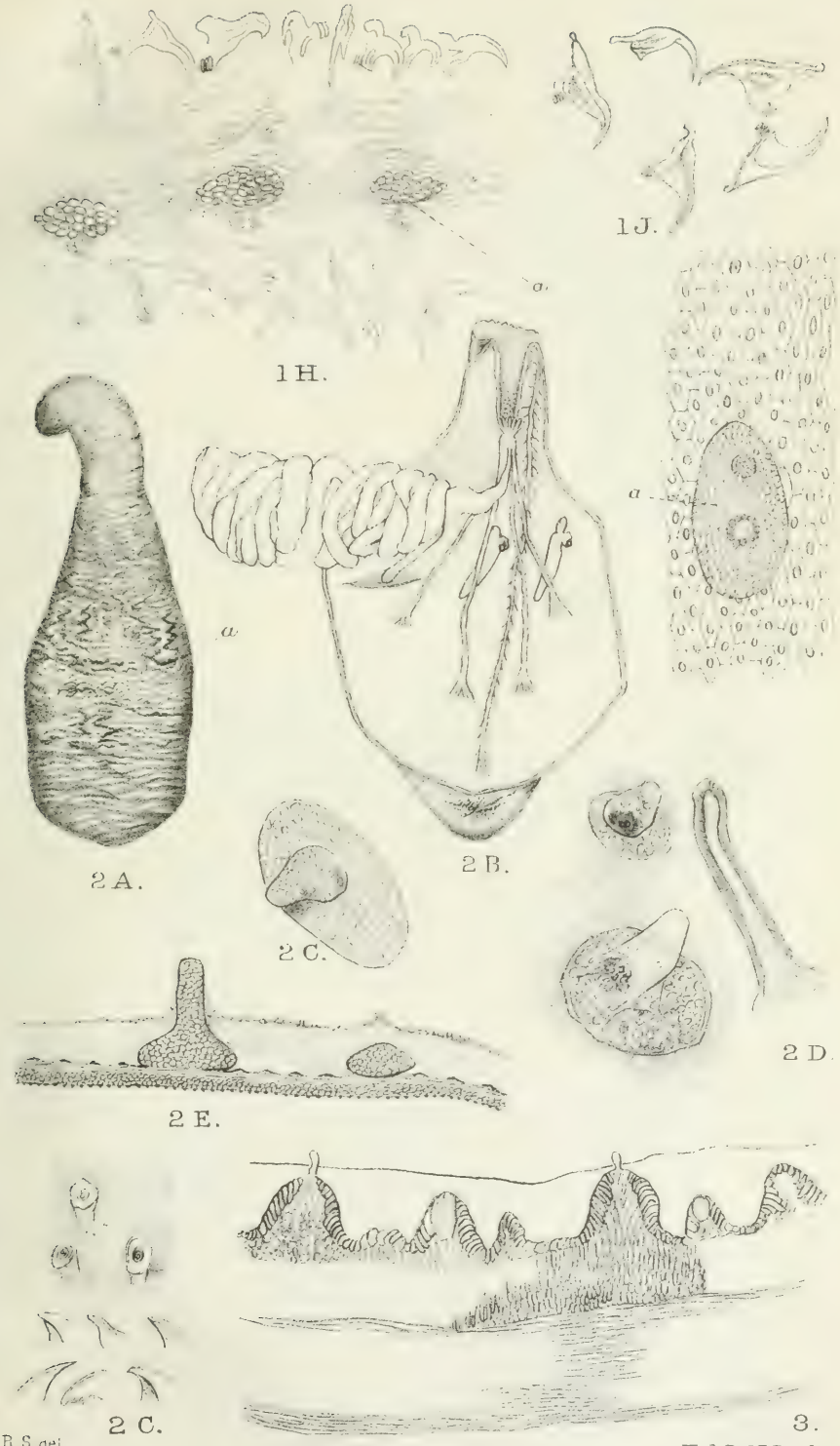
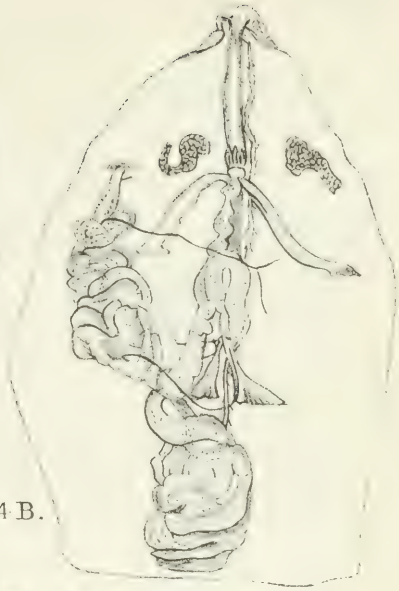


Fig. 1, Physcosoma abyssorum, sp. n.
Fig. 2, Phascolosoma rugosum, sp. n.
Fig. 3, Phascolosoma margaritaceum, (Sars).

4 A.

4 E.



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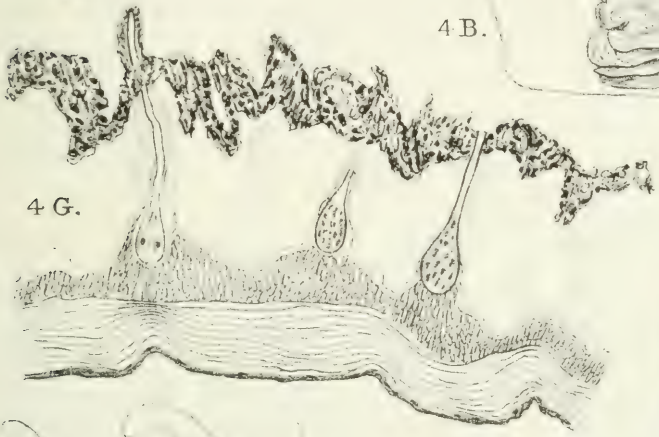

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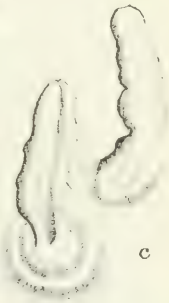
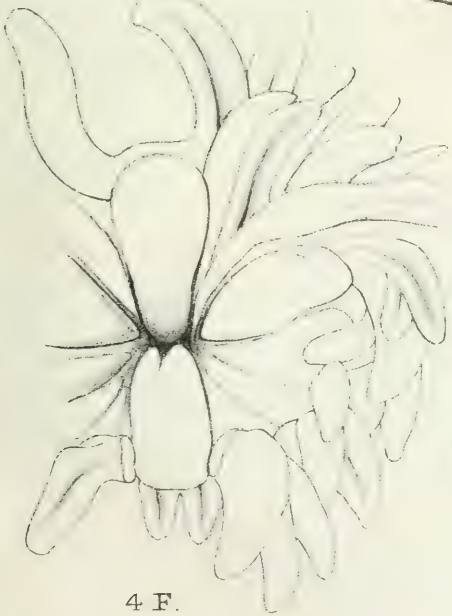


c

b

4 C.

a



4 F.

4 D.

Fig. 4a. Miss E. Barnes del.
Fig 4b-g. R.S. del.

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Fig. 4, Phascolosoma mutabile, sp.n.

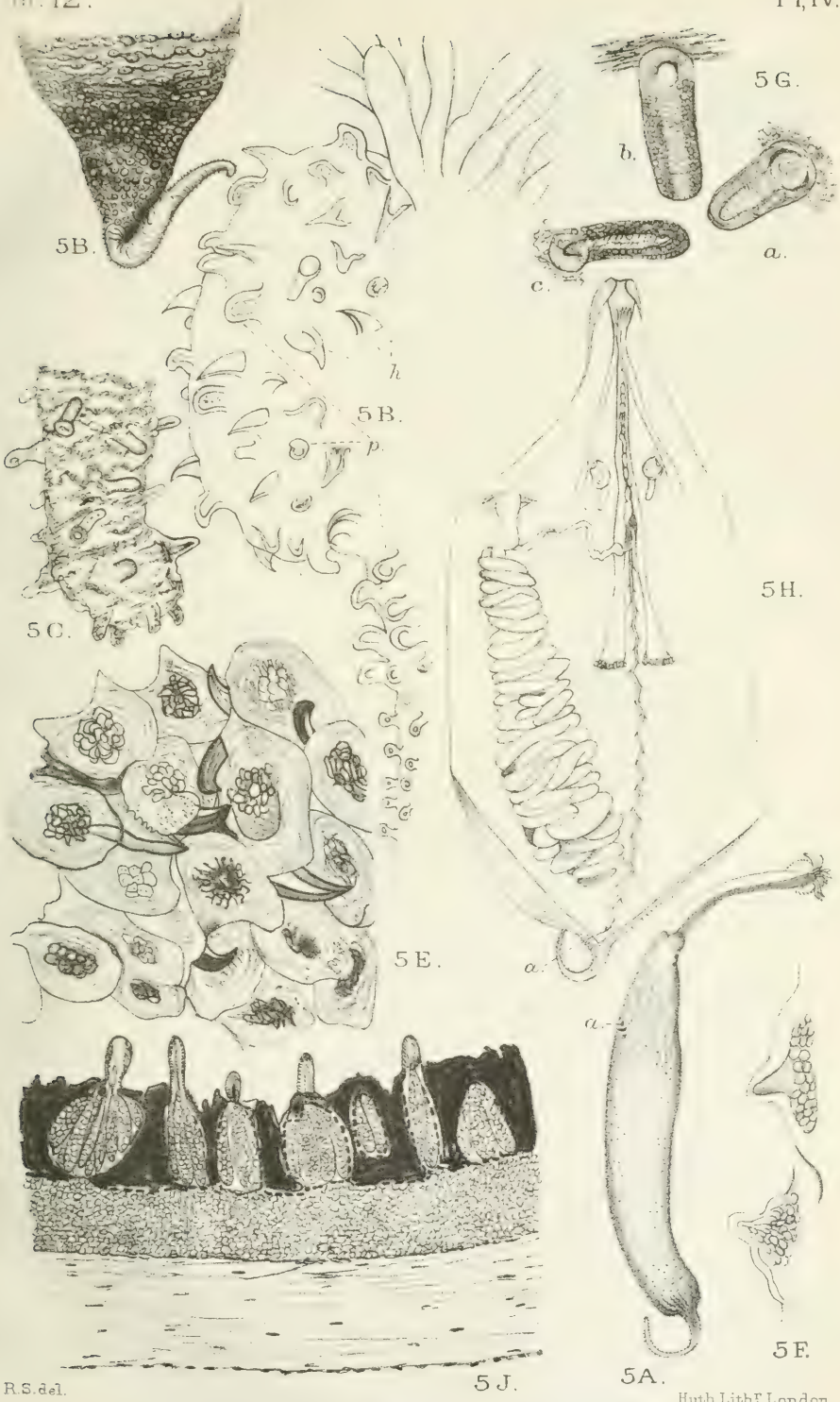

Fig. 5, Phascolosoma muricaudatum, sp.n.

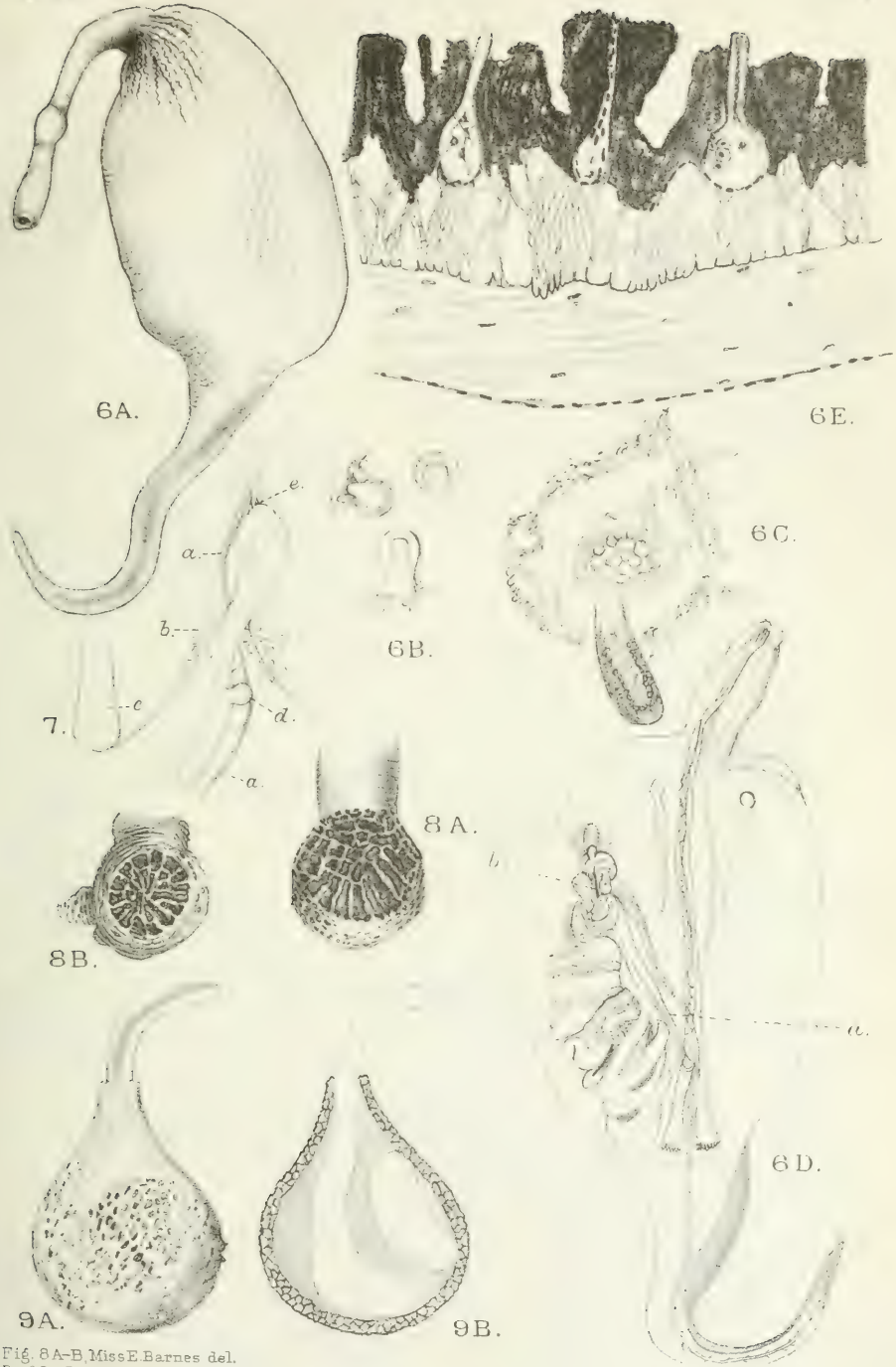

Fig. 8 A–B, Miss E. Barnes del.
Figs. 6 & 7, R.S. del.

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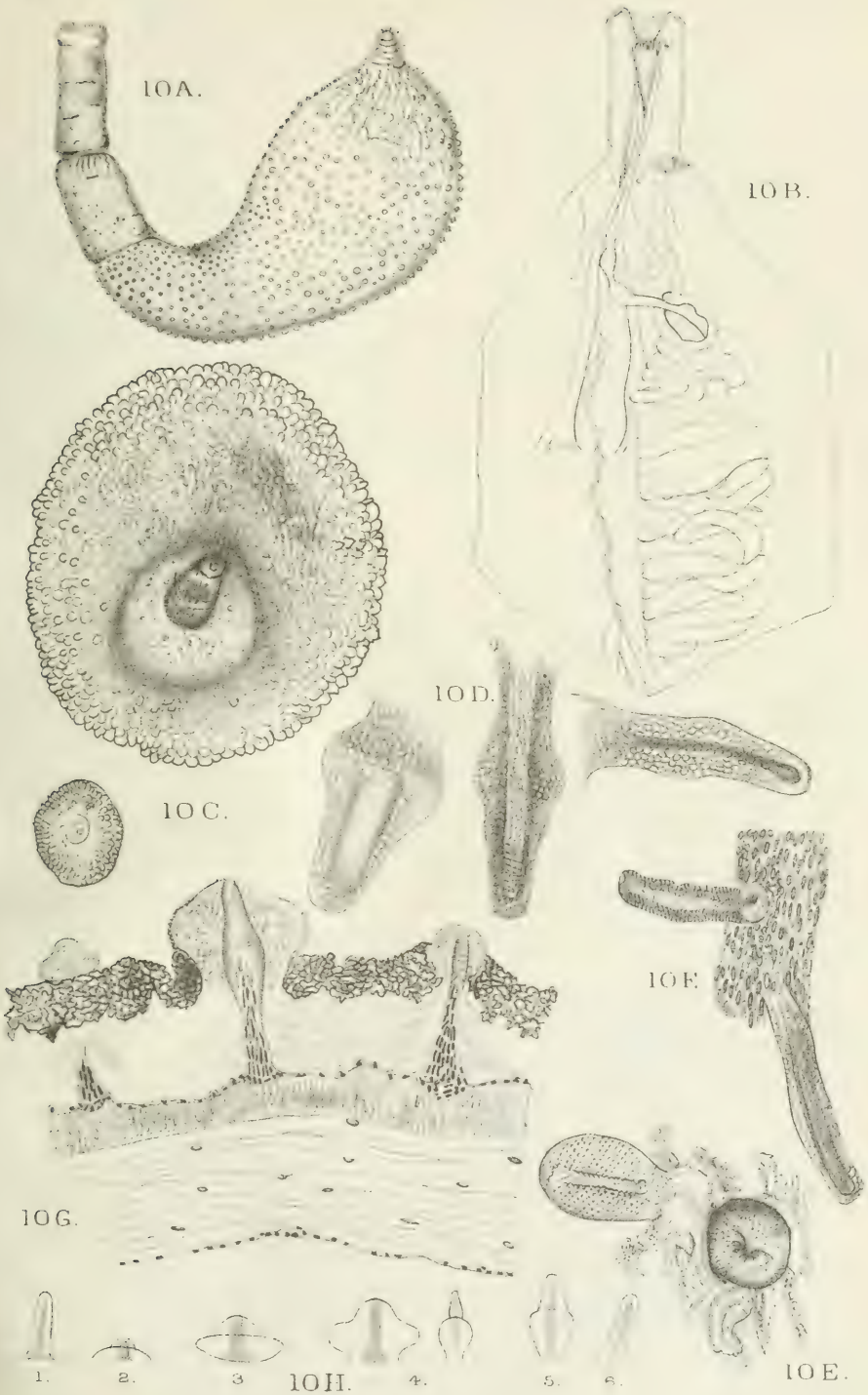
Fig. 6, Phascolosoma bulbosum, sp.n.
Fig. 7, Sipunculus norvegicus, Kor. & Dan.
Fig. 8, Aspidosiphon Müllери, Diesing.
Fig. 9, Phascolosoma Johnstoni, Forbes.



R.S. del.

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Fig. 10, Phascolosoma constrictum, sp. n.

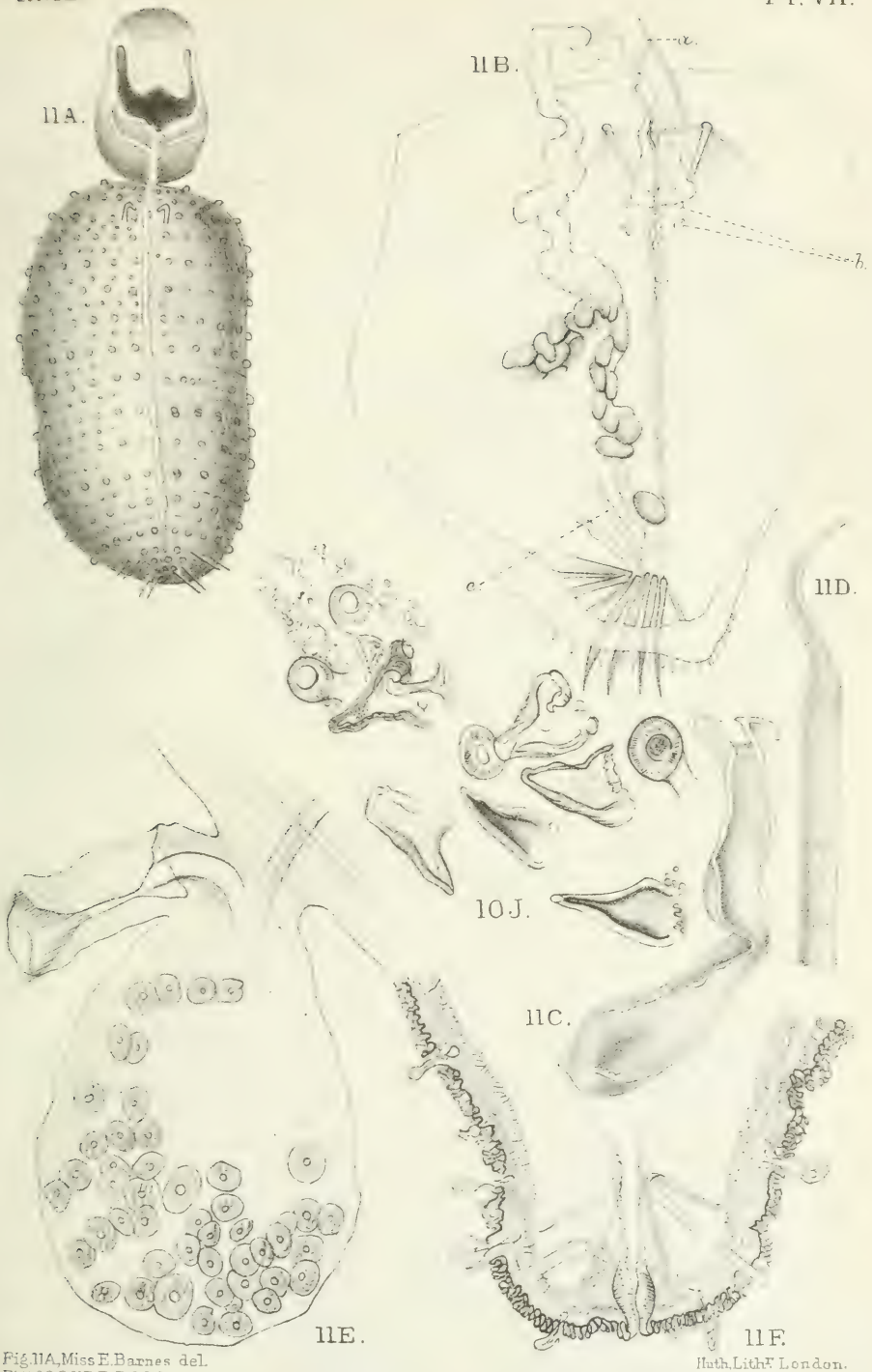

Fig. 11A, Miss E. Barnes del.
Figs. 10 J, 11B-F, R.S. del.

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Fig. 10, Phascolosoma constrictum, sp. n.
Fig. 11, Echiurus abyssalis, Skorikow.

ON A COLLECTION OF RECENT CRINOIDS FROM THE WATERS ABOUT IRELAND.

BY

AUSTIN H. CLARK,

U.S. National Museum, Washington.

Through the kindness of the Fisheries Branch of the Department of Agriculture and Technical Instruction I have been enabled to examine a most interesting collection of crinoids taken by the Irish Fishery cruiser *Helga* in the seas to the west and north of Ireland, and a specimen from the Faeroe Channel taken by Dr. Wolfenden's yacht *Silver Belle*.

Although small, the collection is one of very considerable importance, for it contains the first specimen of a species of *Atelecrinus* to be taken outside the tropics, and the first from the eastern side of the Atlantic; specimens of *Pentametrocrinus atlanticus* and of *Trichometra delicata* from far to the northward of their previously ascertained habitat; and examples of a new species of *Trichometra*.

I.—COMATULIDS.

FAMILY *ANTEDONIDAE*.

SUB-FAMILY *ANTEDONINAE*.

Antedon petasus (Düben and Koren).

W. 5—23 iii '04. Five miles south-west by west of Great Skellig, County Kerry, 60–65 fathoms.—One mature specimen with the arms about 60 mm. long and the cirri about XL, 13–14, 9 mm. long.

S.R. 360—8 viii '06. 52° 04′ N., 11° 27′ W.; 108–120 fathoms. —One specimen with the cirri about LXX, 14, 13 mm. long.

Antedon petasus differs from *A. bifida* in having the cirri much more numerous with slightly fewer segments of which the distal are proportionately slightly shorter and somewhat more compressed laterally, so that they appear proportionately somewhat broader in lateral view. The cirri of *A. petasus* are always more strongly curved than those of *A. bifida*, and are relatively shorter.

In *A. bifida* the cirri are XXI–XXXII (usually about XXV), 14–17 (usually 15–16). It is evident, therefore, that the specimens recorded above agree with *A. petasus* rather than with *A. bifida*. Direct comparison with a large series of the former from Kristineberg, Sweden (belonging to the Zoological Museum at Copenhagen) proves this to be the case, the only difference to be detected being that in the Swedish specimens the distal cirrus segments are very slightly shorter.

Antedon petasus, occurring in shallow water along the coasts of Scandinavia, probably also ranges over much of the northern portion of the habitat of *A. bifida*, living in the deeper and colder water off shore.

SUB-FAMILY *ZENOMETRINAE*.

Leptometra celtica (Barrett and McAndrew).

S.R. 321—iv '06. 50° 58′ N., 11° 17′ W., 208–480 fathoms.—Two broken specimens, one large and one medium-sized; both have the IBr series in close lateral apposition.

S.R. 360—8 viii '06. 52° 04′ N., 11° 27′ W., 108–120 fathoms.—One large broken specimen, similar to the large specimen recorded above.

S.R. 1173—19 v '11. 51° 50′ N., 11° 47′ W., 275 fathoms.—Forty-one specimens; the largest has the cirri XXII, 44–45, 45 mm. long, and the arms about 90 mm. long; all have the IBr series in close lateral apposition.

SUB-FAMILY *HELIOMETRINAE*.

Hathrometra prolixa (Sladen).

"*Silver Belle*," *Station No.* 9; 60° 18′ N., 4° 43′ W; 495 fathoms.—One small specimen with arms 65 mm. long.

Hathrometra sp.

S.R. 506—12 ix '07. 50° 34′ N., 11° 19′ W., 661–672 fathoms.—One specimen, without cirri.

Hathrometra sp.

S.R. 353—6 viii '06. 50° 38′ N., 11° 32′ W., 250–542 fathoms.—One specimen of a species allied to *H. Sarsii*.

Trichometra hibernica, sp. nov.

S.R. 151—27 viii '04. 54° 17′ N., 11° 33′ W., 388 fathoms.—Three broken specimens, of which the largest has been taken as the type. This may be described as follows:—

The centrodorsal is concealed by the cirri.

The cirri are very numerous, 25–33 (usually nearer the latter), probably about 13 mm. long; the third–fifth segments are the longest, one-third or one-half again (usually nearer the former) as long as broad; the following slowly decrease in length after, from two to four being about as long as broad and the distal slightly, though not very greatly, broader than long; the longer proximal segments are slightly constricted centrally with rather prominent distal ends; the short distal segments have a median dorsal carination.

The ossicles of the IBr series and proximal brachials have everted and serrate distal edges.

The IBr_1 are not in contact basally, and their sides make an angle of about 60° with the sides of the adjacent IBr_1; the axillaries (IBr_2) and lower brachials are widely free laterally.

The two other specimens are similar, but smaller; one of them has the arms about 25 mm. and the cirri about 11 mm. in length.

S.R. 223—12 v '05. 53° 07′ N., 14° 50′ W., 410–500 fathoms.—Two dry specimens.

The genus *Trichometra* is very closely related to the north Atlantic genus *Hathrometra*, of which it is the generalised tropical representative, occurring on both coasts of the mid-Atlantic, in the Indian Ocean, and in the East Indian region. The species of *Trichometra* all have the distal edges of the brachials and of the ossicles of the IBr series everted and prominently serrate or spinous, the cirri comparatively tenacious and not likely to be lost during capture, and P_1 excessively elongated with exceedingly long and slender outer segments which have greatly produced overlapping distal ends, while in the species of *Hathrometra* the edges of the brachials and of the ossicles of the IBr series are unmodified and smooth, P_1 is less elongated with shorter and less slender outer segments which have only slightly produced distal ends, and the cirri are extremely fragile, dropping off at the slightest touch.

Trichometra hibernica is most closely related to a corresponding species on the eastern coast of North America, which, however, has considerably longer cirri composed of longer segments.

Trichometra delicata, A. H. Clark.

Trichometra delicata, 1911. A. H. Clark, Bull. du mus. d'hist. nat. (Paris), No. 4, 1911, p. 258.

Helga CXX.—24 v '01. 53° 58′ N., 12° 24′ W., 382 fathoms.—One specimen; the cirri, which are 7 mm. long, have 15–20 segments, of which the longest are three times as long as the median diameter; the arms are about 20 mm. long.

This is a small specimen, not quite mature ; it differs from the type of the species, which is in the Paris Museum, only in its smaller size and in the lesser number of cirrus segments, this latter probably due to immaturity.

Family *PENTAMETROCRINIDAE.*

Pentametrocrinus atlanticus (Perrier).

S.R. 506—12 ix '07. 50° 34′ N., 11° 19′ W., 661–672 fathoms.—One rather small specimen with arms about 75 mm. long.

S.R. 331—9 v '06. 51° 12′ N., 11° 55′ W., 610–680 fathoms.—One medium sized specimen, somewhat smaller than the succeeding.

S.R. 489—3 ix '07. 51° 35′ N., 11° 55′ W., 720 fathoms.—One medium-sized specimen ; the cirri are XXV, 15, about 25 mm. long.

In all of these specimens the perisome of the disk and interbrachial areas is very thickly set with small regular calcareous plates as in *P. semperi*. This was first noticed by Kœhler, and is well shown in his figures.

Family *ATELECRINIDAE.*

Atelecrinus Helgae, sp. nov.

Helga CXX—24 viii '01. 53° 58′ N., 12° 24′ W., 382 fathoms. —One broken specimen, which may be described as follows :—

The centrodorsal is sharply conical, 2·5 mm, in diameter at the base, and 3 mm. long interradially, measuring along its side.

The cirrus sockets are thirty-five in number, arranged in two regular, very closely crowded columns in each radial area, three or four to a column.

On either side of each cirrus socket is a subtriangular thickening (the swollen transverse ridge) which is produced outward and slightly downward (distalward) so that the centrodorsal has a strongly serrate profile ; in the midradial line these processes form a zigzag line running down the centre of the radial area ; in the interradial lines they lie on either side of a very narrow slit-like furrow. In the basal portion of the centrodorsal are five prominent interradial ridges which run from the produced centre of each basal downward, becoming narrower, sharper and lower, disappearing between the proximal cirrus sockets.

The basals are very short, with the interradial portion swollen and rising to the height of the ridge on the proximal portion of the centrodorsal, and the radial portion reduced to a narrow line separating the radial from the centrodorsal.

The radials are short, four or five times as broad as long in the median line.

The IBr_1 are approximately oblong, nearly twice as broad as long in the median line; the median portion of the distal edge is slightly incised; the axillaries (IBr_2) are nearly rhombic, about as broad as long, with the anterior angle slightly produced. The proximal portion of the lateral edge may be produced into a rather prominent tubercle corresponding to a slight thickening of the anterolateral angle of the IBr_1, or both the lateral edge of the IBr_1 and that of the axillary may be cut away so that they form an obtuse angle with each other as in *A. conifer*. The brachials resemble those of *A. balanoides*, but are proportionately slightly shorter.

The length of the specimen from the tip of the centrodorsal to the distal border of the ninth brachial (the hypozygal of the third syzygial pair) is 13 mm. None of the arms are preserved beyond this point.

This new species is related to the West Indian *A. balanoides*, but the centrodorsal is smaller and more sharply conical, with straight instead of more or less convex sides, and with only about half as broad a cirrus-free basal portion; the cirrus sockets are also more numerous, and all of them are closely crowded against those above and below and on either side instead of being more or less separated as in *balanoides*; this close crowding of the cirrus sockets brings their lateral processes into much more definite radial and interradial lines than are evident in *A. balanoides*. While the cirrus sockets of *A. balanoides* are arranged in ten columns the sides of the centrodorsal are not distinctly marked off into ten sharply differentiated areas as is the case in *A. Helgae*.

II.—STALKED CRINOIDS.

Family *BOURGUETICRINIDAE*.

Rhizocrinus lofotensis (M. Sars).

Helga CXX—24 viii '01. 53° 58′ N., 12° 24′ W., 382 fathoms.—One five-armed specimen; this was compared directly with some of Professor Sars' type material from the Lofoten Islands, and no differences were found.

Wt.P.467—S.38. 725. 10/12. B.&N., Ltd.

FURTHER RECORDS OF THE CEPHALOPODA DIBRANCHIATA OF THE COASTS OF IRELAND

BY

ANNE L. MASSY.

Some necessary corrections to my former list (1909) have been made here, *Doratopsis vermicularis* (Rüppell) being withdrawn.

I was not then acquainted with the nearly allied genus *Planctoteuthis* (Pfeffer, 1912), and the specimens, on being compared closely with Chun's (1910) description of *P. exophthalmica*, proved to be of that species. Two examples which I had recorded as young *Histioteuthis bonelliana*, Férussac, have proved to be *Calliteuthis Meneghinii* (Verany), which was recently obtained also during investigations carried out on board the Scotch Fishery Cruiser *Goldseeker* (Russell, 1909, sub *Calliteuthis reversa*, Verrill). Another rare species, *Teuthowenia megalops* (Prosch) has been added to the British-and-Irish list.

I have to thank Mr. E. A. Smith of the British Museum, and Mr. Nichols of the Dublin Museum, for their courtesy in allowing me to re-examine specimens in their charge.

Dr. Pfeffer of Hamburg has kindly given me help on several occasions.

SUB-ORDER I. **Octopoda.**

FAMILY *POLYPODIDAE.*

GENUS **Polypus,** Schneider, 1784.

Polypus ergasticus, P. & J. Fischer, 1892.

Polypus profundicola, Massy, 1907.

S.R. 1242.—Trawl at 590 fathoms.—One ♀.

The above specimen measures about 320 mm. in total length, and 90 mm. from end of body to eyes.

Distribution.—West Coast of Africa, 22° 54′ N. lat. (Fischer and Joubin, 1906). Off south-west coast of Ireland.[1]

[1] *Fisheries, Ireland, Sci. Invest.*, 1907, *I*, [1909].

Sub-order II. Decapoda.

Division B.—OEGOPSIDA.

Family *ARCHITEUTHIDAE.*

Genus **Architeuthis** (Steenstrup) Verrill, 1880.

Architeuthis sp.—Two upper mandibles.

The above are almost as large as the upper jaws of *A. princeps*, Verrill, figured on Plate XI of "The Cephalopods of the North-eastern coast of America"; the frontal lamina is broken in both, but the palatine lamina of one specimen is uninjured and measures 86 mm. in length, the total length of jaw being about 110 mm. The jaws were found in the stomachs of two sperm whales caught off the coast of Mayo, in September, 1910. They were given to Mr. Holt by Captain Bruun, who stated that the whales contained some huge squids too much digested for examination, and a number of beaks.

Family *ENOPLOTEUTHIDAE.*

Genus **Octopodoteuthis,** Rüppell, 1844.

Octopodoteuthis sicula, Rüppell, 1844.

Veranya sicula, Krohn, 1847.

Verania sicula, Hoyle, 1886.

S.R. 439.—Mosquito-net triangular net at surface.—One, 19 mm.

S.R. 589.—Midwater otter trawl at 0–500 fathoms.—One, 14 mm.

S.R. 805.—Midwater otter trawl at surface.—One, 107 mm.

The example from station S.R. 439 possesses a mantle-length of 8 mm. and fins of 6 mm. in length and 12 mm. in breadth. The tentacle, which is but slightly thicker than the ventral arm, exceeds the latter in length by about the length of the club, the total length of tentacle from the mouth being 17 mm. The club closely resembles the illustration given by Jatta (1896, Tav. 13, fig. 2). On the carpal portion of the ventral surface are two very small suckers, which are succeeded by two so large that their outer edges overlap on either side on to the dorsal surface; these are succeeded by two suckers almost as large, and the distal part of club appears to be bare; the large suckers have a perfectly smooth horny ring. Hooks are developed on all the arms, but the distal portion of the dorsal and ventral arms only showed suckers that had undergone modification, the ring having disappeared, and hooks if present were entirely retracted. The extreme tip appeared to be missing from all the arms. The specimen from S.R. 589 has a mantle-length of 6 mm. and fins of 3 mm. in length and 9 mm. in breadth. The arms are a good deal

mutilated, but many hooks are discernible, and the club closely resembles that already described. The specimen from S.R. 805 has a dorsal mantle-length of 50 mm , and the fins measure 55 mm. in breadth ; some of the eight arms have their tips imperfect, the 2nd on right, 4th on right and 2nd on left are, however, perfect, and possess swollen, dark-coloured tips measuring from 2-3 mm.

Distribution.—Mediterranean. North Atlantic (the oceanic form, see Pfeffer, 1912).

FAMILY *GONATIDAE.*

GENUS **Gonatus,** Gray, 1849.

Gonatus Fabricii (Lichtenstein) 1818.

Gonatus amoena, Gray, 1849.

Lestoteuthis Kamtschatica, Verrill, 1880.

Cheloteuthis rapax, Verrill, 1881.

Lestoteuthis Fabricii, Verrill, 1881.

Gonatus Fabricii, Hoyle, 1886.

Gonatus antarcticus, Lönnberg, 1898.

S.R. 1244.—Sprat net on trawl, 670 fathoms. —One, 185 mm.

Distribution.—Arctic seas of both hemispheres. Mediterranean. Japan. Cape of Good Hope. Magellan's Straits. "Das Stük vom Kap der guten Hoffnung dürfte vielleicht der südlichen Form zuzurechnen sein" (Pfeffer, 1912, p. 242).

Vertical Range.—Extends to 906 fathoms (Hoyle, 1886)

FAMILY *HISTIOTEUTHIDAE.*

GENUS **Calliteuthis,** Verrill, 1880.

Calliteuthis Meneghinii (Verany) 1851.

Calliteuthis reversa, Verrill, 1880, 1881, 1882.
,, ,, Joubin, 1899 and 1900.
,, ,, Pfeffer, 1900.
,, ,, Hoyle, 1904.
,, ,, Russell, 1909.

Calliteuthis reversa, Chun, 1910.

Histioteuthis juv., Chun, 1910.

S.R. 503.—Mosquito net triangular net at surface.—One. Mosquito net triangular net at 0–80 fathoms.—One.

The above examples have been already recorded (Massy, 1907, 1909) as young specimens of *H. bonelliana,* Férussac.

The specimen taken at the surface has since been identified by Dr. Pfeffer and is described at length in his recent magnificent monograph on the Oegopsid Cephalopoda of the Plankton Expedition (1912, pp. 270, 271). The other example, which has a mantle-length of about 9 mm., must also be referred to the same species, as I find on examination that the rings of the suckers of the tentacular and of the other arms are without teeth. The mantle extremity is blunt, as in the Irish specimen figured by Pfeffer (1912, Taf. 21, fig. 3). There are about thirteen rows of luminous organs on the ventral mantle surface, and a few luminous organs are visible on the dorsal mantle surface. The fins measure 5 mm. in length and 9 mm. in breadth; the distance from the dorsal mantle-margin to the bifurcation of dorsal arms is 7 mm.

Distribution.—North-west coast of Scotland (Russell, 1909). North Atlantic (Pfeffer, 1912). Coast of Portugal (Joubin). East Coast of North America (Verrill). Indian Ocean (Chun, 1910).

Spp. incert.

S.R. 224.—Midwater otter trawl at 0–700 fathoms.—One.

S.R. 231.—Midwater otter trawl at 0–1150 fathoms.—One.

S.R. 449.—Midwater otter trawl at 0–700 fathoms.—One.

S.R. 470.—Midwater otter trawl, 0–500 fathoms.—One.

S.R. 479.—Mosquito-net townet and coarse townet on trawl at 468–560 fathoms.—One.

S.R. 589.—Midwater otter trawl at 0–500 fathoms.—One.

S.R. 593.—Midwater otter trawl at surface.—Five.

The above specimens all have a mantle-length of 2 to about 4 mm. Pfeffer (1912, p. 265) states that we know no character by which to distinguish between the two species *Calliteuthis Meneghinii* (Verany) and *Histioteuthis bonelliana* (Férussac) when at such a youthful stage that the mantle-length measures only 3 mm.

FAMILY *BRACHIOTEUTHIDAE.*

GENUS **Brachioteuthis,** Verrill, 1881.

SUB-GENUS **Tracheloteuthis,** Steenstrup, 1881.

Brachioteuthis (Tracheloteuthis) Riisei (Steenstrup) 1857.

Tracheloteuthis Behnii, Steenstrup, 1882.

Entomopsis Velaini, Rochebrune, 1884.

Entomopsis Clouei, Rochebrune, 1884.

Verrilliola gracilis, Pfeffer, 1884.

Verrilliola nympha, Pfeffer, 1884.

Brachioteuthis Riisei, Chun, 1910.

S.R. 337.—Midwater otter trawl at 0–20 fathoms.—Two, 7–12 mm.

S.R. 439.—Mosquito net triangular net at 0–300 fathoms.—Two, 10–12 mm.

S.R. 443.—Midwater otter trawl at 0–500 fathoms.—Two, 8 mm.

S.R. 752.—Midwater otter trawl at surface.—Three, 13–15 mm.

Distribution.—From about 60° N., to about 60° S., i.e., cosmopolitan with the exception of the Arctic and Antarctic regions (Pfeffer, 1912).

Family *CHIROTEUTHIDAE.*

Genus **Chiroteuthis,** d'Orbigny, 1839.

Sub-genus **Planctoteuthis,** Pfeffer, 1912.

Chiroteuthis (Planctoteuthis) exophthalmica (Chun) 1908.

Doratopsis exophthalmica, Chun, 1908, 1910.
,, *vermicularis,* Massy, 1909.

S.R. 481.—Midwater otter trawl at 0–900 fathoms.—One.

S.R. 589.—Midwater otter trawl at 0–500 fathoms.—One.

S.R. 590.—Midwater otter trawl at 0–480 fathoms.—One.

The specimen from station S.R. 481 has been already recorded (Massy, 1909) as *Doratopsis vermicularis* (Rüppell).

As Dr. Pfeffer possessed no examples of *D. vermicularis* except from the Mediterranean, I fortunately sent him the specimen from station S.R. 590, believing it to be of that species: although it was in extremely bad condition he was able to identify it as *Planctoteuthis exophthalmica* (Chun) (Pfeffer, 1912, p. 574). On re-examining the specimen from S.R. 481 I found it also agreed with the characters of *P. exophthalmica.* From the tip of ventral arm to end of body it measures about 40 mm., about 13 mm. of this length is occupied by the mantle (to end of pen). The fins of butterfly-wing shape are 5 mm. in length and about 9 mm. in breadth. From the middle of eyes to mantle-margin dorsally the distance is 6 mm., and from the middle of eyes to the bifurcation of dorsal arms, 5 mm. The breadth of head is 5 mm; the eyes have a pointed projection ventrally, and on the front edge of each, dorsally, are two bright red chromatophores as described by Chun (1910, p. 291). One of the ventral arms is mutilated, but the other measures 16 mm.; both carry a few suckers on the proximal portion, arranged singly and far apart. The order of arms is 4231. The right tentacle measures 22 mm. in length, and the left 27 mm. The outer surface of the slender club is rounded and has a row of expanded chromatophores of dull red, and on the stalk there are a few dark contracted chromatophores. The extreme distal portion of each club appears to be bare, then come four rows of suckers, two or three in each row; these are followed by suckers (all of about equal size) arranged four in a

row; one club possesses about eight of these rows, the other appears to have eleven. The suckers are then placed three in a row for two rows, and proximally only two are in each row; of this last arrangement there are two rows in one and three in another. About six of the proximal suckers are larger than the others. There are about sixty suckers on one club and about fifty-four on the other; the stems of the tentacles are without suckers. On the space from bifurcation of arms to line between centre of eyes dorsally there are five dark contracted chromatophores in a row with three more on either side; between centre of eyes and dorsal mantle-margin larger yellow-brown chromatophores are present. The dorsal mantle has a large, wine-coloured chromatophore in the median line just above fins, and also over fifty scattered chromatophores, chiefly dark and contracted. Ventrally the mantle seems to have been denuded of some of its surface, but about fifteen dark contracted chromatophores are on the posterior third. The dorsal surface of the ventral and other arms are sprinkled at wide intervals with conspicuous yellow-brown expanded and dark contracted chromatophores.

The specimen from S.R. 589 measures 34 mm. from tip of ventral arm to end of pen. The mantle is contracted and the distance from the dorsal margin to end of pen is 12 mm. The butterfly-wing shaped fins are 3·50 mm. in length and 6·50 mm. in breadth. From the mid-eye region to mantle-margin dorsally the distance is 6 mm., and from the mid-eye region to the bifurcation of dorsal arms the distance is about 4 mm. The eyes are missing. One ventral arm has lost the extreme tip and measures 12 mm., the other measures 13 mm.; both have four suckers on the proximal portion arranged singly and far apart. The order of arms is 4231. The right tentacle is mutilated, the other is 35 mm. in length.

The lengths of arms and tentacles are known, however, to vary extraordinarily, so much depending upon states of contraction and methods of preservation. The club possesses distally two rows of suckers, arranged two in a row, then a row of three suckers, then fourteen rows, each containing four suckers (all about the same size), these are succeeded by a row consisting of three suckers, then follow three rows of two suckers and finally a single sucker. The five proximal suckers are larger than the rest; about seventy-three suckers altogether are on the club, the dorsal surface of which is rounded and possesses about three rows of yellow-brown chromatophores, some larger than the rest. The dorsal surface of the arms have a few conspicuous chromatophores of the same tint.

About forty-one chromatophores (chiefly dark and contracted, but some yellow-brown) are visible on the dorsal mantle, and seven on the ventral mantle, the latter being confined to the posterior third.

Distribution.—31° 59′ N., 15° 5′ W.; 34° 13′ S., 80° 30′ E. (Chun, 1910).

Sp. incert.

S.R. 366.—Midwater otter trawl at 0–400 fathoms.—One.

S.R. 589.—Midwater otter trawl at 0–550 fathoms.—One.

The example from station S.R. 366 may be a specimen of *P. exophthalmica*, but it is much damaged, the tentacles having become detached, and their clubs having, apparently, lost many suckers. The dorsal mantle-length to end of pen is about 8 mm., and from the dorsal mantle-margin to the bifurcation of arms the distance is 7 mm.

The fins measure *ca.* 2·50 mm. in length and 6 mm. in breadth. The order of arms is 4231. The eyes are missing. There are expanded yellow-brown chromatophores on the dorsal head region, and there are a few on the dorsal mantle. The ventral mantle shows expanded yellow-brown chromatophores limited to the posterior third. The specimen from station S.R. 589 is also probably a young example of *P. exophthalmica*, but as it is very young and in bad condition, it is not easy to assign it with certainty. The mantle has been turned partly inside-out and the ventral arms are mutilated. Both tentacles measure about 6 mm. There are yellow-brown chromatophores on the head region and back of club. One eye is absent, part of another was present, but had become detached; it was oval, but the part which in *P. exophthalmica* carries the characteristic pointed ventral projection was absent. The club possesses suckers arranged four in a row for many rows; the proximal suckers are larger and placed two in a row. Although stalks are not apparent, the suckers seemed to project more from the club-surface than in the specimens of *P. exophthalmica* already noticed.

Family *CRANCHIIDAE.*

Sub-Family *TAONIINAE.*

Genus **Desmoteuthis,** Verrill, 1881.

Desmoteuthis hyperborea (Steenstrup), 1857.

Leachia hyperborea, Steenstrup, 1857.

Taonius hyperboreus, Steenstrup, 1861.

Leachia ellipsoptera, Carpenter, Jeffreys and Thompson, 1870.

Desmoteuthis tenera, Verrill, 1882.

Loligopsis hyperborea, Rochebrune, 1884.

Taonius hyperboreus, Hoyle, 1886, Norman, 1890, Posselt, 1898.

S.R. 1242.—Sprat net on trawl, 590 fathoms.—One.

The mantle and fins of this specimen are considerably contracted and the eyes are damaged. The order of arms is 3241.

The head and dorsal surface of arms appear to have been covered with closely-sprinkled purple-brown chromatophores. The mantle is pale, with a few large chocolate-coloured chromatophores usually oval in shape and measuring 3 mm. in length, a few being 3 mm. in breadth also; the distance between each varies from 5-10 mm.; twenty-one are scattered over the dorsal mantle-surface, and a number of very small chromatophores are placed on the median dorsal line, continuing throughout the fin region on either side of the pen.

The fins are colourless on both sides.

On the ventral surface twenty-three large chromatophores are arranged in about six indefinite rows, and the form of the pen throughout the fin region is outlined with a row of very small dark chromatophores, the surface between being also thickly sprinkled with them. The pen, which is yellow-brown in colour, projects 2 mm. beyond the fins.

Total length, ...	*ca.* 134 mm.
Mantle-length dorsally, ...	81 mm.
Length of fin, ...	34 mm.
Breadth of fin, ...	21 mm.

Length of arms :—

1st on right,	17 mm.	1st on left,	24 mm.
2nd ,,	29 mm.	2nd ,,	31 mm.
3rd ,,	32 mm.	3rd ,,	35 mm.
4th ,,	24 mm.	4th ,,	27 mm.

Tentacle on right, 57 mm.
,, left, 49 mm.

Distribution.—North Greenland. Jan Mayen. Off the north-west and south-west coast of Ireland. *Goldseeker* Exp. (Russell, 1909). New England.

Genus **Taonidium**, Pfeffer, 1900.

Taonidium Pfefferi, Russell, 1909.

S.R. 1175.—Midwater otter trawl at *ca.* 0–500 fathoms.—One.

This example is considerably larger than the type specimen described by Russell (1909), having a total length of about 63 mm. The body is more fusiform than the type, the mantle-length being about three times that of its greatest breadth. The pen is traceable as a streak down the centre of the dorsal mantle surface; the margin of the mantle agrees with the type; the colouring is also similar, but the chromatophores are more numerous in proportion to the size, about five irregular rows of large chromatophores being present on both sides of mantle; thirty-six are visible on the dorsal and twenty-six on the ventral

surface; the largest measure 2 mm. in length. The arms are slightly webbed at base, especially between the dorsal pair; a delicate protective membrane runs along either side of the inner surface of arms. The tentacles are expanded distally into a club with moderate web and protective membrane. The suckers of the club are in rows of four, about eighteen rows being present; about six rows distally are very small, they gradually become larger, about four rows of the central portion being larger than the rest, and decrease in size proximally. All the suckers of the club have a circular yellow-brown ring with from five to thirteen teeth; when so few as five are present there are often gaps, showing that some teeth have been broken off; there are also about three rows of papillae on each sucker. The suckers on the stem of the tentacle are very small and delicate and on long stalks; they are at first placed four in a row, but are further apart and only two in each row proximally and appear to cease at about 2 mm. from base of tentacle. About six oblong chromatophores are arranged in a row on the dorsal surface of each club, one of which has also a smaller row of chromatophores; the dorsal surface of the stems each possess about eight chromatophores. The dorsal surface of each eye-stalk has a large squarish chromatophore as in the type and a large chromatophore is covered by the funnel.

The principal dimensions of the specimen are appended, but they must be considered as approximate, as the specimen is much contracted, the fin portion being almost withdrawn inside mantle:—

Total length, ...	*ca.* 63 mm.
Dorsal mantle-length, ...	*ca.* 37 mm.
Breadth of mantle, ...	*ca.* 15 mm.
Length of fins, ...	*ca.* 7 mm.
Breadth of fins, ...	*ca.* 8 mm.
Top of funnel to mantle-margin ..	6 mm.
Length of eyes, ...	5 mm.
Breadth of eyes, ...	*ca.* 3 mm.

Length of arms:—

1st on right,	4 mm.	1st on left	4 mm.
2nd ,,	6 mm.	2nd ,,	missing.
3rd ,,	8 mm.	3rd ,,	6·50 mm.
4th ,,	5 mm.	4th ,,	5·50 mm.
Right tentacle,	19 mm	Left tentacle,	15 mm.
Club,	4 mm.		

Distribution—"A single specimen was taken on Aug. 31st, 1907, in 60° 3′ N., 3° 53′ W., in 505 m. It is, however, very probably a surface form" (Russell, 1909, p. 453).

GENUS **Teuthowenia**, Chun, 1910.

Teuthowenia megalops (Prosch) 1849.

Cranchia megalops, Steenstrup, 1861.

Owenia megalops, Pfeffer, 1900, 1908.

S.R. 224.—Midwater otter trawl at 0–750 fathoms.—One, 11 mm.

S.R. 231.—Midwater otter trawl at 0–1150 fathoms.—One, 19 mm. Coarse silk triangular net at 0-750 fathoms.—One, 32 mm.

S.R. 302.—Midwater otter trawl at surface.—Two, 6–9 mm.

S.R. 337.—Midwater otter trawl at 0–20 fathoms.—One, 17 mm.

S.R. 439.—Mosquito-net triangular net at 0–300 fathoms.—One, 10 mm.

The above specimens have all been seen by Dr. Pfeffer, who informed me that the specimen from station S.R. 439 is probably the prettiest in any collection. It has a mantle-length of 4 mm. by 3 mm. in breadth; the extremity is rounded rather than pointed, and the fins are rudimentary. The funnel does not quite attain to base of arms. The length of the eyes is twice that of their breadth; they are set obliquely and measure about 1 mm. in length and are broadest at their base; the optic nerve can be seen as in Chun's illustration of *Teuthowenia antarctica* (Chun, 1910, Taf. LVI, fig. 1); ventrally a slighter nerve is also visible at either side situated above the other; the end surface of eyes is pointed ventrally, the eye hole is circular and the lens prominent. The 3rd arms are mutilated, the 2nd pair were rather longer than the pigmented portion of eyes. Both tentacles measure about 5 mm. and bear suckers (on long slender stalks) throughout their entire length; the suckers are placed four in a row and are set fairly regular distally, but are irregular and placed in extending order proximally, the web extends for a considerable distance. The body is pale with a tinge of lavender; there is a dark chromatophore on the dorsal surface of one eye and three brownish-red ditto on the other, and three of the same colour on the surface between the eyes. On the dorsal mantle are seven dark contracted chromatophores, and on the ventral mantle six ditto, and a few very small on the siphon. One eye ventrally has a rust-coloured chromatophore, and a few of the same tint ornament the tentacles.

Some of the other specimens, those from station S.R. 302, for example, have the eyes set much straighter in a line with the head, and both have blackish or reddish-brown chromatophores on the dorsal surface of each eye. The mantle-length in both is about 3 mm., and fins are not discernible; it is not possible to state if end of body was originally rounded or pointed. The tentacles have suckers throughout their length.

One specimen has small dark chromatophores, some of which seem to have formed a circle round the posterior portion of

mantle; the outer surface of tentacles in this example have reddish-yellow chromatophores. The other specimen has about eight chromatophores on the dorsal mantle, and a number of very small ditto (chiefly dark, but some yellow-brown); ventrally there are seven chromatophores on the mantle, and a number of very small ones, all coloured as on the dorsal surface.

Distribution.—Westwards of Färöes (Prosch). 58° N., 27° W., (Copenhagen Museum). Bay of Biscay, surface to 100 fathoms (Hoyle, 1906, Pfeffer, 1912, p. 745).

PARTICULARS OF STATIONS.

S.R. 224.—12 v '05, 53° 7′ N., 15° 6′ W., 860 fathoms, ooze, surface temperature 10·7° C., salinity at surface 35·32 ‰.

S.R. 231.—20 v '05, 55° 1′ N., 10° 45′ W., 1200 fathoms, surface temperature 10·9° C., salinity of surface 35·28 ‰.

S.R. 302.—5 II '06, 51° 53′ N., 11° 58′ W., 460 fathoms, fine muddy sand, surface temperature 10·5° C., salinity at surface 35·39 ‰.

S.R. 337.—12 v '06, 51° 21′ 30″ N., 12° 9′ W., 768 fathoms, surface temperature 11·0° C.

S.R. 366.—10-11 VIII '06, 51° 24′ N., 11° 40′ W., 461 fathoms, surface temperature 15·55° C.

S.R. 439.—15 v '07, 51° 47′ 30″ N., 12° 28′ W., 723 fathoms, ooze, surface temperature 11·75° C., salinity 35·44 ‰.

S.R. 443.—16-17 v '07, 51° 28′ N., 12° 5′ W., 683 fathoms, surface temperature 11·65° C., salinity 35·16 ‰.

S.R. 449.—19 v '07, 50° 26′ N., 11° 36′ W., 950 fathoms, surface temperature 10·75° C., salinity 35·19 ‰.

S.R. 470.—24 VIII '07, 50° 16′ N., 11° 27′ W., 770 fathoms, ooze, temperature at surface 15·8° C., at 500 fathoms 9·03° C., salinity at surface 35·30 ‰, at 500 fathoms 35·35 ‰.

S.R. 479.—28 VIII '07, 51° 20′ N., 11° 41′ W., 468-560 fathoms, temperature at surface 15·65° C., salinity at surface 35·41 ‰.

S.R. 481.—29 VIII '07, 50° 59′ N., 11° 52′ W., 920-1064 fathoms, ooze, temperature at surface 16·15° C., salinity at surface 35·35 ‰.

S.R. 503.—12 IX '07, 50° 42′ N., 11° 26′ W., 990 fathoms, temperature at surface 16·2° C., salinity at surface 35·34 ‰.

S.R. 589.—2 VIII '08, 51° 54′ N., 12° 14′ W., 593 fathoms, ooze, surface temperature 17·1° C., at 550 fathoms, 9·45° C., salinity at surface 35·43 ‰, at 550 fathoms 35·48 ‰.

S.R. 590.—3 VIII '08, 51° 51′ 30″ N., 12° 8′ W., 480 fathoms, ooze, surface temperature 17·2° C., bottom temperature 9·28° C., salinity at 450 fathoms 35·46°/$_{oo}$.

S.R. 593.—6 VIII '08., 50° 32′ N., 11° 34′ W., 770 fathoms, ooze, surface temperature 16·2° C., salinity at surface 35·48°/$_{oo}$, at 650 fathoms 35·53°/$_{oo}$.

S.R. 752.—16 V '09, 51° 51′ N., 12° 13′ W., 523 fathoms, ooze, surface temperature 11·9° C., at 50 fathoms 10·54° C., at 100 fathoms 10·45° C., at 500 fathoms 8·9° C., salinity at surface 35·32°/$_{oo}$; at 50 fathoms 35·32°/$_{oo}$; at 100 fathoms 35·34°/$_{oo}$; at 500 fathoms 35·43°/$_{oo}$.

S.R. 805.—14 VIII '09, 51° 52′ N., 12° 14′ W., 539 fathoms, ooze, surface temperature 17·78° C., at 50 fathoms 11·14° C., at 100 fathoms 10·72° C., salinity at surface 35·44°/$_{oo}$, at 50 fathoms 35·47°/$_{oo}$, at 100 fathoms 35·44°/$_{oo}$.

S.R. 1175.—19 V '11, 51° 37′ 30″ N., 11° 56′ W., *ca.* 400 fathoms.

S.R. 1242.—14 VIII '11, 51° 28′ N., 11° 54′ W., 590 fathoms, ooze.

S.R. 1244.—15 VIII '11.—51° 38′ N., 12° 2′ W., 670 fathoms.

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THE DEEP-WATER ASTEROIDEA, OPHIUROIDEA AND ECHINOIDEA OF THE WEST COAST OF IRELAND,

BY

G. P. FARRAN.

Plates I and II.

The following account deals with the Asteroidea, Ophiuroidea and Echinoidea which have been taken by the S.S. *Helga* on the west coast of Ireland since 1904, in depths greater than 50 fathoms. The earlier captures have already been dealt with by Mr. S. W. Kemp (1907), and most of the captures here recorded, especially of the Asteroids, had been identified by him with a view to publication, which was, however, prevented by his leaving the Fisheries Branch for the Indian Museum at Calcutta.

The total number of species taken was sixty-nine, including two of which the specific identification is uncertain. Of these, forty-six have already been recorded from the west coast of Ireland ; seven, viz., *Mimaster Tizardi*, *Culcita borealis*, *Poraniomorpha villosa*, *Ophiopleura aurantiaca*, *Ophioscolex purpurea*, *Ophiomyxa serpentaria*, *Gorgonocephalus Lincki*, are new Irish records, although they have been already recorded from the Faeroe Channel. Eleven are new to the British and Irish area though known from elsewhere in the North Atlantic. These are :—

Benthopecten armatus.
Psilasteropsis patagiatus.
Ophiura carnea.
Ophiura Ljungmanni.
Amphilepis norvegica.
Ophiacantha crassidens.
Ophiacantha aristata.
Ophiolebes claviger.
Ophiotoma coriacea.
Sperosoma Grimaldii.
Hemiaster expergitus.

One species, *Ophiomusium Lymani*, recorded once from a doubtful locality off the west coast of Ireland, has again been taken, and it has been found necessary to describe as new two Ophiuroids which could not be identified.

The new records are all of deep-water forms, and throw little light on questions of distribution, though in some cases the known range of the species has been considerably extended.

Some few changes in nomenclature have been introduced owing to the identification of species already known from the British and Irish area with those described from elsewhere which were previously regarded as distinct.

The method of capture was usually the beam trawl, but sometimes the dredge. The mesoplankton (jungfisch) trawl

was occasionally allowed to touch the bottom with successful results.

In conclusion, my best thanks are due to Mr. F. J. Bell for the facilities he has afforded me in examining the British Museum collections under his care, and also to Dr. H. L. Clark for kindly sending me numerous specimens from the Museum of Comparative Zoology at Harvard for examination and comparison. To both these gentlemen I am indebted for much valuable advice, and also to Dr. R. Koehler and Dr. T. Mortensen in Europe, and Mr. A. H. Clark and Dr. W. K. Fisher in America, for the trouble they have taken in examining specimens for me and in giving me the benefit of their experience. I have also to thank Miss J. Stephens for the names of the Sponges and Alcyonarians with which several of the Echinoderms were found associated.

ASTEROIDEA.

PHANEROZONIA.

Family *BENTHOPECTENIDAE*.

Benthopecten armatus (Sladen).

Pararchaster armatus, Sladen, 1889.

Pl. I, Fig. 1.

Helga.

S. R. 944—17 v '10. 51° 22′ N., 12° 41′ W., soundings 982 fms., ooze. Trawl.—Thirty.

This species is now added to the British and Irish deep-water fauna. It was originally described by Sladen in 1889, under the name *Pararchaster armatus*, from *Challenger* specimens taken off Nova Scotia and New Jersey and off the coast of Portugal. In the Irish specimens there are usually 2-3 subequal spinules on each plate in the papular area at the base of the arms, but towards the extremity of the arms there is rarely more than one. Sladen describes and figures these spinules as single or rarely in groups of two or three, but an examination of the *Challenger* specimens showed that the arrangement in groups of 2-4 was frequent. In the largest Irish specimen R = ca. 60 mm. (tips of arms broken), and in the smallest R = 11 mm., the average value of R being about 35 mm. Authorities differ as to the synonymy of this species. Verrill (1895) regards it as a synonym of *Benthopecten spinosus* described by him in 1884. Ludwig, in a recent revision of the species and genera belonging to the order *Notomyota* (1910), holds that *Benthopecten spinosus* is distinct, but that Sladen's *Pararchaster armatus* is the same as *Archaster simplex* described by Perrier in 1881, and should consequently be known as *Benthopecten simplex*. According to Sladen, however, Perrier's

figure "is altogether unlike the smallest example of *P. armatus* in character of armature both of the adambulacral and inferomarginal plates." Under these circumstances it seems best, provisionally, to retain Sladen's name.

It may be noted, however, that the elongated disc spines which are so noticeable in *B. spinosus* are not to be found in any of the Irish specimens of *B. armatus*. In the largest Irish specimen (R = ca. 60 mm.) the largest disc spine measures only 1·5 mm., while in a specimen of *B. spinosus* in the British Museum (R = 95 mm.) the disc spines are as much as 7 mm. long, and in a smaller specimen (R = 50 mm.) they measure 2·5 mm. The large interbrachial spines in the latter specimen measure only 6 mm., whereas in Irish specimens of R = 40 mm. they reach a length of 8 mm. It was only in the largest Irish specimen (R = ca. 60 mm.) that the comb-shaped pedicellariae could be found.

Family *CHEIRASTERIDAE*.

Pontaster tenuispinus (Dub. and Kor.).

Pontaster tenuispinus, Bell, 1892.
Pontaster tenuispinus, Kemp, 1905.

Helga.

S. R. 188—3 II '05. 51° 53′ N., 11° 59′ W., soundings 320–372 fms., mud. Trawl.—Several.

S. R. 212—6 V '05. 51° 54′ N., 11° 57′ W., soundings 378–411 fms., fine muddy sand. Trawl.—Fifty-four.

S. R. 222—12 V '05. 53° 1′ N., 14° 34′ W., soundings 293 fms., fine sand. Trawl.—Two.

S. R. 321—1 V '06. 50° 58′ N., 11° 17′ W., soundings 208–480 fms., fine sand. Trawl.—Nine.

S. R. 329—9 V '06. 51° 21′ 30″ N., 11° 35′ W., soundings 215–415 fms. Trawl.—Two.

S. R. 330—9 V '06. 51° 16′ N., 11° 37′ W., soundings 374–415 fms., fine sand. Trawl.—Three.

S. R. 351—5 VIII '06. 50° 19′ 30″ N., 11° 6′ W., soundings 230–250 fms., fine sand. Trawl.—Six.

S. R. 353—6 VIII '06. 50° 38′ 30″ N., 11° 32′ W., soundings 250–542 fms., muddy sand. Trawl.—Many

S. R. 440—16 V '07. 51° 45′ N., 11° 49′ W., soundings 350–389 fms. Trawl.—Several.

S. R. 447—18 V '07. 50° 20′ N., 10° 57′ W., soundings 221–343 fms., fine sand. Trawl.—Many.

S. R. 448—18 V '07. 50° 21′ N., 11° 0′ W., soundings 343–346 fms. Trawl.—Three.

S. R. 1005—12 VIII '10. 51° 22′ N., 11° 30′ 30″ W., soundings 249 fms., fine sand. Dredge.—Four.

The ordinary bathymetric range of this species off the south-west coast of Ireland seems to lie between 250 and 450 fathoms, or where the bottom of muddy sand begins to pass into

foraminiferous ooze. Between these depths it occurs frequently, sometimes in large numbers. All the Irish specimens were of a pale orange-red colour, which appears to distinguish the type from the more deeply coloured cold-water variety *platynota* (Grieg, 1907).

SUB-FAMILY *PLUTONASTERINAE.*

Plutonaster bifrons (Wyv. Thoms.).

Plutonaster bifrons, Bell, 1892.
Plutonaster bifrons, Kemp, 1905.

Helga.

S. R. 327—8 v '06. 51° 46′ N., 12° 14′ 30″ W., soundings 550–800 fms., ooze. Trawl.—Twelve.

S. R. 333—10 v '06. 51° 37′ N., 12° 9′ W., soundings 557–579 fms., ooze. Trawl.—Nine.

S. R. 334—10 v '06. 51° 35′ 30″ N., 12° 26′ W., soundings 500–520 fms. Trawl.—Two.

S. R. 335—12 v '06. 51° 15′ N., 12° 17′ W., soundings 673–893 fms. Trawl.—Eight.

S. R. 336—12 v '06. 51° 19′ N., 12° 20′ W., soundings 673–720 fms. Trawl.—One.

S. R. 364—10 VIII '06. 51° 23′ 30″ N., 11° 47′ W., soundings 620–695 fms., ooze. Trawl.—One.

S. R. 368—11 VIII '06. 51° 39′ N., 12° 1′ W., soundings 608–450 fms., fine sand. Trawl.—One.

S. R. 397—2 II '07. 51° 46′ N., 12° 5′ W., soundings 549–646 fms., ooze. Trawl.—One.

S. R. 401—5 II '07. 51° 14′ N., 11° 51′ W., soundings 600–660 fms. Trawl.—One.

S. R. 477—28 VIII '07. 51° 15′ N., 11° 47′ W., soundings 707–710 fms., ooze. Trawl.—Six.

S. R. 484—30 VIII '07. 51° 35′ N., 11° 57′ W., soundings 602–610 fms. Trawl.—Two.

S. R. 489—4 IX '07. 51° 35′ N., 11° 55′ W., soundings 720 fms. Trawl.—Six.

S. R. 497—10 IX '07. 51° 2′ N., 11° 36′ W., soundings 775–795 fms., ooze. Trawl.—Two.

S. R. 499—11 IX '07. 50° 55′ N., 11° 29′ W., soundings 666–778 fms. Trawl.—Three.

S. R. 500—11 IX '07. 50° 52′ N., 11° 26′ W., soundings 625–666 fms. Trawl.—One.

S. R. 501—11 IX '07. 50° 49′ N., 11° 22′ W., soundings 447–625 fms. Trawl.—One.

S. R. 593—6 VIII '08. 50° 31′ N., 11° 31′ W., soundings 670–770 fms., ooze. Trawl.—Nine.

S. R. 746—14 V '09. 51° 32′ N., 12° 13′ W., soundings 620–658 fms., ooze. Trawl.—Five.

S. R. 944—17 V '10. 51° 22′ N., 12° 41′ W., soundings 982 fms., ooze. Trawl.—Several.

It is evident from the above records that *P. bifrons* does not usually occur on the Irish coast at less depths than 500 fathoms, but below that depth it appears to be fairly widely distributed in small numbers.

Family *ASTROPECTENIDAE.*

Astropecten irregularis, Penn.

Astropecten irregularis, Bell, 1892.
Astropecten irregularis, Kemp, 1905.

Helga.

S. R. 185—30 I '05. 50° 20′ N., 10° 20′ W., soundings 82½ fms., fine sand and shells. Trawl.—Few.

S. R. 187—31 I '05. 51° 14′ 31″ N., 9° 43′ W., soundings 57 fms., sandy mud. Dredge.—One.

S. R. 211—5 V '05. 50° 20′ N., 10° 20′ W., soundings 81 fms., coarse sand. Trawl.—Five.

S. R. 215—9 V '05. 52° 01′ N., 11° 21′ W., soundings 106 fms., fine sand. Trawl.—Twenty.

S. R. 216—9 V '05. 52° 21′ N., 11° 54′ W., soundings 143–164 fms., fine sand. Trawl.—Three.

S. R. 217—9 V '05. 52° 44′ N., 12° 20′ W., soundings 208 fms., fine sand. Trawl.—One.

S. R. 220—11 V '05. 53° 39′ N., 12° 24′ W., soundings 185 fms., fine sand and shells. Trawl.—One.

S. R. 225—13 V '05. 53° 2′ N., 13° 48′ W., soundings 105–109 fms., fine sand and shells. Trawl.—Three.

S. R. 226—13 V '05. Porcupine Bank, 53° 12′ N., 13° 57′ W., soundings 93 fms., gravel and shells. Dredge.—Four.

S. R. 227—14 V '05. 53° 20′ N., 13° 0′ W., soundings 164 fms., fine sand. Dredge —One. Trawl —Two.

S. R. 405—8 II '07. 51° 56′ N., 11° 0′ W., soundings 84 fms., fine sand. Trawl.—One.

S. R. 528—7 XI '07. 50° 21′ 30″ N., 10° 24′ W., soundings 85 fms., sand and shells. Dredge—Two.

S. R. 591—4 VIII '08. 51° 46′ N., 10° 44′ 30″ W., soundings 73–78 fms., sand. Trawl.—Few.

S. R. 807—17 VIII '09. 51° 37′ 30″ N., 11° 6′ W., soundings 105 fms., fine sand. Trawl.—Two.

Frequently taken below 50 fathoms, but its range does not extend much beyond 200 fathoms, probably on account of the change in the nature of the bottom, as in shallow water it is rarely found except on fine sand.

In one specimen from the Porcupine Bank (S. R. 226) several of the supero-marginal plates bore from one to three small spines, arranged in a vertical row on each plate.

Psilaster andromeda, Mull. and Tros.

Psilaster andromeda, Bell, 1892.
Psilaster andromeda, Kemp, 1905.

Helga.

S. R. 188—3 II '05. 51° 53′ N., 11° 59′ W., soundings 320–372 fms., mud. Trawl.—Many.

S. R. 212—6 V '05. 51° 54′ N., 11° 57′ W., soundings 378–411 fms., fine muddy sand. Trawl.—Six.

S. R. 321—1 V '06. 50° 59′ N., 11° 17′ W., soundings 208–480 fms., fine sand. Trawl.—Seven.

S. R. 353—6 VIII '06. 50° 38′ 30″ N., 11° 32′ W., soundings 250–542 fms., muddy sand. Trawl.—Twenty-eight.

S. R. 359—8 VIII '06. 51° 59′ N., 12° 9′ W., soundings 465–492 fms., ooze. Trawl.—Eighty-three.

S. R. 397—2 II '07. 51° 46′ N., 12° 5′ W., soundings 549–646 fms., ooze. Trawl.—Five.

S. R. 440—16 V '07. 51° 45′ N., 11° 49′ W., soundings 350–389 fms. Trawl.—Two.

S. R. 447—18 V '07. 50° 20′ N., 10° 57′ W., soundings 221–343 fms., fine sand. Trawl.—One.

S. R. 448—18 V '07. 50° 21′ N., 11° 0′ W., soundings 343–346 fms. Trawl.—Two.

S. R. 489—4 IX '07. 51° 35′ N., 11° 55′ W., soundings 720 fms. Trawl.—One.

S. R. 490—7 IX '07. 51° 57′ 30″ N., 12° 7′ W., soundings 470–491 fms., ooze. Trawl.—One hundred and nineteen.

S. R. 491—7 IX '07. 51° 57′ 30″ N., 12° 13′ W., soundings 491–520 fms. Trawl.—Very many.

S. R. 493—8 IX '07. 51° 58′ N., 12° 25′ W., soundings 553–570 fms. Trawl.—Twelve.

S. R. 494—8 IX '07. 51° 59′ N., 12° 32′ W., soundings 550–570 fms. Trawl.—Several.

S. R. 496—8 IX '07. 51° 54′ N., 12° 54′ W., soundings 473–500 fms. Trawl.—Fourteen.

S. R. 502—11 IX '07. 50° 46′ N., 11° 21′ W., soundings 447–515 fms. Trawl.—Twenty.

S. R. 590—3 VIII '08. 51° 50′ N., 12° 9′ W., soundings 480–493 fms., ooze. Trawl.—Ca. forty.

S. R. 592—6 VIII '08. 50° 39′ N., 11° 25′ W., soundings 400–510 fms., ooze. Trawl.—Seven.

S. R. 752—16 V '09. 51° 51′ N., 12° 13′ W., soundings 523–595 fms., ooze. Trawl.—Three full-grown, several very small.

S. R. 753—17 V '09. 51° 24′ N., 11° 59′ 30″ W., soundings 561–572 fms., ooze. Trawl.—One.

S. R. 805—14 VIII '09. 51° 50′ 30″ N., 12° 14′ W., soundings 539–544 fms., ooze. Trawl.—Few.

S. R. 944—17 V '10. 51° 22′ N., 12° 41′ W., soundings 982 fms., ooze. Trawl.—One large, one small.

S. R. 1005—12 VIII '10. 51° 22′ N., 11° 30′ 30″ W., soundings 249 fms., fine sand. Dredge.—One.

This species occurs on the Irish coast between 250 and 1,000 fathoms, the largest numbers being found between 400 and 500 fathoms. These depths are slightly greater than those in which it occurs in the Norwegian Sea (Grieg, 1907), where it was found between 160 and 600 fathoms, usually at about 220 fathoms. In some of the Norwegian fiords, however, it has been taken in water as shallow as 10 fathoms (Storm, 1888).

Verrill (1895) suggests that *Psilaster florae* from the east coast of North America may be the same as *P. andromeda*, and Koehler (1909) includes it in his synonymy of the species.

Psilasteropsis patagiatus, (Sladen).

Psilaster patagiatus, Sladen, 1889.
Psilaster andromeda (pars), Perrier, 1894.
Psilaster andromeda, Perrier, 1896.
Psilasteropsis patagiatus, Koehler, 1909.

Helga.

S. R. 335—12 v '06. 51° 15′ 30″ N., 12° 17′ W., soundings 673–893 fms. Trawl.—Three.

In the Irish specimens the supero-marginal plates, seen from above, are square, or slightly wider than deep, and without spinules, but in the British Museum type, examined by Mr. Kemp, they are much deeper than wide and bear occasional spinules. In side view the marginals are much deeper in the Irish specimens than in those in the British Museum. These differences are much less noticeable when comparing the Irish specimens with Koehler's figures of the same species (1909, Pl. III, fig. 2, Pl. XIX, fig. 1).

The disagreement seems to be due to the fact that the specimens in the British Museum are in spirit, while those taken by the *Helga* have been dried. Dr. Koehler, who has compared one of the Irish specimens with those taken by him, writes that they agree, and that the figures referred to also represent a dried example.

The measurements of the Irish specimens are: R=105 mm., r=24 mm. R=67 mm., r=14 mm. R=61 mm., r=15 mm.

The present record, besides adding the species to the British and Irish list, extends its known range for a considerable distance northwards, the most northern of previous records being from the Bay of Biscay, and most of the recorded specimens coming from between the Azores and Cape Verde Islands.

SUB-FAMILY *LUIDIINAE.*

Luidia ciliaris, Philippi.

Luidia ciliaris, Bell, 1892.

Helga.

S. R. 215—9 v '05. 52° 1′ N., 11° 21′ W., soundings 106 fms., fine sand. Trawl.—One.

Helga.

S. R. 225—12 v '05. 53° 2′ N., 13° 48′ W., soundings 105–109 fms., fine sand and shells. Trawl.—One.

S. R. 227—13 v '05. 53° 20′ N., 13° 0′ W., soundings 164 fms., fine sand. Trawl.—One.

S. R. 360—8 VIII '06. 52° 4′ N., 11° 27′ W., soundings 108–120 fms., fine sand. Trawl.—One.

S. R. 379—1 XI '06. 50° 14′ N., 10° 53′ W., soundings 126–139 fms., fine sand and shells. Trawl.—Few.

S. R. 405—8 II '07. 51° 56′ N., 11° 0′ W., soundings 84 fms., fine sand. Trawl.—One.

S. R. 447—18 V '07. 50° 20′ N., 10° 57′ W., soundings 221–343 fms., fine sand. Trawl.—One.

S. R. 755—19 V '09. 52° 3′ N., 11° 20′ W., soundings 92–100 fms., fine sand. Trawl.—One.

Luidia ciliaris seems rarely to reach a depth of 100 fathoms. and its occurrence on Station S. R. 447 between 221 and 343 fathoms probably constitutes a record for depth.

Luidia Sarsi, Düb. and Kor.

Luidia Sarsi, Bell, 1892.

Helga.

S. R. 185—30 I '05. 50° 20′ N., 10° 20′ W., soundings 82½ fms., fine sand and shells. Trawl.—Six.

S. R. 187—31 I '05. 51° 14′ 30″ N., 9° 43′ W., soundings 57 fms., sand and mud. Dredge.—One. Trawl.—One.

S. R. 188—3 II '05. 51° 53′ N., 11° 59′ W., soundings 320–372 fms., mud. Trawl.—One ?

S. R. 211—5 V '05. 50° 20′ N., 10° 20′ W., soundings 81 fms., coarse sand. Trawl.—Three.

S. R. 212—6 V '05. 51° 54′ N., 11° 57′ W., soundings 378–411 fms., fine muddy sand. Trawl.—One ?

S. R. 213—6 V '05. 51° 59′ N., 11° 25′ W., soundings 119 fms., fine sand. Dredge.—Two.

S. R. 215—9 V '05. 52° 1′ N., 11° 21′ W., soundings 126 fms., fine sand. Trawl.—One.

S. R. 216—9 V '05. 52° 21′ N., 11° 54′ W., soundings 143–164 fms., fine sand. Trawl.—Six.

S. R. 225—13 V '05. 53° 2′ N., 13° 48′ W., soundings 105–109 fms., fine sand and shells. Dredge.—One.

S. R. 227—14 V '05. 53° 20′ N., 14° 0′ W., soundings 164 fms., fine sand. Trawl.—Ten. Dredge.—Few.

S. R. 360—8 VIII '06. 52° 4′ N., 11° 27′ W., soundings 108–120 fms., fine sand. Trawl.—Two.

S. R. 362—9 VIII '06. 51° 34′ 30″ N., 11° 27′ W., soundings 145–160 fms., fine sand. Trawl.—Two.

S. R. 379—1 XI '06. 50° 14′ N., 10° 53′ W., soundings 126–139 fms., fine sand and shells. Trawl.—Few.

S. R. 384—6 XI '06. 51° 54′ 30″ N., 11° 37′ W., soundings 162–218 fms., fine sand. Trawl.—One.

Helga.

S. R. 405—8 II '07. 51° 56′ N., 11° 0′ W., soundings 84 fms., fine sand. Trawl.—Two.

S. R. 440—16 V '07. 51° 45′ N., 11° 49′ W., soundings 350-389 fms. Trawl.—One.

S. R. 528—7 XI '07. 50° 21′ 30″ N., 10° 24′ W., soundings 85 fms., sand and shells. Dredge.—One.

S. R. 591—4 VIII '08. 51° 46′ N., 10″ 44′ 30° W., soundings 73–78 fms., sand. Trawl.—One.

S. R. 755—19 V '09. 52° 3′ N., 11° 20′ W., soundings 92–100 fms., fine sand. Trawl.—One.

In the above list the records from stations S. R. 188 and S. R. 212 have been queried as, in both instances, the species had been taken in the haul of the trawl immediately preceding the station, in much shallower water, and it is possible that a specimen may have been overlooked and left in the net. This possibility of error does not apply to the record from S. R. 440, 350-389 fms.

Family *PENTAGONASTERIDAE.*

Sub-Family *PENTAGONASTERINAE.*

Pentagonaster balteatus, Sladen.

Pentagonaster balteatus, Sladen, 1891.
Pentagonaster granularis (pars), Bell, 1892.
Pentagonaster Gosselini, Perrier, 1894.
Pentagonaster granularis (pars), Nichols, 1903.
Pentagonaster granularis (pars), Kemp, 1905.
Pentagonaster Gosselini, Koehler, 1909.

Helga.

S. R. 497—10 IX '07. 51° 2′ N., 11° 36′ W., soundings 775–795 fms., ooze. Trawl.—Two.

This species, described by Sladen in 1891 from specimens taken off the west coast of Ireland, is represented by two specimens, each measuring R=28 mm., r=16 mm., which are slightly larger than the type of *P. balteatus* (r=22 mm.) now in the Dublin Museum.

In his paper on the Echinoderms of the West Coast of Ireland (1905), Mr. S. W. Kemp, following Professor Bell (1892), united *P. balteatus* and *P. concinnus* as synonyms of *P. granularis*, but in working out the *Helga's* collections he, subsequently, found it necessary to separate them. There does not seem to be sufficient grounds for retaining *P. granularis* in the Irish list, as, with the exception of one small specimen taken by the *Helga* in 1904, which cannot at present be traced, all the Irish individuals of *P. granularis* have proved to be either *P. balteatus* or *P. dentatus* (=*P. concinnus*).

P. balteatus is also known from the Azores and the Cape Verde Islands. It was described by Perrier (1894) under the

name *P. Gosselini*, from specimens taken at the Azores by the *Talisman*, and recorded under that name (Koehler, 1909) as having been taken off the Cape Verde Islands by the *Princess Alice*.

The name *P. Gosselini* must, however, give place to the earlier *P. balteatus*. There can be no doubt that the two species are synonymous, as I sent one of my specimens to Professor R. Koehler, who was good enough to compare it with the specimens taken by the *Talisman*. Professor Koehler writes that it is absolutely identical with *P. Gosselini*. It is also identical with Sladen's type of *P. balteatus* in the Dublin Museum, with which I have compared it.

Dr. H. L. Clark has been good enough to compare one of the Irish specimens with the type of *P. grenadensis*, Perrier, from the *Blake* Collections in the Museum of Comparative Zoology at Harvard. The two species have a superficial resemblance, but Dr. Clark informs me that they are distinct.

Pentagonaster dentatus, Perrier.

Pentagonaster dentatus, Perrier, 1881.
Pentagonaster dentatus, Perrier, 1884.
Pentagonaster grandis, Perrier, 1885.
Pentagonaster Perrieri, Sladen, 1889.
Pentagonaster concinnus, Sladen, 1891.
Pentagonaster granularis (pars), Bell, 1892.
Pentagonaster Perrieri, Perrier, 1894.
Pentagonaster Perrieri, Koehler, 1896, 1909.
Pentagonaster granularis (pars), Nichols, 1903.
Pentagonaster granularis (pars), Kemp, 1905.

Helga.

S. R. 335—12 v '06. 51° 15′ 30″ N., 12° 17′ W., soundings 673–893 fms. Trawl.—Two.

S. R. 364—10 viii '06. 51° 23′ 30″ N., 11° 47′ W., soundings 620–695 fms., ooze. Trawl.—One.

S. R. 400—5 ii '07. 51° 21′ N., 11° 49′ W., soundings 525 fms. Trawl.—Five.

S. R. 448—18 v '07. 50° 21′ N., 11° 0′ W., soundings 343–346 fms. Trawl.—One.

S. R. 477—28 viii '07. 51° 15′ N., 11° 47′ W., soundings 707–710 fms., ooze. Trawl.—Two.

S. R. 489—4 ix '07. 51° 35′ N., 11° 55′ W., soundings 720 fms. Trawl.—Two.

S. R. 497—10 ix '07. 51° 2′ N., 11° 36′ W., soundings 775–795 fms., ooze. Trawl.—Two.

S. R. 499—11 ix '07. 50° 55′ N., 11° 29′ W., soundings 666–778 fms. Trawl.—One.

S. R. 502—11 ix '07. 50° 46′ N., 11° 21′ W., soundings 447–515 fms. Trawl.—Two.

S. R. 593—6 viii '08. 50° 31′ N., 11° 31′ W., soundings 670–770 fms., ooze. Trawl.—Two.

This species was first described as *P. dentatus* by Perrier in 1881 from specimens collected by the *Blake* in the West Indies. The same species was taken by the *Travailleur* and *Talisman*, but was not recognised, and was re-described by Perrier (1885) under the name of *P. grandis*. Sladen in the *Challenger* Reports (1889) pointed out that the name *P. grandis* was preoccupied and proposed *P. Perrieri* as an alternative. This name was adopted by Perrier and Koehler in dealing with the *Travailleur*, *Talisman* and *Princess Alice* collections. In 1891 Sladen described a new species *P. concinnus* from specimens taken off the west coast of Ireland. This was treated as a form of *P. granularis* by Bell (1892) and others, but has proved to be the same as *P. dentatus*.

One of the Irish specimens has been compared by Professor Koehler with the specimens collected by the *Travailleur* and *Talisman* and the *Princess Alice*, and has been found to be identical with them. This puts it beyond doubt that *P. Perrieri* and *P. concinnus* are synonymous, as I have compared my specimens with the type of *P. concinnus* in the Dublin Museum. Professor Koehler (1909) had himself arrived at this conclusion from Sladen's description of *P. concinnus*.

Another Irish specimen has been compared by Dr. H. Lyman Clark with the type of *P. dentatus* in the Museum of Comparative Zoology at Harvard. He writes that he has no doubt that *P. concinnus*, *P. dentatus* and *P. Perrieri* are one and the same thing.

P. dentatus can usually be distinguished at a glance from *P. granularis* by the uniformity and equal spacing of its abactinal plates, which are all hexagonal. In *P. granularis* the interradial plates tend to become quadrangular and are tightly fitted together, forming a much closer pavement than the hexagonal plates do on the radial lines.

This species reaches a considerable size, the two largest specimens, from S. R. 335, measuring R = 95 mm., r = 63 mm., and R = 86 mm., r = 50 mm. It seems to be uniformly distributed in very small numbers over the area lying between 350 and 800 fathoms off the Irish coast.

Nymphaster arenatus (Perrier).

Pentagonaster arenatus, Perrier, 1884.
Nymphaster protentus, Sladen, 1889.
Nymphaster protentus, Bell, 1889.
Nymphaster subspinosus, Bourne, 1890.
Nymphaster protentus, Sladen, 1891.
Nymphaster subspinosus, Bell, 1892.
Dorigona arenata, Perrier, 1894.
Nymphaster arenatus, Verrill, 1895.
Dorigona arenata, Koehler, 1896.
Nymphaster subspinosus, Nichols, 1903.
Nymphaster subspinosus, Kemp, 1905.
Dorigona arenata, Koehler, 1909, p. 83.

Helga.

S. R. 321—1 v '06. 50° 58′ N., 11° 17′ W., soundings 208–480 fms., fine sand. Trawl.—Two.

S. R. 329—9 v '06. 51° 21′ 30″ N., 11° 34′ W., soundings 215–415 fms. Trawl.—One.

S. R. 353—6 VIII '06. 50° 38′ 30″ N., 11° 32′ W., soundings 250–542 fms., muddy sand. Trawl.—Seventeen.

S. R. 364—10 VIII '06. 51° 23′ 30″ N., 11° 47′ W., soundings 620–695 fms., ooze. Trawl.—One.

S. R. 447—18 v '07. 50° 20′ N., 10° 57′ W., soundings 221–343 fms., fine sand. Trawl.—One.

S. R. 448—18 v '07. 50° 21′ N., 11° 0′ W., soundings 343–346 fms. Trawl.—One.

S. R. 482—29 VIII '07. 51° 6′ N., 11° 26′ W., soundings 368 fms., fine sand. Trawl.—One.

S. R. 502—11 IX '07. 50° 46′ N., 11° 21′ W., soundings 447–515 fms. Trawl.—Six.

S. R. 504—12 IX '07. 50° 42′ N., 11° 18′ W., soundings 627–728 fms., stones and coral. Trawl.—Thirty-six.

S. R. 505—12 IX '07. 50° 39′ N., 11° 14′ W., soundings 464–627 fms. Trawl.—Fifty.

S. R. 506—12 IX '07. 50° 34′ N., 11° 19′ W., soundings 661–672 fms. Trawl.—Five.

S. R. 592—6 VIII '08. 50° 39′ N., 11° 25′ W., soundings 400–510 fms., ooze. Trawl.—Five.

The species described by Sladen under the name of *N. protentus* seems to be a synonym of *N. arenatus* described by Perrier in 1884 from specimens collected by the *Blake* in the West Indies. It was suggested by Canon Norman (Bourne, 1890) that *N. protentus* was a synonym of *N. subspinosus*, Perrier, and this view was adopted by Professor Bell in his British Museum Catalogue, but was not accepted by Sladen.

The figures and descriptions of *N. arenatus* given by Perrier would seem to indicate that it resembles *N. protentus* much more closely than does *N. subspinosus*, and Dr. H. L. Clark, who has kindly compared one of my specimens with Perrier's type at Harvard, tells me that it is undoubtedly *N. arenatus*. Professor Koehler, to whom also I sent one of the Irish specimens (which are, undoubtedly, the *N. protentus* of Sladen), informs me that it is identical with the form which he has recorded from numerous localities on the east side of the Atlantic as *Dorigona arenata*.

Although the small spines on the marginal plates, which are one of the distinguishing characters of *N. subspinosus*, are not found in any of the Irish specimens, yet there are occasionally one or more enlarged granules present.

Pseudarchaster Pareli (Düb. and Kor.).

Astropecten Parelii, Düb. and Kor., 1844.
Archaster Parelii, Wyv. Thomson, 1873.
Plutonaster (*Tethyaster*) *Parelii*, Sladen, 1889.
Plutonaster Parelii, Bell, 1892.
Plutonaster Parelii, Ludwig, 1900.
Plutonaster Pareli, Kemp, 1905.
Plutonaster Pareli, Grieg, 1907.
Astrogonium Pareli, Koehler, 1907, 1909.
Pseudarchaster Pareli, Fisher, 1911.

Helga.

S. R. 329—9 v '06. 51° 21′ 30″ N., 11° 34′ W., soundings 215–415 fms. Trawl.—Two.

S. R. 333—10 v '06. 51° 37′ N., 12° 9′ W., soundings 557–579 fms., ooze. Trawl.—One.

S. R. 353—6 viii '06. 50° 38′ 30″ N., 11° 32′ W., soundings 250–542 fms., muddy sand. Trawl.—Two.

S. R. 363—10 viii '06. 51° 22′ N., 12° 0′ W., soundings 695–720 fms., ooze. Trawl.—One.

S. R. 400—5 ii '07. 51° 18′ N., 11° 50′ W., soundings 525–600 fms., mud and ooze. Trawl.—One.

S. R. 440—16 v '07. 51° 45′ N., 11° 49′ W., soundings 350–389 fms. Trawl.—One.

S. R. 487—3 ix '07. 51° 36′ N., 11° 57′ W., soundings 540–660 fms. Trawl.—One.

S. R. 490—7 ix '07. 51° 57′ 30″ N., 12° 7′ W., soundings 470–491 fms., ooze. Trawl.—One.

S. R. 491—7 ix '07. 51° 57′ 30″ N., 12° 13′ W., soundings 491–520 fms. Trawl.—Three.

S. R. 500—11 ix '07. 50° 52′ N., 11° 56′ W., soundings 625–666 fms. Trawl.—One.

S. R. 502—11 ix '07. 50° 46′ N., 11° 21′ W., soundings 447–515 fms. Trawl.—One.

S. R. 504—12 ix '07. 50° 42′ N., 11° 18′ W., soundings 627–728 fms., stones and coral. Trawl.—Three.

S. R. 592—6 viii '08. 50° 39′ N., 11° 25′ W., soundings 400–510 fms., ooze. Trawl.—Three.

S. R. 746—14 v '09. 50° 32′ N., 12° 13′ W., soundings 620–658 fms., ooze. Trawl.—Three.

As Koehler (1907) and Fisher (1911) have pointed out, this species was wrongly referred to the genus *Plutonaster*, and properly takes its place in the Family Pentagonasteridae (Goniasteridae) rather than in the Archasteridae, in which it formerly stood. I have for convenience adopted the generic name used by Fisher, without entering into the academic question of whether it or *Astrogonium* is more properly applicable to the genus to which it is here applied.

Dr. Koehler, who has had considerable experience both of the type of this species and of the variety *longobrachiale*, has been good enough to examine one of my specimens. He informs me that, although its arms are more pointed than in the specimens he has seen of the type, it cannot be referred to the variety, in which the arms are, relatively, much more slender and longer.

This species reaches a very large size in Irish waters. The two largest specimens obtained by the *Helga* measured R=192 mm., r=70 mm. and R=178 mm., r=57 mm. respectively.

Small specimens are rather scarce, for out of nineteen of the *Helga* specimens in which the arms were measured, in five only was R less than 80 mm.

SUB-FAMILY *MIMASTERINAE*.

Mimaster Tizardi, Sladen.

Mimaster Tizardi, Bell, 1892.

Helga.

S. R. 335—12 v '06. 51° 15′ N., 12° 17′ W., soundings 673–893 fms. Trawl.—One.

S. R. 397—2 ii '07. 51° 46′ N., 12° 5′ W., soundings 549–646 fms., ooze. Trawl.—One.

S. R. 400—5 ii '07. 51° 18′ N., 11° 50′ W., soundings 525–600 fms., ooze. Trawl.—Four.

S. R. 477—28 viii '07. 51° 15′ N., 11° 47′ W., soundings 707–710 fms., ooze. Trawl.—Two.

S. R. 484—30 viii '07. 51° 35′ N., 11° 57′ W., soundings 602–610 fms. Trawl.—One.

S. R. 489—4 ix '07. 51° 35′ N., 11° 55′ W., soundings 720 fms. Trawl.—One.

S. R. 592—6 viii '08. 50° 39′ N., 11° 25′ W., soundings 400–510 fms., ooze. Trawl.—One.

S. R. 746—14 v '09. 51° 32′ N., 12° 13′ W., soundings 620–658 fms., ooze. Trawl.—Two.

S. R. 753—17 v '09. 51° 24′ N., 11° 59′ 30″ W., soundings 561–572 fms., ooze. Trawl.—One.

S. R. 754—17 v '09. 51° 26′ N., 11° 57′ 30″ W., soundings 544–572 fms., ooze. Trawl.—Three.

The general appearance of this species varies a good deal. Some specimens are flat with thin margins, while others have their abactinal face very much swollen, the arms being curved upwards, and the whole animal much distorted.

Mimaster Tizardi has previously been recorded only from the Faeroe Channel. It is rather remarkable that it should not have been taken by the *Travailleur* and *Talisman* or any of the Prince of Monaco's expeditions, as the *Helga's* researches indicate that it is by no means uncommon.

Family *PENTACEROTIDAE.*

Culcita borealis, Sussbach and Breckner.

Culcita borealis, Sussbach and Breckner, 1911.

Pl. II, Figs. 1, 2.

Helga.

S. R. 223—12 v '05. 53° 7′ N., 14° 50′ W., soundings 410-500 fms., coral and stones. Trawl.—One.

S. R. 483—30 viii '07. 51° 37′ N., 11° 56′ W., soundings 610–664 fms., muddy sand. Trawl.—One.

S. R. 486—3 ix '07. 51° 37′ 30″ N., 12° 0′ W., soundings 600–660 fms., coral and stones. Trawl.—One.

The genus *Culcita* was unknown from the Atlantic Ocean until, in 1911, Sussbach and Breckner described a new species, *Culcita borealis*, from a specimen taken by the German fishery steamer *Poseidon* in June, 1905, about forty miles north-west of the Shetlands in 110 fathoms.

The three specimens taken by the *Helga*, though showing great variations in form, belong undoubtedly to this species, and I have had the opportunity of examining two specimens taken by Dr. Wolfenden's yacht, *Silver Belle*, in 320 fathoms off the coast of Portugal which bear a much closer resemblance to Sussbach and Breckner's figures than do the Irish examples.

The measurements of the largest Irish specimen, from station S. R. 483, are R = 70 mm., r = 50 mm., height = 30 mm. In form it is not unlike the Shetland example, but it is more flattened and not so convex on the actinal face. The specimen from station S. R. 223 (Pl II, fig. 1) is oval rather than pentagonal in outline, and the abactinal face is convex and very high. Its greatest length is 78 mm., width 63 mm., and height 52 mm. In the smallest specimen (Pl. II, fig. 2), from station S. R. 486, the inter-radial areas are well marked. Its form thus approaches the Randasia or five-armed stage found in young specimens of *Culcita* from elsewhere.

In the Irish specimens the skin is leathery and less wrinkled than is shown in Sussbach and Breckner's figures, but this seems to be merely a question of the degree of contraction, as in Dr. Wolfenden's specimens the wrinkling of the upper surface is very marked. The papulae are retracted in the medium-sized specimen, but in the two others they are exserted as white villi of ca. 2 mm. in length crowded on the definite areas in which they occur. The arrangement in small groups of about 4 mm. in diameter, consisting of 8 to 12 papulae, which is evident when they are retracted, cannot be made out when they are exserted. The arrangement of the papulae in the two smallest Irish specimens agrees fairly well with that described by Sussbach and Breckner. There is a small circum-anal patch, and on each interbrachial area there are two triangular patches separated by a narrow band, free from papulae, expanding externally. The radial lines are also free

from papulae. Along each infra-marginal area there is a narrow band of papulae joining the tips of the ambulacral grooves.

In the largest specimen a slightly different arrangement is to be seen. The sub-marginal band of papulae is absent, as is also the circumanal patch, the anus being situated in a small area free from papulae. The papulae occupy a wide petaloid area on each radial, the mid-radial line or midrib of the petal being free from papulae. This arrangement may be a later stage than that found in the smaller specimens.

There is a good deal of variation in the form of the ambulacral and oral armature, the spines at the angle of the mouth, covered with leathery skin, being rather larger in the smallest specimen than in the others, and the adambulacral spines varying in number from one to three in all the specimens.

The colour of the Irish specimens when fresh was a deep red, resembling that of *Porania pulvillus*.

This species does not occur on the ooze which occupies most of the area between 500 and 700 fathoms on the south-west coast of Ireland. Two of the specimens were found on rough ground with stones and Lophohelia, and the third, from station S. R. 483, was associated with Alcyonarians and the hexactinellid sponge *Aphrocallistes*. The Shetland specimen was found on a bottom of sand and broken shells.

Family *GYMNASTERIIDAE*.

Porania pulvillus, O. F. Müll.

Helga. *Porania pulvillus*, Bell, 1892.

S. R. 185—30 I '05. 50° 20′ N., 10° 20′ W., soundings 82½ fms., fine sand and shells. Trawl.—Few. Dredge.—Three.

S. R. 211—5 V '05. 50° 20′ N., 10° 20′ W., soundings 81 fms., coarse sand. Trawl.—Fifteen.

S. R. 215—9 V '05. 52° 1′ N., 11° 21′ W., soundings 106 fms., fine sand. Trawl.—Two.

S. R. 216—9 V '05. 52° 21′ N., 11° 54′ W., soundings 143–164 fms., fine sand. Trawl.—One.

S. R. 225—13 V '05. 53° 2′ N., 13° 48′ W., soundings 105–109 fms., fine sand and shells. Trawl.—Two.

S. R. 227—13 V '05. 53° 20′ N., 13° 0′ W., soundings 164 fms., fine sand. Trawl.—One.

S. R. 277—15 XI '05. 51° 17′ 30″ N., 11° 34′ W., soundings 550 fms., gravel and shells. Dredge.—One.

S. R. 360—8 VIII '06. 52° 4′ N., 11° 27′ W., soundings 108–120 fms., fine sand. Trawl.—Two.

S. R. 591—4 VIII '08. 51° 46′ N., 10° 44′ 30″ W., soundings 73–78 fms., sand. Trawl.—Two.

S. R. 755—19 V '09. 52° 3′ N., 11° 20′ W., soundings 92–100 fms., fine sand. Trawl.—One.

S. R. 807—17 VIII '09. 51° 37′ 30″ N., 11° 6′ W., soundings 105 fms., fine sand. Trawl.—One.

The record from 550 fathoms on station S. R. 277 is remarkable. The locality is about the same as that of the specimen from 388 fathoms recorded by Kemp (1905).

Poraniomorpha villosa (Sladen).

Lasiaster villosus, Sladen, 1889.
Lasiaster villosus, Bell, 1892.

Helga.

S. R. 506—12 IX '07. 50° 34′ N., 11° 19′ W., soundings 661–672 fms. Trawl.—One.

Östergren (1904, p. 615) followed by Grieg (1907) has united the genera *Poraniomorpha* and *Lasiaster*, to the latter of which *P. villosa* was referred by the describer.

The measurements of the Irish specimen (R=28 mm., r=15 mm.) are considerably more than those of the type taken by the *Porcupine* (R=10·5 mm., r=6 mm.), with which it has been compared, but otherwise it shows little difference except that the arms are more distinctly marked off from the disc, the interbrachial angle being sharply defined, not rounded off as in the type. The diameter of the arms at their base is 17 mm.

The original specimen was taken by the *Porcupine* on the Wyville Thompson ridge, south of the Faeroe Channel.

Grieg (1907) considers this species to be identical with, or perhaps a variety of, the very variable *P. hispida*.

Family *ASTERINAE*.

Sub-Family *PALMIPEDINAE*.

Palmipes placenta (Penn.).

Palmipes placenta, Bell, 1892.

Helga.

S. R. 185—30 I '05. 50° 20′ N., 10° 20′ W., soundings 82½ fms., fine sand and shells. Trawl.—Seven.

S. R. 211—5 V '05. 50° 20′ N., 10° 20′ W., soundings 81 fms., coarse sand. Trawl.—One.

S. R. 213—6 V '05. 51° 59′ N., 11° 25′ W., soundings 119 fms., fine sand. Dredge.—One.

S. R. 215—9 V '05. 52° 1′ N., 11° 21′ W., soundings 106 fms., fine sand. Trawl.—Two.

S. R. 225—13 V '05. 53° 23′ N., 12° 48′ W., soundings 105–109 fms., fine sand and shells. Trawl.—Three.

S. R. 528—7 XI '07. 50° 21′ 30″ N., 10° 24′ W., soundings 85 fms., sand and shells. Dredge.—One.

S. R. 591—4 VIII '08. 51° 46′ N., 10° 44′ 30″ W., soundings 73–78 fms., sand. Trawl.—One.

The record depth, for Irish specimens, of 135 fathoms (Kemp, 1905) has not since been exceeded. The species is not uncommon on suitable ground, usually coarse sand or sand and shells. down to 100 fathoms.

CRYPTOZONIA.

Family *STICHASTERIDAE.*

Stichaster roseus, O. F. Müll.

Stichaster roseus, Bell, 1892.

Helga.

S. R. 187—31 I '05. 51° 14′ 30″ N., 9° 43′ W., soundings 57 fms., sand and mud. Trawl.—Three.

S. R. 196—11 II '05. 54° 42′ N., 10° 34′ W., soundings 242 fms., stones. Dredge.—Three.

S. R. 215—9 V '05. 52° 1′ N., 11° 21′ W., soundings 106 fms., fine sand. Trawl.—Six.

S. R. 216—9 V '05. 52° 21′ N., 11° 54′ W., soundings 143–164 fms., fine sand. Trawl.—Three.

S. R. 225—13 V '05. 53° 2′ N., 13° 48′ W., soundings 105 fms., fine sand and shells. Dredge.—One.

S. R. 360—8 VIII '06. 52° 4′ N., 11° 27′ W., soundings 108–120 fms., fine sand. Trawl.—One.

S. R. 755—19 V '09. 52° 3′ N., 11° 20′ W., soundings 92–100 fms., fine sand. Trawl.—One.

The limit of depth of this species in its typical form may, apparently, be put at 250 fathoms.

Stichaster roseus var. **ambiguus,** nov.

Pl. II, Fig. 3.

Helga.

S. R. 222—12 V '05. 53° 1′ N., 14° 34′ W., soundings 293 fms., fine sand. Trawl.—Two.

S. R. 329—9 V '06. 51° 21′ N., 11° 34′ W., soundings 215–415 fms. Trawl.—One.

S. R. 504—12 IX '07. 50° 42′ N., 11° 18′ W., soundings 627–728 fms., stones and coral. Trawl.—One.

The specimens of *Stichaster* from deep water appear at first sight to differ so much from the shallow-water specimens of *Stichaster roseus* that they might be regarded as a distinct species. A close examination does not, however, show any characters of sufficient importance to support this view, but they are at any rate entitled to a varietal name.

The arms in the variety are much stouter and shorter than in the littoral specimens, and the plating stands out much more distinctly, the longitudinal rows of plates being in most case traceable for a long distance. Usually there are two rows of plates exterior to the adambulacral row, and outside these a slightly larger upper and lower marginal row. The median radial row is well marked, consisting of chevron-shaped plates, and four more or less irregular rows intervene between it and the marginals. This arrangement cannot always be traced in all the arms of any one specimen, and, on the other hand, shallow-water specimens of *Stichaster roseus* may sometimes be

found which show a similar plan. The granules covering the plates resemble those found in *S. roseus*, as do also the spines on the adambulacrals, but, probably on account of the larger size of the specimens, the arrangement of the adambulacral spines appears to be more regular in the variety. In the largest specimen, R=106 mm., the ambulacra are bordered by three rows of blunt, slightly flattened, spines, the two innermost of which are sloped inwards, the outer row being upright or sloped outwards. Outside this row is a row of stouter, more pointed, and more irregular spines which slope outwards, with about two spines to each plate. This is succeeded by a similar but more closely set row, with about three spines to each plate. The papular spaces are well marked, with three to five papulae in each.

The measurements of the *Helga* specimens are :—

Station No.	R.	r.	Greatest diam. of Arm.
S. R. 222	106 mm.	20 mm.	22 mm.
,, ,, ...	84 mm.	18 mm.	22 mm.
S. R. 329	75 mm.	14 mm.	—
S. R. 504	66 mm.	15 mm.	16 mm.

R=5·8r.

The size of these specimens exceeds that of any shallow-water examples that I have seen, although the length of the arms is sometimes equalled. It is worth noting that one of them had one, and another three, regenerated arms, and that the two other specimens were broken during capture. This indicates that the variety either is very fragile or else has the power of autotomy. This has been noticed in the case of the arctic species *S. albulus* (Ludwig, 1900), but does not seem to take place usually in the shallow-water *S. roseus*.

Zoroaster fulgens, Wyv. Thomson.

Pl. I, Fig. 3.

Zoroaster fulgens, Wyv. Thoms., 1873.
Zoroaster diomedeae, Verrill, 1884.
Zoroaster fulgens, Bell, 1892.
Zoroaster trispinosus, Koehler, 1896.

Helga.

S. R. 327—8 v '06. 51° 41′ N., 12° 16′ 30′ W., soundings 550–800 fms., ooze. Trawl.—Ten.

S. R. 331—9 v '06. 51° 12′ N., 11° 55′ W., soundings 610–680 fms., ooze. Trawl.—Several.

S. R. 333—10 v '06. 51° 37′ N., 12° 9′ W., soundings 557–579 fms., ooze. Trawl.—Seven.

S. R. 335—12 v '06. 51° 15′ 30″ N., 12° 17′ W., soundings 673–893 fms. Trawl.—One.

S. R. 336—12 v '06. 51° 19′ N., 12° 20′ W., soundings 673–720 fms. Trawl.—Ten.

Helga.

S. R. 359—8 VIII '06. 51° 59′ N., 12° 9′ W., soundings 465–492 fms., ooze. Trawl.—Twenty-five.

S. R. 368—10 VIII '06. 51° 38′ 30″ N., 12° 0′ W., soundings 450–608 fms., fine sand. Trawl.—Ten.

S. R. 387—7 XI '06. 51° 47′ N., 12° 12′ W., soundings 530–535 fms., ooze. Trawl.—Two.

S. R. 397—2 II '07. 51° 46′ N., 12° 5′ W., soundings 549–646 fms., ooze. Trawl.—Sixty.

S. R. 398—2 II '07. 51° 45′ N., 12° 2′ 30″ W., soundings 547–549 fms. Trawl.—Six.

S. R. 400—5 II '07. 51° 18′ N., 11° 50′ W., soundings 525–600 fms., ooze. Trawl.—Thirty-six.

S. R. 401—5 II '07. 51° 14′ N., 11° 51′ W., soundings 600–660 fms. Trawl.—One.

S. R. 477—28 VIII '07. 51° 15′ N., 11° 47′ W., soundings 707–710 fms., ooze. Trawl.—Seven.

S. R. 479—28 VIII '07. 51° 20′ N., 11° 41′ W., soundings 468–560 fms. Trawl.—One.

S. R. 483—30 VIII '07. 51° 37′ N., 11° 56′ W., soundings 610–664 fms., muddy sand. Trawl.—Twenty.

S. R. 484—30 VIII '07. 51° 35′ N., 11° 57′ W., soundings 602–610 fms. Trawl.—Five.

S. R. 486 3 IX '07. 51° 37′ 30″ N., 12° 0′ W., soundings 600–660 fms., stones. Trawl.—Three.

S. R. 487—3 IX '07. 51° 36′ N., 11° 57′ W., soundings 540–660 fms., ooze and stones. Trawl.—Thirty-three.

S. R. 489—4 IX '07. 51° 35′ N., 11° 55′ W., soundings 720 fms. Trawl.—Five.

S. R. 490—7 IX '07. 51° 57′ 30″ N., 12° 7′ W., soundings 470–491 fms., ooze. Trawl.—Thirty-five.

S. R. 491—7 IX '07. 51° 57′ 30″ N., 12° 13′ W., soundings 491–520 fms. Trawl.—Many.

S. R. 493—8 IX '07. 51° 58′ N., 12° 25′ W., soundings 533–570 fms. Trawl.—Thirty-six.

S. R. 494—8 IX '07. 51° 59′ N., 12° 32′ W., soundings 550–570 fms. Trawl.—Fifty.

S. R. 496—8 IX '07. 51° 54′ N., 12° 54′ W., soundings 473–500 fms. Trawl.—Two.

S. R. 497—10 IX '07. 51° 2′ N., 11° 36′ W., soundings 775–795 fms., ooze. Trawl.—Four.

S. R. 499—11 IX '07. 50° 55′ N., 11° 29′ W., soundings 666–778 fms. Trawl.—Thirteen.

S. R. 500—11 IX '07. 50° 52′ N., 11° 26′ W., soundings 625–666 fms. Trawl.—Two.

S. R. 590—3 VIII '08. 51° 50′ N., 12° 9′ W., soundings 480–493 fms., ooze. Trawl.—Ca. thirty.

S. R. 592—6 VIII '08. 50° 39′ N., 11° 25′ W., soundings 400–510 fms., ooze. Trawl.—Six.

S. R. 593—6 VIII '08. 50° 31′ N., 11° 31′ W., soundings 670–770 fms., ooze. Trawl.—Eight.

Helga.

S. R. 746—14 v '09. 51° 32′ N., 12° 13′ W., soundings 620–658 fms., ooze. Trawl.—Three.

S. R. 753—17 v '09. 51° 24′ N., 11° 59′ 30″ W., soundings 561–572 fms., ooze. Trawl.—Six.

S. R. 754—17 v '09. 51° 26′ N., 11° 57′ 30″ W., soundings 544–572 fms., ooze. Trawl.—One.

S. R. 805—14 VIII '09. 51° 50′ 30″ N., 12° 14′ W., soundings 539–544 fms., ooze. Trawl.—Several.

S. R. 944—17 v '10. 51° 22′ N., 12° 41′ W., soundings 982 fms., ooze. Trawl.—Two small.

Most of the Irish specimens are of large size, R = 90–100 mm., with straight stiff arms tapering slightly at the base but rapidly towards the tip. They have been compared with the *Challenger* specimens in the British Museum, and there can be no doubt that they are *Z. fulgens* as described and figured by Sladen (1889). Dr. Koehler, who has examined some of the Irish specimens, informs me that they are also the same as the species described by him (1896) as *Z. trispinosus* from the Bay of Biscay. The identity of *Z. fulgens* with *Z. diomedeae* from the east coast of North America appears to be equally certain, as Mr. A. H. Clark and Dr. W. K. Fisher inform me. They point out, however, that the mid-radial plates on the arms in the American examples are, comparatively, slightly longer than in the European. The proportional length of these plates in the Irish specimens seems fairly constant, although occasionally one or two long plates may be found amongst a series of shorter ones.

While the specimens of *Z. fulgens* which were taken on most of the stations were of the typical thick-armed form, those from S. R. 335, 336 and 593 presented a rather different appearance. They were considerably smaller than usual, R = 53-94 mm., the length of the arms in the largest specimen thus slightly exceeding the smallest specimen of the thick armed form, and were characterised by the slenderness of their arms which were uniformly tapered to a fine point, and frequently irregularly bent or curved. The general arrangement of the plates and spines was similar to that of the thick armed form, but some differences could be made out. The number of mid-radial plates was much greater; in specimens of R = 55 mm. and R = 94 mm. they numbered 60 and 93, respectively, while a specimen of the typical form with R = 93 had only 55 plates on each arm. The mid-radial plates were as long as broad instead of being distinctly broader than long. The intermediate aboral plates adjoining the mid-radials were very small, and almost entirely overlapped by the plates on each side, whereas in the thick armed form the exposed portion is usually as broad as long and almost equal to half the width of the mid-radials. The number of plates in each transverse series is the same as in the thick armed form, namely,

one adambulacral, five or six intermediate actinal, a supero- and infero-marginal, an intermediate abactinal and a mid-radial.

It is possible that the slender armed form may be the young stage of the typical form, which could be attained by the loss of some of the distal series of plates and the increase in size and alteration in form of the remainder, accompanied by an increase in thickness of the arm disproportional to its length. There was, however, in the *Helga* collection from station S. R. 331 a single small specimen (R = 55) with thick arms bearing only 45 mid-radial plates, which represents what might be expected to be the young of the typical form. The only character in which it approached to slender armed form was the small size and depressed position of the abactinal intermediate plates, which were hardly visible between the overlapping adjoining rows.

On account of this specimen (which may, however, represent a distinct type), and from the fact that the transition, if assumed to take place, from the slender to the stout armed form must be an abrupt one, I feel inclined to regard the two forms as distinct. This seems to have been the view of Perrier (1884), who described an Asteroid which appears to be identical with the slender form under the name of *Zoroaster Ackleyi*, from specimens taken in the Gulf of Mexico. Dr. H. L. Clark and Dr. W. K. Fisher, both of whom have been good enough to examine an Irish specimen and compare it with *Z. Ackleyi*, do not concur in this view, but prefer to regard both *Z. Ackleyi* and the Irish slender form as the young stage of *Z. fulgens*, and in view of their opinion it seems best, in default of further evidence, to include all under that name.

Family *SOLASTERIDAE*.

Sub-Family *SOLASTERINAE*.

Solaster papposus (Fabr.).

Solaster papposus, Bell, 1892.
Solaster affinis, Kemp, 1905.

Helga.

S. R. 185—30 I '05. 50° 20′ N., 10° 20′ W., soundings 82½ fms., fine sand and shells. Trawl.—One.

S. R. 211—5 V '05. 50° 20′ N., 10° 20′ W., soundings 81 fms., coarse sand. Trawl.—11-armed, two; 12–13-armed four.

As Grieg (1907) has recently shown it is most probable that Brandt's original description of *Solaster affinis* belongs in reality to the arctic form of *S. papposus*, in which the abactinal skeleton forms an open network. This form is to be distinguished from the cold-water species of the Norwegian Sea, *S. squamatus*, Doderlein, in which the skeleton is composed of closely set plates, although in external appearance the two species are said to differ but little.

As there appears to be considerable doubt as to whether *S. affinis* exists as a distinct species, or if it does, whether any of the Irish specimens are referable to it, I have reverted to the name *S. papposus*. In all the Irish specimens which I have examined, including the specimens recorded as *S. affinis* by Kemp, the network of the skeleton was made up of broad calcareous bars. The slender bars which characterise the arctic form were not found in any instance.

Sub-Family *KORETHRASTERINAE*.

Korethraster sp.

Helga.

S. R. 151—27 VIII '04. 54° 17′ N., 11° 33′ W., soundings 388 fms., rock and stones. Temperature at bottom 9·5° C. Dredge.—One.

S. R. 479—28 VIII '07. 51° 20′ N., 11° 41′ W., soundings 468–560 fms. Temperature at 400 fms. 9·5° C. Trawl.—Four.

The *Helga* specimens are of very small size. In that from S. R. 151, a six-armed specimen, R = 5 mm., and in those from S. R. 479 R = 3 mm. or less. These examples undoubtedly belong to the genus *Korethraster*, and had they been taken in the Norwegian Sea I should have had no hesitation in referring them to *K. hispidus*, Wyv. Thomps. As, however, they certainly are immature, it is possible that they may belong to *K. setosus*, Perrier, itself doubtless an immature form, or to some other species of which the earlier stages are not known.

The description and figures of *K. hispidus*, given by Sladen (1889), agree very closely with the largest *Helga* specimen. The armature of five spines on the conjoined adambulacral and infero-marginal plates is present, and the form and armature of the mouth plates is similar, except that there are, in my specimen (as in *K. setosus*), three marginal spines on each side instead of two.

Korethraster hispidus has only been taken in or close to the cold water area of the Norwegian Sea and Faeroe Channel. Grieg (1907) gives +2·1° C. as the maximum recorded temperature, and its occurrence in water of as high a temperature as 9·5° C. is hardly to be expected.

Family *PTERASTERIDAE*.

Sub-Family *PTERASTERINAE*.

Pteraster personatus, Sladen.

Pteraster personatus, Bell, 1892.

Helga.

S. R. 335—12 V '06. 51° 15′ N., 12° 17′ W., soundings 673–893 fms. Trawl.—One.

This specimen differs from the type which is preserved in the Dublin Museum in having seven spines on each side of

the mouth-plate, instead of five, but, as it agrees in all other details and comes from almost the same spot, there can be no doubt that it is the same species. Sladen's specimen was taken in 51° 1′ N., 11° 50′ W, at a depth of 750 fathoms.

The dimensions of the *Helga* specimen are R = 44 mm., r = 21 mm. In the type specimen they are R = 55 mm., r = 25 mm., although Sladen (1891) gives R = 70. The tips of the arms in the type are tightly curved backwards on the abactinal surface, and possibly in a fresh state the value of R might be greater than it is at present. It is not unlikely, however, that some mistake has occurred, as an examination of Sladen's figure would not lead one to expect so high a value for R.

Hymenaster giganteus, Sladen.

Hymenaster giganteus, Bell, 1892.

Helga.

S. R. 222—12 v '05. 53° 1′ N., 14° 34′ W., soundings 293 fms., fine sand. Trawl.—One.

S. R. 331—9 v '06. 51° 12′ N., 11° 55′ W., soundings 610–680 fms., ooze. Trawl.—Two.

S. R. 506—12 IX '07. 50° 34′ N., 11° 19′ W., soundings 661–672 fms. Trawl.—Three.

S. R. 593—6 VIII '08. 50° 31′ N., 11° 31′ W., soundings 670–770 fms., ooze. Trawl.—Five.

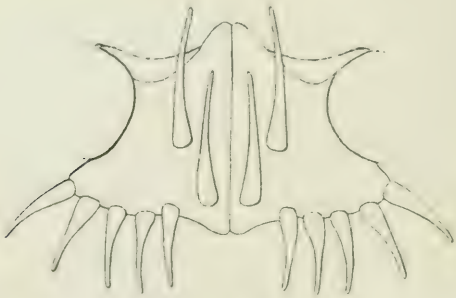

Fig. 1. Mouth-plates of *Hymenaster giganteus.*

Most of the specimens are of large size, the largest (R = 160 mm.) being from station S. R. 331, and agree closely with the type of *H. giganteus* which is now in the Dublin Museum.

Sladen in his description (1891) does not expressly mention the fleshy inter-radial concrescence of the actinal and abactinal membranes, which is characteristic both of the type and of the *Helga* specimens. The mouth-plates bear 3 or 4 mouth spines and two secondary spines, the numbers varying in the same specimen. The adambulacral armature consists of two fleshy spines and a fleshy papilla. In a specimen measuring R = 110 mm. the longest actino-lateral spine is the eighteenth

from the mouth, and measures 33 mm., and the arm ossicles number forty-six, the distal eighteen being reflexed, with very minute actino-lateral spines.

In one specimen from S. R. 593 (R = 80 mm.) the adambulacral armature consisted of three spines, or rarely two, slightly fleshy at the tip, the two largest spines being subequal and proximal in position, and the distal spine slender and about three-fifths as long as the other two. The mouth-plates bore 4 or 5 mouth spines and two secondary spines. This specimen is intermediate between *H. giganteus* and *H. membranaceus*, and raises a suspicion that the latter may be merely a young *H. giganteus*. If this should prove to be so the name *H. membranaceus* must stand.

Hymenaster rex, Perrier (1894), from off Senegal, is an allied species, and agrees closely in general appearance. In it there is a muscular thickened interbrachial area not traversed by the actino-lateral spines. The number of actino-lateral spines is given by Perrier as twenty-five, which, if the distal reflexed ossicles, which bear very minute spines, were not counted, would agree with the thirty large spines found in Irish specimens. There are three adambulacral spines, but they are figured as not having a fleshy wing. The number of mouth-plate spines agrees with the larger *Helga* specimens. The number of spines in the valves of the aboral crown is fifteen. In the *Helga* specimens it appears to be fourteen or fifteen. The most reliable distinction between *H. rex* and *H. giganteus* seems to be the form of the mouth-plate which, as figured by Perrier, differs considerably from that found in the *Helga* specimens.

Family *ECHINASTERIDAE*.

Henricia abyssicola, Norman.

Cribrella sanguinolenta, var. *abyssicola*, Norman, 1869.
Henricia sanguinolenta, var. *abyssicola*, Bell, 1892.

Pl. I, Fig. 2.

Helga.

S. R. 363—10 VIII '06. 51° 22′ N., 12° 0′ W., soundings 695–720 fms., ooze. Trawl.—Five.

S. R. 477—28 VIII '07. 51° 15′ N., 11° 47′ W., soundings 707–710 fms., ooze. Trawl.—Five.

S. R. 499—11 IX '07. 50° 55′ N., 11° 29′ W., soundings 666–778 fms. Trawl.—Two.

S. R. 500—11 IX '07. 50° 52′ N., 11° 26′ W., soundings 625–666 fms. Trawl.—Three.

S. R. 746—14 V '09. 50° 32′ N., 12° 13′ W., soundings 620–658 fms., ooze. Trawl.—One.

The *Helga* specimens agree with those from the *Flying Falcon* collection in the Dublin Museum, which were named by Sladen as var. *abyssicola*. There does not seem to be much reason why the variety should not rank as a separate species;

in fact, the points of resemblance to the littoral form might easily be overlooked without close examination. *H. abyssicola* is, when alive, always of a creamy-white colour, and its arms are usually much contorted. Its bathymetric range on the west coast of Ireland seems to lie between 650 and 750 fathoms.

Henricia abyssalis (Perrier), which occurs off the Azores, Morocco and the Straits of Gibraltar, in similar depths, is closely allied, but distinguished by the narrowness of the plates which form the meshes on the abactinal surface. The corresponding species on the west side of the Atlantic is *Henricia Antillarum* (Perrier), which, though resembling *H. abyssicola* in general appearance, differs, as Dr. H. L. Clark, who has examined both species, informs me, in the armature of the adambulacral plates.

The size reached by this species seems to be much less than in the case of *H. sanguinolenta*. The largest Irish specimen, the arms of which were distended by the enlarged gonads, which were escaping through rupture of the abactinal surface, only measured R = 4·8 cm., r = ·8 cm.

Family *ASTERIIDAE*.

Asterias rubens, L.

Asterias rubens, Bell, 1892.

Helga.

S. R. 185—30 I '05. 50° 20′ N., 10° 20′ W., soundings 82½ fms., fine sand and shells. Trawl.—Thirteen.

S. R. 187—31 I '05. 51° 14′ 30″ N., 9° 43′ W., soundings 57 fms., sand and mud. Trawl.—One.

S. R. 211—5 V '05. 50° 20′ N., 10° 20′ W., soundings 81 fms., coarse sand. Trawl.—Six.

S. R. 215—9 V '05. 52° 01′ N., 11° 21′ W., soundings 106 fms. Trawl.—Two.

S. R. 216—9 V '05. 52° 21′ N., 11° 54′ W., soundings 143–164 fms. Trawl.—Two.

S. R. 220—11 V '05. 53° 39′ N., 12° 24′ W., soundings 185 fms. Trawl.—One.

S. R. 225—13 V '05. 53° 2′ N., 13° 48′ W., soundings 105–109 fms. Dredge.—One. Trawl.—Two.

S. R. 226—13 V '05. 53° 12′ N., 13° 57′ W., soundings 93 fms. Dredge.—One.

S. R. 384—6 XI '06. 51° 54′ 30″ N., 11° 37′ W., soundings 162–218 fms. Trawl.—Two.

S. R. 405—8 II '07. 51° 56′ N., 11° 0′ W., soundings 84 fms. Trawl.—One.

S. R. 591—4 VIII '08. 51° 46′ N., 10° 44′ 30″ W., soundings 73–78 fms. Trawl.—Three.

S. R. 755—19 V '09. 52° 3′ N., 11° 20′ W., soundings 92–100 fms., fine sand. Trawl.—Three.

All these records are within the known bathymetric range of the species.

Asterias glacialis, L.

Asterias glacialis, Bell, 1892.

Helga.

S. R. 187—31 I '05. 51° 14′ 30″ N., 9° 43″ W., soundings 57 fms., sand and mud. Trawl.—One.

This appears to be the only Irish record from below 50 fathoms.

Family *BRISINGIDAE.*

Brisinga endecacnemos, Asbj.

Brisinga endecacnemos, Bell, 1892.

Helga.

S. R. 188—3 II '05. 51° 53′ N., 11° 59′ W., soundings 320–372 fms., mud. Trawl.—Discs and arms, moderate.

S. R. 212—6 V '05. 51° 54′ N., 11° 57′ W., soundings 411 fms., fine muddy sand. Trawl.—Discs and arms, several.

S. R. 321—1 V '06. 50° 59′ N., 11° 17′ W., soundings 208–480 fms., fine sand. Trawl.—Arms.

S. R. 329—9 V '06. 51° 21′ 30″ N., 11° 34′ W., soundings 215–415 fms. Trawl.—One.

S. R. 330—9 V '06. 51° 16′ N., 11° 37′ W., soundings 374–415 fms., fine sand. Trawl.—Fragments.

S. R. 353—6 VIII '06. 50° 37′ N., 11° 32′ W., soundings 250–542 fms., muddy sand. Trawl.—Many fragments.

S. R. 440—16 V '07. 51° 45′ N., 11° 49′ W., soundings 350–389 fms. Trawl.—Fragments.

S. R. 490—7 XI '07. 51° 57′ 30″ N., 12° 7′ W., soundings 470–491 fms., ooze. Trawl.—One arm.

S. R. 491—7 XI '07. 51° 57′ 30″ N., 12° 13′ W., soundings 490–520 fms. Trawl.—Fragments.

S. R. 493—8 XI '07. 51° 58′ N., 12° 25′ W., soundings 533–570 fms. Trawl.—Fragments.

S. R. 494—8 XI '07. 51° 59′ N., 12° 32′ W., soundings 550–570 fms. Trawl.—Fragments.

S. R. 496—8 XI '07. 51° 54′ N., 12° 54′ W., soundings 473–500 fms. Trawl.—Fragments.

S. R. 501—11 XI '07. 50° 49′ N., 11° 22′ W., soundings 447–625 fms. Trawl.—Fragments.

S. R. 502—11 XI '07. 50° 46′ N., 11° 21′ W., soundings 447–515 fms. Trawl.—Fragments.

S. R. 506—12 XI '07. 50° 34′ N., 11° 19′ W., soundings 661–672 fms. Trawl.—Few arms.

S. R. 590—3 VIII '08. 51° 50′ N., 12° 9′ W., soundings 480–493 fms., ooze. Trawl.—Arm.

S. R. 592—6 VIII '08. 50° 39′ N., 11° 25′ W., soundings 400–510 fms., ooze. Trawl.—Fragments.

Helga.

S. R. 752—16 v '09. 51° 51′ N., 12° 13′ W., soundings 523–595 fms., ooze. Trawl.—Fragments.

S. R. 944—17 v '10. 51° 22′ N.. 12° 41′ W., soundings 982 fms., ooze. Trawl.—Three discs, several arms.

Fragments of this species are frequently taken in the trawl between 350 and 1,000 fathoms. Usually the arms only are present, but occasionally discs are taken.

All the specimens which have passed through Mr. Kemp's hands have been named by him as *B. endecaenemos*, and those which I have examined I have recorded under the same name, though I must confess my inability to distinguish between *B. endecaenemos* and *B. coronata*. The number of arms in the Irish specimens varies from nine to twelve, the usual number being ten.

OPHIUROIDEA.

ZYGOPHIURAE.

Family *OPHIOLEPIDIDAE.*

Ophiura ciliaris, Linn.

Ophiura ciliaris, Bell, 1892.

Helga.

S. R. 185—30 I '05. 50° 20′ N., 10° 20′ W., soundings 82½ fms., fine sand and shells. Trawl.—Two.

S. R. 187—31 I '05. 51° 14′ 30″ N., 9° 43′ W., soundings 57 fms., sand and mud. Dredge.—Four. Trawl.—Two.

S. R. 211—5 v '05. 50° 20′ N., 10° 20′ W., soundings 81 fms., coarse sand. Trawl.—Thirteen.

S. R. 225—13 v '05. 53° 2′ N., 13° 48′ W., soundings 105–109 fms., fine sand and shells. Dredge.—One.

S. R. 360—8 VIII '06. 52° 4′ N., 11° 27′ W., soundings 108–120 fms., fine sand. Trawl.—One.

S. R. 591—4 VIII '08. 51° 46′ N., 10° 44′ 30″ W., soundings 73–78 fms. Trawl.—One.

S. R. 755—19 v '09. 52° 3′ N., 11° 20′ W., soundings 92–100 fms., fine sand. Trawl.—Two.

Rarely found below 100 fathoms. Probably the change in the nature of the bottom, which becomes more muddy with the increase in depth, is in part the cause of this limitation, as in shallow water this species is found only on sandy ground.

Ophiura albida, Forbes.

Ophiura albida, Bell, 1892.

Helga.

S. R. 226—13 v '05. 53° 12′ N., 13° 57′ W., soundings 93 fms., coarse sand, shells and gravel. Dredge.—One.

S. R. 528—7 XI '07. 50° 21′ 30″ N., 10° 24′ W., soundings 85 fms., sand and shells. Dredge.—Seven.

The fewness of records of *O. albida* below 50 fathoms is probably, as in the case of *O. ciliaris*, due in part to the unsuitable nature of the ground over which the *Helga* worked. In shallow water it is usually found on coarse sandy gravel.

Ophiura carnea, Ltk.

Ophiura carnea, Lütken, 1858.
Ophioglypha carnea, Lyman, 1865, 1882.
Ophioglypha carnea, Koehler, 1898.

Helga.

CXXI—24 VIII '01. 53° 54′ N., 11° 50′ W., soundings 199 fms., fine sand. Net on Trawl.—Five.

S. R. 44—17 VIII '03. 53° 34′ N., 11° 29′ W., soundings 120 fms., fine sand. Net on Trawl.—Four.

S. R. 150—25 VIII '04. 53° 54′ N., 12° 19′ W., soundings 220 fms., fine sand. Net on Trawl.—Twenty.

S. R. 152—27 VIII '04. 54° 7′ N., 11° 37′ W., soundings 220 fms. Net on Trawl.—Two. Bottom Townet.—Two.

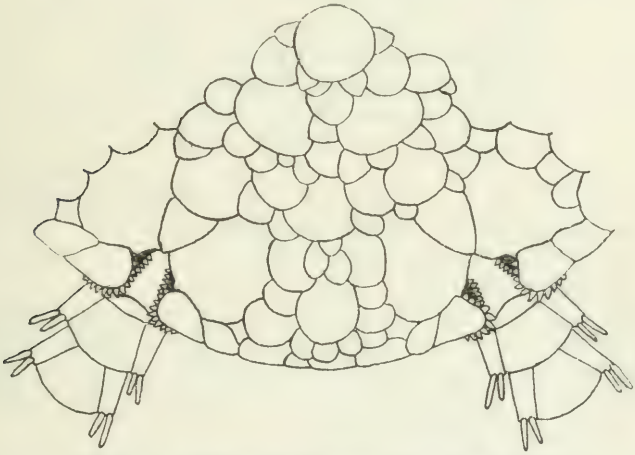

Fig. 2. *Ophiura carnea*, abactinal view.

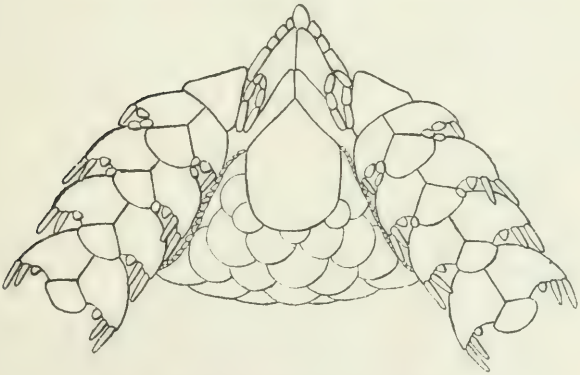

Fig. 3. *Ophiura carnea*, actinal view.

Although *O. carnea* has not previously been recorded from British and Irish waters its occurrence is not unexpected, as it has long been known from the Norwegian Sea, and more recently the *Hirondelle* and *Princess Alice* have extended our knowledge of its range to the Bay of Biscay, the coast of Portugal and the Azores (Koehler, 1898, 1909), and Marenzeller (1893) has recorded it from the Mediterranean.

Its habitat is on a bottom of sand or muddy sand at moderate depths.

It is easily recognised by its thick disc and slender arms, but its most characteristic feature is the manner in which the arm comb is continued on to the upper surface of the disc on either side of the large first upper arm plate, which itself bears very evident lateral combs of spines.

The diameter of the disc of the largest Irish specimen measured 6 mm.

Ophiura signata, Verrill.

Ophiura signata, Verrill, 1882.
Ophioglypha signata, Lyman, 1883.
Ophioglypha signata, Hoyle, 1884.
Ophioglypha signata, Sladen, 1891.
Ophiura signata, Bell, 1892.
Ophiura signata, Kemp, 1905.

Helga.

S. R. 171—5 XI '04. 52° 7′ N., 11° 58′ W., soundings 337 fms. Trawl.—One very small.

S. R. 188—3 II '05. 51° 53′ N., 11° 59′ W., soundings 320–372 fms., mud. Trawl.—Two.

S. R. 212—6 V '05. 51° 54′ N., 11° 57′ W., soundings 378–411 fms., fine muddy sand. Net on Trawl.—Eight.

S. R. 222—12 V '05. 53° 1′ N., 14° 34′ W., soundings 293 fms., fine sand. Net on Dredge.—Two. Net on Trawl.—Two.

S. R. 351—5 VIII '06. 50° 19′ 30″ N., 11° 6′ W., soundings 240–250 fms., fine sand. Net on Trawl.—Four small.

S. R. 353—6 VIII '06. 50° 38′ N., 11° 32′ W., soundings 250–542 fms., muddy sand. Net on Trawl.—Five small.

S. R. 360—8 VIII '06. 52° 4′ N., 11° 27′ W., soundings 108–120 fms., fine sand. Net on Trawl.—Fourteen very small.

S. R. 365—10 VIII '06. 51° 25′ N., 11° 32′ W., soundings 385–440 fms., sand and stones. Net on Trawl.—Ca. twenty small.

S. R. 367—11 VIII '06. 51° 38′ N., 11° 37′ W., soundings 287–332 fms., muddy sand. Net on Trawl.—Forty-six.

S. R. 399—5 II '07. 51° 28′ N., 11° 33′ 30″ W., soundings 342 fms., mud and stones. Net on Dredge.—Several.

Helga.

S. R. 447—18 v '07. 50° 20′ N., 10° 57′ W., soundings 221–343 fms., fine sand. Net on Trawl.—One.

S. R. 482—29 VIII '07. 51° 6′ N., 11° 26′ W., soundings 368 fms., fine sand. Net on Trawl.—Several.

S. R. 487—3 IX '07. 51° 36′ N., 11° 57′ W., soundings 540–660 fms., ooze and stones. Net on Trawl.—One very small.

S. R. 497—10 IX '07. 51° 2′ N., 11° 36′ W., soundings 775–795 fms., ooze. Net on Trawl.—One very small.

S. R. 505—12 IX '07. 50° 39′ N., 11° 14′ W., soundings 464–627 fms. Net on Trawl.—Four.

S. R. 593—6 VIII '08. 50° 31′ N., 11° 31′ W., soundings 670–770 fms., ooze. Net on Trawl.—One very small.

S. R. 753—17 v '09. 51° 24′ N., 11° 59′ 30″ W., soundings 561–572 fms., ooze. Net on Trawl.—Three, very small.

This is one of the most characteristic species of the mud and ooze between 300 and 500 fathoms, and was usually found whenever the townets attached to the trawl or dredge contained material stirred up from the bottom.

It is rather remarkable that it is not more frequently recorded from dredgings in the North-east Atlantic.

Ophiura affinis, Lütken.

Ophiura affinis, Bell, 1892.

Helga.

S. R. 185—30 I '05. 50° 20′ N., 10° 20′ W., soundings 82½ fms., fine sand and shells. Dredge.—One.

S. R. 226—13 v '05. 53° 12′ N., 13° 57′ W., soundings 93 fms., gravel and shells. Dredge.—One.

S. R. 807—17 VIII '09. 51° 37′ 30″ N., 11° 6′ W., soundings 105 fms., fine sand. Net on Trawl.—Twelve.

This species is found on the west coast of Ireland at depths of from 10 to 120 fathoms, and, though widely distributed on sandy ground, occurs only in very small numbers.

Ophiura Ljungmanni, Lyman.

Ophiura Ljungmanni, Lyman, 1882.

Helga.

S. R. 851—9 XI '09. 50° 48′ N., 11° 41′ W., soundings 900 fms., ooze. Petersen Mesoplankton Trawl on bottom.—Two.

S. R. 944—17 v '10. 51° 22′ N., 12° 41′ W., soundings 982 fms., ooze. Trawl.—Six.

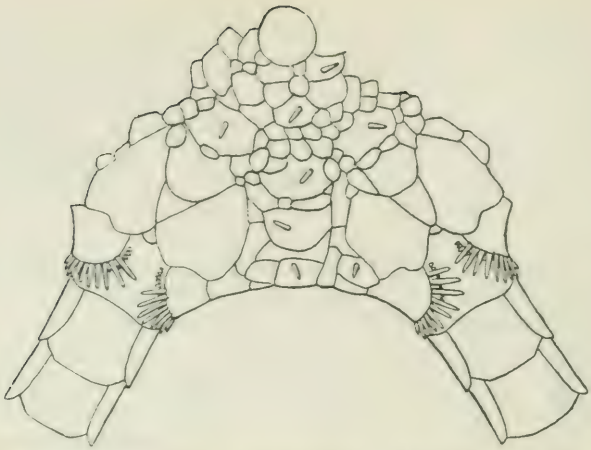

Fig. 4. *Ophiura Ljungmanni*, abactinal view.

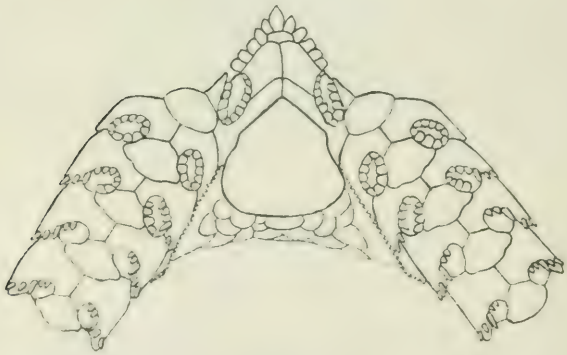

Fig. 5. *Ophiura Ljungmanni*, actinal view.

The most noticeable features of this species are its arm-comb of long slender spines which covers a smaller accessory comb, present in the type though not referred to by Lyman (1882) in his description, and its three short arm spines, two close together beside the arm tentacle, and one slightly longer one near the upper margin of the lateral arm plate.

O. Ljungmanni is closely allied to *O. lepida*, Lyman, and some of the specimens labelled as *O. lepida* in the British Museum from the *Challenger* collection, e.g., those from stations 46 and 343, seem to be intermediate between the two species if not definitely referrable to *O. Ljungmanni*. Verrill (1885 *a*) has recorded both species as common on the west side of the Atlantic.

O. Thouleti, Koehler (1896), is another closely allied species, and *O. leptoctenia*, H. L. Clark (1911), is the corresponding species occurring in the Pacific, distinguished by small but, according to the describer, constant differences.

The presence of a supplemental arm-comb is one of the characters of *O. Thouleti* which Dr. Koehler (1909) points out as separating that species from *O. Ljungmanni*, but, as noted above, this feature is common to both.

This species is new to the British and Irish area.

Ophiura aurantiaca, Verrill.

Ophiura aurantiaca, Bell, 1892.

Helga.

S. R. 506—12 IX '07. 50° 34′ N., 11° 19′ W., soundings 661–672 fms. Trawl.—Three.

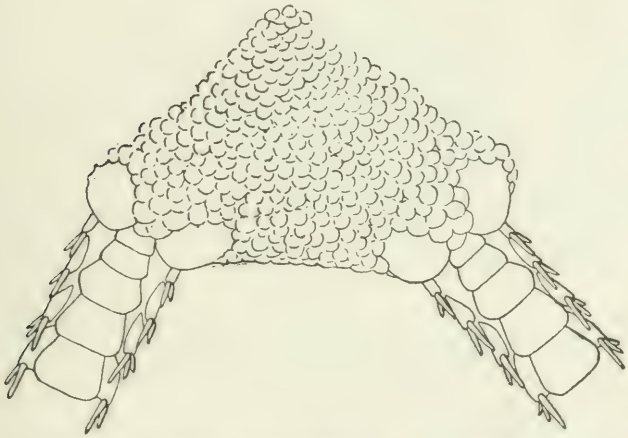

Fig. 6. *Ophiura aurantiaca*, abactinal view.

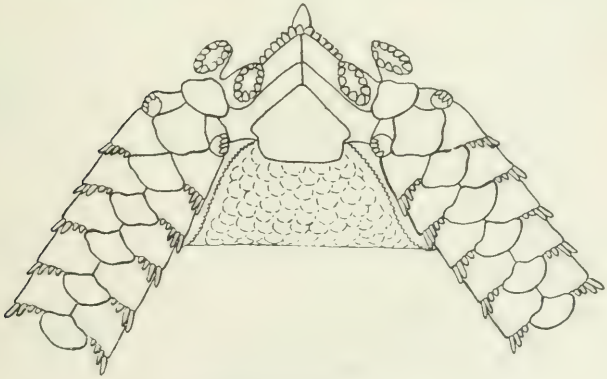

Fig. 7. *Ophiura aurantiaca*, actinal view.

This species, which occurs on both sides of the Atlantic, has already been dredged in British waters in the Faeroe Channel (Hoyle, 1884). Grieg (1903) has published a good figure of it.

Family *AMPHIURIDAE.*

Ophiomusium Lymani, Wvy. Thoms.

Ophiomusium Lymani, Bell, 1892.

Helga.

S. R. 851—9 XI '09. 50° 48′ N., 11° 41′ W., soundings 900 fms., ooze. Petersen Mesoplankton Trawl on bottom.—One.

S. R. 944—17 V '10. 51° 22′ N., 12° 41′ W., soundings 982 fms., ooze. Trawl.—Many.

This species was taken on the two occasions on which the *Helga* fished at depths of 900 or more fathoms, but was not found in any of the numerous hauls made at lesser depths. There seems to be some uncertainty as to where the *Porcupine* specimens, on the strength of which the species was admitted into Professor Bell's British list, were actually found. The statement that they were taken at a depth of 180 fathoms may eb regarded as doubtful, on the grounds of the imperfect definition of the position of the station (45*a*) and the extraordinary steepness of the sea-bottom in that neighhourhood.

Good figures of *O. Lymani* are given by Wyville Thompson (1873) and Koehler (1909).

Amphiura elegans (Leach).

Amphiura elegans, Bell, 1892.

Helga.

S. R. 185—30 I '05. 50° 20′ N., 10° 20′ W., soundings 82½ fms., fine sand and shells. Trawl.—One.

S. R. 331—9 V '06. 51° 12′ N., 11° 55′ W., soundings 610–680 fms., ooze. Trawl.—Four, small.

S. R. 365—10 VIII '06. 51° 25′ N., 11° 32′ W., soundings 385–440 fms., sand and stones. Trawl.—Three.

S. R. 479—28 VIII '07. 51° 30′ N., 11° 41′ W., soundings 468–560 fms. Trawl.—Three, very small.

S. R. 499—11 IX '07. 50° 55′ N., 11° 29′ W., soundings 666–778 fms. Trawl.—Six, very small.

S. R. 755—19 V '09. 52° 3′ N., 11° 20′ W., soundings 92–100 fms., fine sand. Trawl.—Two, small.

Most of the deep water specimens of *A. elegans* taken by the *Helga* are very small, but no other difference is apparent between them and the shallow-water forms. The arrangement of the mouth-plates is similar, and there are always two tentacle scales. The most common situation for this species is between tide marks, under stones, amongst muddy gravel, but it may be found almost everywhere in shallow water. The limit of depth as given by Bell (1892) is 120 fathoms, but the present records extend it to 666 fathoms.

Amphilepis norvegica (Ljungmann).

Helga.

S. R. 752—16 v '09. 51° 51′ N., 12° 13′ W., soundings 523 fms., ooze. Trawl.—Twenty-eight.

S. R. 944—17 v '10. 51° 22′ N., 12° 41′ W., soundings 982 fms., ooze. Trawl.—One.

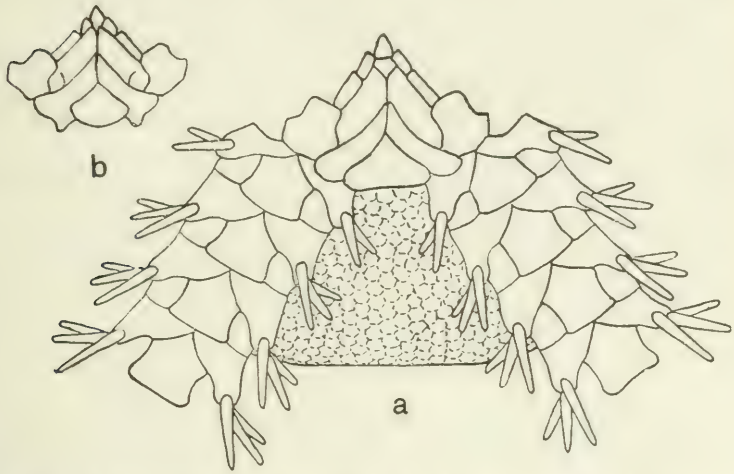

Fig. 8. *Amphilepis norvegica.* *a.* Actinal view of specimen with disc 5 mm. in diameter. *b.* Mouth-plates of specimen with disc 4 mm. in diameter.

This species, though now for the first time recorded from the British and Irish area, has a wide distribution on both sides of the Atlantic. Its headquarters on the European side seem to be off the coast of Norway, where it has been taken at depths of from 50 fathoms (Sussbach and Brechner, 1911) to 600 fathoms (Grieg, 1903). Its range extends southwards to the coast of Portugal.

The Irish specimens are all of small size, the diameter of the disc in the largest measuring only 5 mm.

The size of the mouth shield in this species in relation to the side mouth-plates shows a marked increase with the increased growth of the animal. The figures show the difference between specimens measuring 5 mm. and 4 mm. across the disc. In the smaller specimen the size of the radial shield is relatively much smaller.

Ophiactis abyssicola (Sars).

Ophiactis abyssicola, Bell, 1892.

Helga.

S. R. 223—12 v '05. 53° 7′ N., 14° 50′ W., soundings 410–500 fms., coral. Trawl.—Five.

S. R. 277—15 xi '05. 54° 17′ 30″ N., 11° 34′ W., soundings 550 fms., gravel and shells. Dredge.—Two.

Helga.

S. R. 327—8 v '06. 51° 46′ N., 12° 14′ 30″ W., soundings 550 fms., ooze. Trawl.—One.

S. R. 331—9 v '06. 51° 12′ N., 11° 55′ W., soundings 610–680 fms., ooze. Trawl.—One hundred.

S. R. 334—10 v '06. 51° 35′ 30″ N., 12° 26′ W., soundings 500–520 fms. Trawl.—Four.

S. R. 401—5 ii '07. 51° 14′ N., 11° 51′ W., soundings 600–660 fms. Trawl.—One.

S. R. 477—28 viii '07. 51° 15′ N., 11° 47′ W., soundings 707–710 fms., ooze. Trawl.—Many.

S. R. 478—28 viii '07. 51° 17′ N., 11° 44′ W., soundings 560–707 fms. Trawl.—Twenty.

S. R. 479—28 viii '07. 51° 20′ N., 11° 41′ W., soundings 468–560 fms. Trawl.—Two.

S. R. 483—30 viii '07. 51° 37′ N., 11° 56′ W., soundings 610–664 fms., muddy sand. Trawl.—Twelve.

S. R. 486—3 ix '07. 51° 37′ 30″ N., 12° 0′ W., soundings 600–660 fms. Trawl.—One.

S. R. 497—10 ix '07. 51° 2′ N., 11° 36′ W., soundings 775–795 fms., ooze. Trawl.—One.

S. R. 499—11 ix '07. 50° 55′ N., 11° 29′ W., soundings 666–778 fms. Trawl.—One.

S. R. 500—11 ix '07. 50° 52′ N., 11° 26′ W., soundings 625–666 fms. Trawl.—Few.

S. R. 502—11 ix '07. 50° 46′ N., 11° 21′ W., soundings 447–515 fms. Trawl.—Few.

S. R. 504—12 ix '07. 50° 42′ N., 11° 18′ W., soundings 627–728 fms., coral. Trawl.—Thirty-one.

S. R. 506—12 ix '07. 50° 34′ N., 11° 19′ W., soundings 661–672 fms. Trawl.—Twenty-five.

S. R. 593—6 viii '08. 50° 31′ N., 11° 31′ W., soundings 670–770 fms., ooze. Trawl.—Two.

S. R. 944—17 v '10. 51° 22′ N., 12° 41′ W., soundings 982 fms., ooze. Trawl.—Five.

S. R. 1004—12 viii '10. 50° 22′ 30″ N., 11° 44′ 30″ W., soundings 636–641 fms., fine sand. Trawl.—Few.

This is one of the most numerous of the Irish deep-water Ophiuroids. It occurs in abundance on the Bird's-nest Sponge, *Pheronema*, and also amongst corals and alcyonarians.

The diameter of the disc rarely reaches 6 mm., the specimens from most of the stations measuring from 5 mm. downwards.

It is possible that some of the *Helga* specimens should be referred to *O. corallicola*, Koehler, if that species is not merely a variety of *O. abyssicola*, as the differences between them seem to be rather critical, and many Irish specimens show the emargination of the disc between the arms which is said by Koehler (1896) to be a characteristic of *O. corallicola*.

Ophiactis Balli (Thompson).

Ophiactis Balli, Bell, 1892.

Helga.

S. R. 185—30 I '05. 50° 20′ N., 10° 20′ W., soundings 82½ fms., fine sand and shells. Trawl.—One.

S. R. 196—11 II '05. 54° 42′ N., 10° 34′ W., soundings 242 fms., stones and coral. Dredge.—Many.

S. R. 211—5 V '05. 50° 20′ N., 10° 20′ W., soundings 81 fms., coarse sand. Trawl.—Two.

S. R. 213—6 V '05. 51° 59′ N., 11° 25′ W., soundings 119 fms., fine sand. Dredge.—Five.

S. R. 223—12 V '05. 53° 7′ N., 14° 50′ W., soundings 410–500 fms., coral. Trawl.—One.

S. R. 258—6 IX '05. 50° 35′ 30″ N., 10° 46′ W., soundings 60½ fms., rock. Bottom townet.—Five.

S. R. 480—28 VIII '07. 51° 23′ N., 11° 38′ W., soundings 468 fms., stones. Dredge.—Several.

S. R. 504—12 IX '07. 50° 42′ N., 11° 18′ W., soundings 627–728 fms., coral. Trawl.—Three.

S. R. 944—17 V '10. 51° 22′ N., 12° 41′ W., soundings 982 fms., ooze.

This is a common species in water of from about 30 fathoms downwards, wherever it can find crevices in stones or coral in which to insert iself.

Ophiopholis aculeatus (Linn.).

Ophiopholis aculeatus, Bell, 1892.

Helga.

S. R. 185—30 I '05. 50° 20′ N., 10° 20′ W., soundings 82½ fms., fine sand and shells. Trawl.—One.

S. R. 215—9 V. '05. 52° 1′ N., 11° 21′ W., soundings 106 fms. Trawl.—One.

S. R. 216—9 V '05. 52° 21′ N., 11° 54′ W., soundings 143–164 fms. Trawl.—One.

S. R. 225—13 V '05. 53° 2′ N., 13° 48′ W., soundings 105–109 fms., fine sand and shells. Dredge.—Two. Trawl.—Three.

S. R. 258—6 IX '05. 53° 35′ 30″ N., 10° 46′ W., soundings 60½ fms., rock. Bottom townet.—One.

S. R. 360—8 VIII '06. 52° 4′ N., 11° 27′ W., soundings 108–120 fms., fine sand. Trawl.—Several.

S. R. 591—4 VIII '08. 51° 46′ N., 10° 44′ 30″ W., soundings 73–78 fms. Trawl.—Few.

S. R. 807—17 VIII '09. 51° 37′ 30″ N., 11° 6′ W., soundings 105 fms., fine sand. Trawl.—One.

O. aculeatus does not, apparently, occur below 150 fathoms on the west coast of Ireland, although it has been taken as deep as 560 fathoms in the Faeroe Channel by the *Porcupine* expedition, and in 345 fathoms in the North Sea (Grieg, 1903).

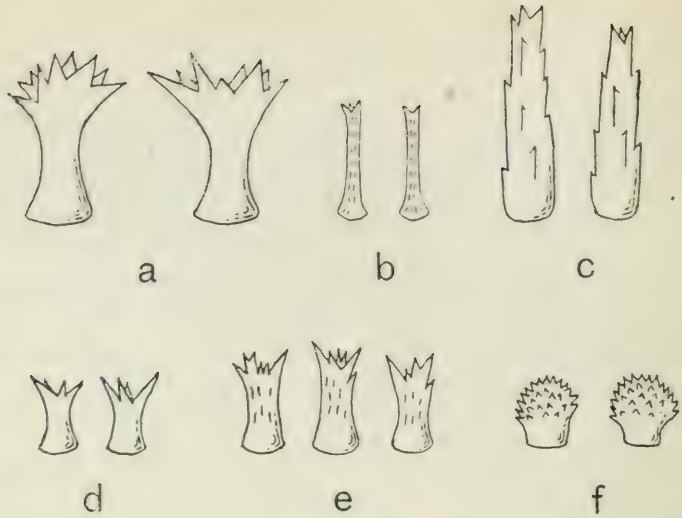

Fig. 9. Disc Spines.

a *Ophiacantha aristata.*
b *Ophiacantha densa.*
c *Ophiacantha crassidens.*
d *Ophiacantha abyssicola.*
e *Ophiacantha hibernica.*
f *Ophiolebes claviger.*

Ophiacantha abyssicola, G. O. Sars.

Ophiacantha abyssicola, G. O. Sars, 1872.
Ophiacantha millespina, Verrill, 1879.
Ophiacantha abyssicola, Bell, 1892.
Ophiacantha abyssicola, Kemp, 1905.

Helga.

CXX—24 VIII '01. 53° 58′ N., 12° 24′ W., soundings 382 fms. Dredge.—Two.

S. R. 194—10 II '05. 54° 49′ N., 10° 30′ W., soundings 366 fms., rock. Dredge.—One.

S. R. 223—12 V '05. 53° 7′ N., 14° 50′ W., soundings 410–500 fms., coral. Trawl.—Five.

S. R. 277—15 XI '05. 54° 17′ 30″ N., 11° 34′ W., soundings 550 fms., gravel and shells. Dredge.—Eight.

This species has already been taken in the Faeroe Channel by the *Porcupine* Expedition and by the *Helga* in Irish waters. It occurs on both sides of the Atlantic from the Arctic Circle to as far south as the Azores.

The *Helga* specimens are small, r=2·7 mm. or less. They have been compared with specimens from Norway in the Norman collection in the British Museum. The most noticeable characters, in addition to the moniliform appearance of the arms, are the disc crochets with three or four delicate diverging spines which are equal in length to the basal portion of the crochet, and the mouth shields, the distal angle of which is produced and slightly hollowed.

Koehler, who has examined specimens of both species, points out (1909) that Verrill's *O. millespina* is a synonym of *O. abyssicola*.

The disc spines of this species are shown in Fig. 9, d (p. 38).

Ophiacantha hibernica, n.sp.

Helga.

S. R. 944—17 v '10. 51° 22′ N., 12° 41′ W., soundings 982 fms., ooze. Trawl.—One.

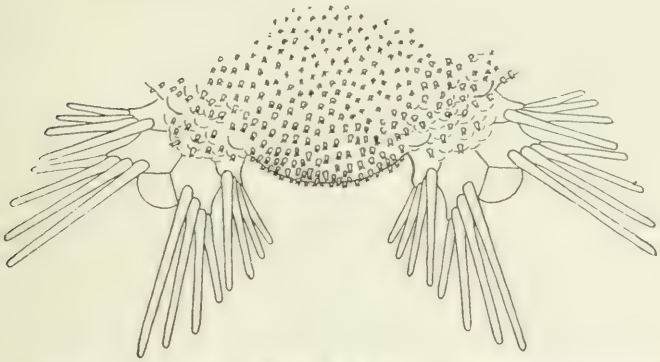

Fig. 10. *Ophiacantha hibernica*, abactinal view.

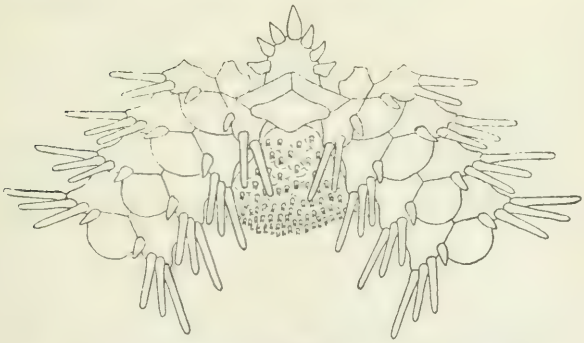

Fig. 11. *Ophiacantha hibernica*, actinal view.

Disc 6·5 mm. in diameter; arms about 40 mm. in length. Disc almost circular, slightly produced between the arms, closely covered with small trifid or multifid spinules or stumps (Fig. 9, e, p. 38), which conceal the fine scaling. The disc scaling is continued for a short distance on to the upper surface of the arms. Radial shields concealed by the disc scaling and spinulation, the position of their outer ends being marked by a slight projection. Upper arm plates moderately large with curved distal margin and slightly acute inner angle, separated by about half their length by the side arm plates. Interbrachial spaces below covered with spinules similar to

those on the disc. Genital slits narrow, reaching almost to the margin of the disc. Mouth shields moderately large, each separated from the other by about its own width, rhombic in form with rounded angles and straight or slightly concave sides. The outer angle is not so prominent nor are the sides so hollowed as in *Ophiacantha abyssicola*. Side mouth shields long and narrow, very slightly widened at their outer ends. Mouth papillae sharp pointed, three on each side and one at the apex of the jaw, the apical papilla the largest, the others sub-equal, the outermost on each side having a distinct shoulder on its outer margin. Under arm plates from the fourth outwards about as wide as long, with much curved outer margin. Near the base of the arm they are only slightly separated by the side arm plates, but from about the twenty-second joint outwards the intervals are equal to or greater than the under arm plates. First under arm plate irregularly shaped, second and third wider than long. Side arm plates not very large, meeting above and below, each with seven spines, decreasing to five towards the tip of the arms. Spines long and slender, the uppermost the longest, extending over two arm joints. On the fourth arm joint it measured 2·3 mm. in length. The spines are smooth, round and hollow, except that on the distal arm joints the lowest spine is slightly flattened and has a fine denticulation along its lower edge. Tentacle scales small, short and broad, about the same size as the oral papillae. Tentacle pores small, covered by the tentacle scales and first arm spines, but easily seen.

This species comes very near to *Ophiacantha inconspicua*, Lutken and Mortensen, as figured in the account of the *Albatross* collections (1899), but Dr. Koehler, who has kindly examined my specimen, tells me that there is nothing in that collection which exactly corresponds. It may, perhaps, be regarded as a modified Atlantic representative of that Pacific species.

The most characteristic features, as far as can be made out from one specimen, are the under arm plates as wide as long and much rounded distally, the disc scaling continued on the upper surface of the arms, the character of the disc spinulation, the form of the mouth shield and, possibly, the peculiar shape of the outermost mouth papilla.

Ophiacantha densa, n.sp.

Helga.

S. R. 223—12 v '05. 53° 7′ N., 14° 50′ W., soundings 410–500 fms., coral. Trawl.—Eight.

S. R. 504—12 IX '07. 50° 42′ N., 11° 18′ W., soundings 627–728 fms., coral. Trawl.—Twenty-one.

S. R. 505—12 IX '07. 50° 39′ N., 11° 14′ W., soundings 464–627 fms. Trawl.—One.

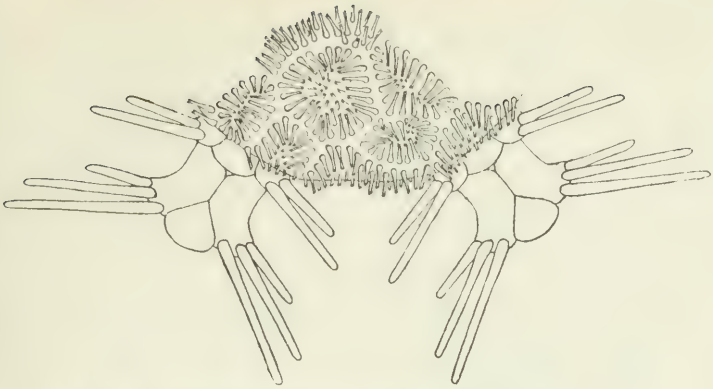

Fig. 12. *Ophiacantha densa*, abactinal view.

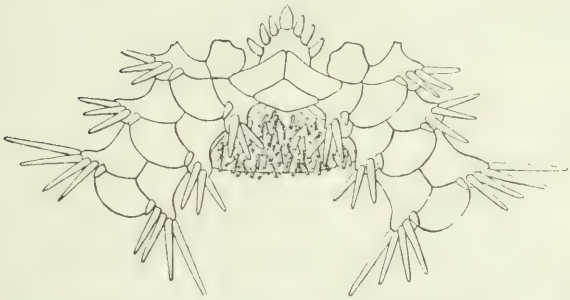

Fig. 13. *Ophiacantha densa*, actinal view.

Diameter of disc 4·5 mm. Length of arm about 20 mm. Disc pentagonal or circular, closely covered with small rod-like spinules which conceal the small scales which clothe the disc. Disc spinules glassy, bifid or trifid at the tip and with an expanded base (Fig. 9, b, p. 38); they appear to be hollow or chambered. Radial shields not visible. Upper arm plates small, triangular, with rounded distal margin, widely separated by the side arm plates. Interbrachial spaces small, closely covered with spinules similar to those on the disc. Genital slits wide, extending almost to the margin of the disc. Oral shields small, lozenge shaped, almost twice as wide as long, outer margin curved or with a very obtuse rounded angle, inner angle not quite so obtuse. Adoral plates broad, parallel sided or slightly narrowed within, forming a lozenge shape with the oral shield. Oral papillae three on each side, sub-equal, and one larger at the apex of the jaw; all pointed and slightly spinulose.

Teeth about four, larger and broader than the apical oral papilla. First under arm plate moderately large, irregularly shaped. Succeeding under arm plates large, sub-equal, with arcuate, almost semicircular, distal margin and very obtuse

proximal angle. Second under arm plate in contact with the first, the rest widely separated by the side arm plates. Side arm plates meeting above and below, each plate carrying four slender arm spines, the uppermost being the largest. The uppermost spine on the first five or six plates is almost as long as two arm joints, but the length rapidly decreases towards the tip of the arm. All the spines are smooth or slightly roughened and opaque. Tentacle scale small, smooth, less than half the length of the under arm plate. Tentacle pores obscure.

The most easily recognised feature of this species is the armature of the disc, which gives a dense matted appearance to the surface, especially in dried specimens. It is probable that all the specimens taken by the *Helga* are young, and some of their characters liable to alteration, but even making allowances for possible growth changes it has proved impossible to refer it to any known species, and I have had to describe it as new. Dr. Koehler, to whom I sent a specimen, was unable to identify it with any of the species described by him.

On two of the occasions on which it was taken it was found accompanied by Lophohelia and Alcyonarians.

Ophiacantha crassidens, Verrill.

Ophiacantha crassidens, Verrill, 1885.
Ophiacantha crassidens, Koehler, 1909.

Helga.

S. R. 805—14 VIII '05. 51° 50′ 30″ N., 12° 14′ W., soundings 539–544 fms., ooze. Trawl.—One.

S. R. 944—17 V '10. 51° 22′ N., 12° 41′ W., soundings 984 fms., ooze. Trawl.—One.

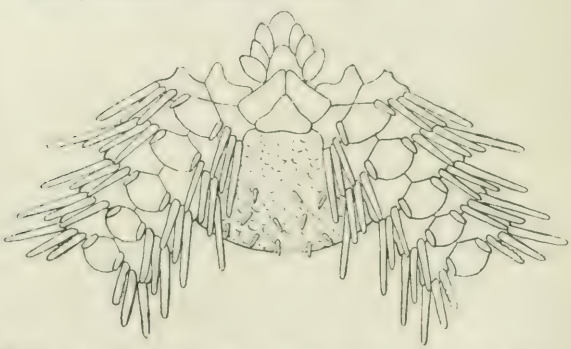

Fig. 14. *Ophiacantha crassidens*, actinal view.

This species is easily recognised. The mouth papillae are very large and flattened. The apical mouth papilla, which is larger than the rest and slightly furrowed longitudinally, is slightly overlapped by those on each side. The mouth shield is cordate, a little wider than long, and the adoral plates are

about two and a half times as long as wide. There are six arm spines, the upper three being round, moderately long and almost smooth, the lower three flattened and bearing several hooked spinules distally on their lower edges. There is one tentacle scale. The disc is covered with small scales, and bears several spines or crochets (Fig. 9, c, p. 38), which are slightly roughened and bi- or trifid at the tip. The radial shields cannot be made out in my specimens.

The description given by Verrill (1885) of *O. crassidens*, taken off Cape Hatteras, agrees very closely with the two *Helga* specimens, and Koehler (1909) has given a further description, with figures, of specimens taken off the Azores, which also agrees fairly well.

I was at first inclined to regard the *Helga* specimens as belonging to *O. prionota*, H. L. Clark (1911), from Japan, but on sending drawings of them to Dr. H. L. Clark he kindly pointed out several differences, notably that in *O. prionota* the lower arm spines are denticulated on both edges, and the adoral plates are not less than twice as long as wide. The two species are, however, closely allied.

Ophiacantha aristata, Koehler.

Ophiacantha aristata, Koehler, 1896.

Helga.

S. R. 331—9 v '06. 51° 12′ N., 11° 55′ W., 610–680 fms., ooze. Net on trawl.—Two.

S. R. 477—28 VIII '07. 51° 15′ N., 11° 47′ W., 707–710 fms., ooze. Trawl.—One.

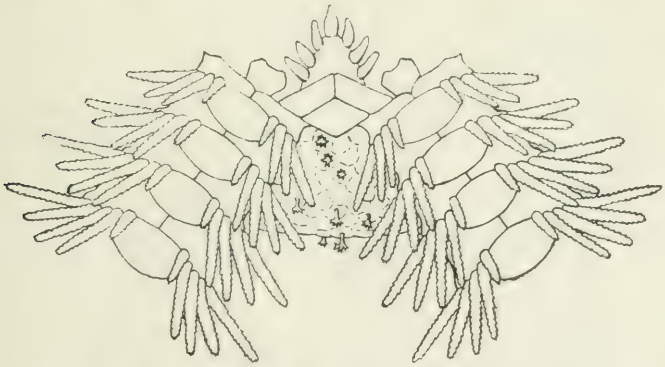

Fig. 15. *Ophiacantha aristata,* actinal view.

Dr. Koehler was good enough to confirm the identification of the *Helga* specimens as *O. aristata.*

This species is easily recognised. The much branched disc crotchets and the large spinulose tentacle scales are two very distinctive features, and the number and form of the dental papillae and arm spines, and the form of the lower and upper arm plates, the latter being unusually small, afford further

characters. There are two points in which my specimens do not agree with Koehler's description. Koehler states that in *O. aristata* the mouth shields are almost as wide (tangentially) as long (radially), and that the tentacle scales are flattened. In the *Helga* specimens the radial measurement of the mouth shields, although greater than usual, is not nearly as great as the tangential, the actual proportion being 9 : 11, and the tentacle scales are not flattened. These differences may, however, be regarded as being within the ordinary limits of variation of the species.

Ophiacantha aristata was known from the Bay of Biscay southwards as far as Morocco, and although it was not previously recorded from so far north, its occurrence off the south-west of Ireland was to be expected.

Ophiolebes claviger (Ljn.).

Ophiactis clavigera, Ljungmann, 1864.
Ophiomitra ? clavigera, Ljungmann, 1871.
Ophiolebes claviger, Lyman, 1882.

Helga.

S. R. 483—30 VIII '07. 51° 37′ N., 11° 56′ W., soundings 610–664 fms., muddy sand. Trawl.—Eight.

S. R. 504—12 IX '07. 50° 42′ N., 11° 18′ W., soundings 627–728 fms., coral. Trawl.—One.

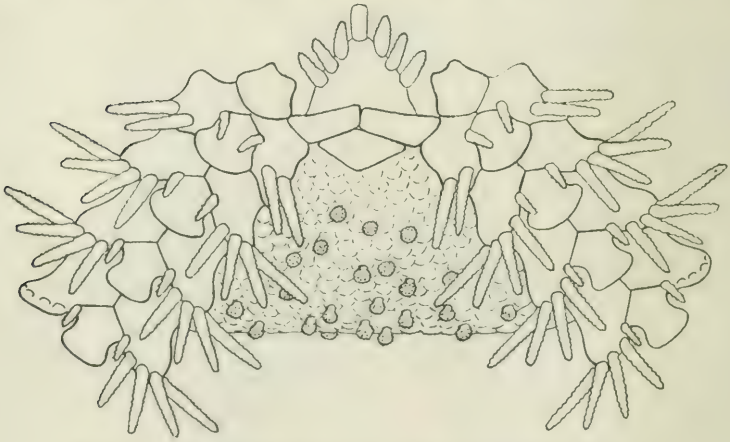

Fig. 16. *Ophiolebes claviger*, actinal view.

This species, which was originally described as an *Ophiactis*, was regarded by Lyman as an *Ophiolebes* though of a novel type. It has not the thick skin and ill-developed arm spines which are characteristics of that genus, and it seems questionable whether it is rightly included, and should not rather be placed with that group of species which includes *Ophiacantha normani*, Lyman; *Ophiacantha cataleimmoidea*, H. L. Clark;

Ophiacantha oedidisca, H. L. Clark; *Ophiomitra globulifera*, Koehler; *Ophiomitra relicta*, Koehler; and *Ophiomitrella cordifera*, Koehler.

The Irish specimens have been compared with a specimen from the North Sea belonging to the Museum of Comparative Zoology at Harvard, kindly lent to me by Dr. H. L. Clark.

The specimen from station S. R. 504 was found twined round the alcyonarian *Paramuricea atlantica*, and the same species, with several others, was present on station S. R. 483. The type specimens of *O. claviger* were also found attached to Gorgonians on the south-west coast of Norway at a depth of 200–300 fathoms (Ljungmann, 1864).

The disc spines are shown in Fig. 9, f, p. 38.

Ophiolebes sp.

Helga.

S. R. 223—12 v '05. 53° 7′ N., 14° 50′ W., soundings 410–500 fms., coral. Trawl.—One.

A single specimen of an *Ophiolebes*, which I have been unable to identify, was taken clinging to a piece of the Anthipatharian *Hornera*. It is probable that in this specimen, as Dr. H. L. Clark has suggested to me, the disc is in process of regeneration, as the first few upper arm plates are very irregularly shaped and the disc deeply notched between the arms, the inter-brachial spaces being reduced almost to nothing, and the radial shields forming prominent ridges along the arms under the thick disc skin. There are six very short arm spines, no tentacle scales, four mouth papillae on each side of the jaw and one terminal tooth papilla. The mouth shields are small, and, in outline, of the same shape as in *Ophiacantha abyssicola* but flat, not hollowed as in that species. The thick skin of the disc contains numerous embedded spinules giving it a roughened appearance. Diameter of disc 8 mm.

Ophiotoma coriacea, Lyman.

Ophiotoma coriacea, Lyman, 1883.

Helga.

S. R. 944—17 v '10. 51° 22′ N., 12° 41′ W., soundings 982 fms., ooze. Trawl.—Two.

The original specimen of *O. coriacea* was dredged by the *Blake* in the Caribbean Sea at a depth of 1,242 fathoms, and the species does not appear to have been recorded since then. The two specimens taken by the *Helga* agree closely with Lyman's description. The size is the same: in the two Irish specimens r = 8·5 mm. and 7·5 mm.; in Lyman's specimen r = 8·0 mm. In the larger specimen R = 85 mm. The disc, as in the type, was of a greenish-grey colour, the arms being paler. The mouth angle is armed with twelve papillae. There are four or five teeth but no tooth papilla. On the side mouth

shield there is a small spinule situated beside the outermost mouth papilla. Lyman found two such spines, one acting as a tentacle scale to the first tentacle pore. The mouth shield, side mouth shields and under and side arm plates are as shown in Lyman's figure. Dr. H. L. Clark, who has kindly compared one of the Irish specimens with Lyman's type of *O. coriacea*, which is in the Museum of Comparative Zoology at Harvard, considers that it is rightly referred to that species. He informs me, however, that the two specimens do not agree exactly, the most noticeable differences being in the teeth and the mouth papillae, which are much broader and more rounded in the type than in the Irish specimen.

It is probable that when the genus *Ophiacantha* comes to be revised some of the species now included in it will have to be transferred to *Ophiotoma*.

Ophiacantha Bartletti, described by Lyman in the same paper (1883) as that in which he records *O. coriacea*, is, apparently, separated from it by very slight characters, and it seems possible that Dr. Koehler's (1911) record of *O. Bartletti* from 1,900 fathoms in the North Atlantic may prove to belong to the latter species. *Ophiacantha megatreta*, H. L. Clark (1911), and *O. paucispina*, Lutken and Mortensen (1899), both from the Pacific, are also congeneric and closely allied species, and Dr. H. L. Clark has suggested to me that all four may even prove to belong to one species. It should be noted that Verrill (1899) has made *Ophiacantha Bartletti* the type of his new genus *Ophiopora*.

Family *OPHIOCOMIDAE*.

Ophiocoma nigra (Abildg.).

Ophiocoma nigra, Bell, 1892.

Helga.

S. R. 185—30 I '05. 50° 20′ N., 10° 20′ W., soundings 82½ fms., fine sand and shells. Trawl.—Many.

S. R. 187—31 I '05. 51° 14′ 30″ N., 9° 43′ W., soundings 57 fms., sand and mud. Trawl.—One.

S. R. 211—5 V '05. 50° 20′ N., 10° 20′ W., soundings 81 fms., coarse sand. Trawl.—Six.

Though common enough in shallow water, *O. nigra* seems to be very scarce in depths greater than 50 fathoms.

Family *OPHIOTHRICIDAE*.

Ophiothrix Lutkeni, Wyv. Thoms.

Ophiothrix Lutkeni, Bell, 1892.

Helga.

S. R. 185—30 I '05. 50° 20′ N., 10° 20′ W., soundings 82½ fms., coarse sand and shells. Trawl.—Many.

S. R. 211—5 V '05. 50° 20° N., 10° 20′ W., soundings 81 fms., coarse sand. Trawl.—Seventeen.

Helga.

S. R. 213—6 v '05. 51° 59′ N., 11° 25′ W., soundings 119 fms., fine sand. Dredge.—One.

S. R. 215—9 v '05. 52° 1′ N., 11° 21′ W., soundings 106 fms., fine sand. Trawl.—Ten.

S. R. 360—8 VIII '06. 52° 4′ N., 11° 27′ W., soundings 108–120 fms., fine sand. Trawl.—Several.

S. R. 379—1 XI '06. 50° 14′ N., 10° 53′ W., soundings 126–139 fms., fine sand and shells. Trawl.—Few.

S. R. 528—7 XI '07. 50° 21′ 30″ N., 10° 24′ W., soundings 85 fms., sand and shells. Dredge.—Two.

S. R. 807—17 VIII '09. 51° 37′ 30″ N., 11° 6′ W., soundings 105 fms., fine sand. Trawl.—One.

This species almost completely takes the place of *Ophiothrix fragilis* below 80 fathoms, and was found down to a depth of 126 fathoms.

STREPTOPHIURAE.

Ophioscolex purpurea, Dub. and Kor.

Ophioscolex purpurea, Bell, 1892.

Helga.

S. R. 223—12 v '05. 53° 7′ N., 14° 50′ W., soundings 410–500 fms., coral. Trawl.—One.

S. R. 805—14 VIII '09. 51° 15′ 30″ N., 12° 14′ W., soundings 539–544 fms., ooze. Trawl.—Three.

Grieg (1903) considers this species a true warm-water form, although it was taken by the *Porcupine* in the cold-water area of the Faeroe Channel, and the present records support this view. *O. purpurea* does not seem to have been taken previously so far south on the European side of the Atlantic, although it has been recorded from the Gulf of Mexico on the American side.

I have compared the Irish specimens with those in the British Museum taken by the *Porcupine* Expedition, and also with another *Porcupine* specimen kindly sent to me by Dr. H. L. Clark from the Museum of Comparative Zoology at Harvard.

In the specimen from S. R. 223 R=35 mm., r=5·5 mm.; and in the largest specimen from S. R. 805, the arms of which are broken, r=5 mm.

Ophiomyxa serpentaria, Lyman.

Ophiomyxa serpentaria, Lyman, 1883.
Ophiomyxa serpentaria, Bell, 1892.
Ophiodera serpentaria, Verrill, 1899.
Ophiodera serpentina, Koehler, 1909.

Helga.

CXX—24 VII '01. 53° 58′ N., 12° 24′ W., soundings 382 fms. Dredge.—One.

S. R. 331—9 v '06. 51° 12′ N., 11° 55′ W., soundings 610–680 fms., ooze. Trawl.—Three.

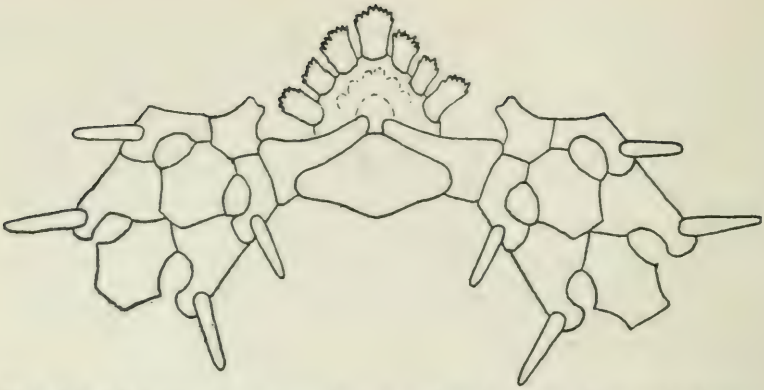

Fig. 17. *Ophiomyxa serpentaria*, actinal view, disc not shown.

The four specimens of *Ophiomyxa* taken by the *Helga* ought most probably to be referred to *O. serpentaria*, as, so far as Lyman's figure and description go, they are in agreement with it. The single *Porcupine* specimen from the Faeroe Channel described by Lyman is now represented by some fragments in the Museum of Comparative Zoology at Harvard, which, as Dr. H. L. Clark informs me, do not prove of any value in this case. The *Helga* specimens are all of small size, R = ca. 50 mm., r = ca. 5 mm., and in bad condition, those from S. R. 331 being stuck full of the spicules of *Pheronema*.

The upper arm plates are said by Lyman to be absent in this species, but on warming the thick skin of the upper surface of the arms in caustic potash the presence of rudimentary thin perforated plates could be made out.

Verrill (1899), followed by Koehler, has subdivided the genus *Ophiomyxa*, making *O. serpentaria* the type of a new genus *Ophiodera*.

The specimen from station CXX was found attached to the hexactinellid sponge *Aphrocallistes*, and those from S. R. 331 to *Pheronema*.

Ophiobyrsa hystricis, Lyman.

Ophiobyrsa hystricis, Bell, 1892.

Helga.

S. R. 188—3 II '05. 51° 53′ N., 11° 59′ W., soundings 320–372 fms., mud. Trawl.—Six.

S. R. 212—6 V '05. 51° 54′ N., 11° 57′ W., soundings 411 fms., fine muddy sand. Trawl.—One.

S. R. 321—1 V '06. 50° 58′ N., 11° 17′ W., soundings 208–480 fms., fine sand. Trawl.—Fragment.

S. R. 329—9 V '06. 51° 21′ N., 11° 34′ W., soundings 215–415 fms., fine sand. Trawl.—One.

S. R. 330—9 V '06. 51° 16′ H., 11° 37′ W., soundings 374–415 fms., fine sand. Trawl.—One.

Helga.

S. R. 440—16 v '07. 51° 45′ N., 11° 49′ W., soundings 350–389 fms. Trawl.—Three.

S. R. 477—28 viii '07. 51° 15′ N., 11° 47′ W., soundings 707–710 fms., ooze. Trawl.—One.

S. R. 505—12 ix '07. 50° 39′ N., 11° 14′ W., soundings 464–627 fms. Trawl.—One.

S. R. 745—14 v '09. 51° 38′ N., 11° 39′ W., soundings 250–278 fms., fine sand. Long lines.—One.

Though this species was taken several times it was hardly ever found in good condition. Usually the disc was missing or damaged, and often the arms also were broken.

Although several times recorded from British and Irish waters, from the Faeroe Channel to the south-west of Ireland, *O. hystricis* has rarely been met with elsewhere.

FAMILY *GORGONOCEPHALINAE.*

Gorgonocephalus Lincki (M. Tr.).

Gorgonocephalus Lincki, Bell, 1892.

Helga.

S. R. 483—30 viii '07. 51° 37′ N., 11° 56′ W., soundings 610–664 fms., muddy sand. Trawl.—Three.

Three specimens were trawled at station S. R. 483, the trawl bringing up at the same time many fragments of the hexactinellid sponge *Aphrocallistes*, pieces of Alcyonarians, one specimen of *Culcita borealis* and a very large number of *Araeosoma hystrix*. One *Gorgonocephalus* was clasping a large branch of *Calligorgia flabellum*; the other two were twined through the meshes of the trawl net, which had to be cut before they could be detached.

From the fact of three specimens having been taken in one haul of the trawl it appears that amongst suitable surroundings *G. Lincki* is not uncommon. The particular association of Alcyonarians and Sponges amongst which it was found seems, however, to occupy a very small area off the south-west coast of Ireland.

ECHINOIDEA

FAMILY *CIDARIDAE.*

Dorocidaris papillata (Leske).

Cidaris papillata, Bell, 1892.

Dorocidaris papillata, Mortensen, 1903.

Helga.

S. R. 185—30 i '05. 50° 20′ N., 10° 20′ W., soundings 82½ fms., fine sand and shells. Trawl.—Ca. twenty.

S. R. 188—3 ii '05. 51° 53′ N., 11° 59′ W., soundings 320–372 fms., mud. Trawl.—Three.

S. R. 194—10 ii '05. 54° 49′ N., 10° 30′ W., soundings 366 fms., rock. Dredge.—Three small.

S. R. 196—11 ii '05. 54° 42′ N., 10′ 34′ W., soundings 242 fms., stones. Dredge.—Many small.

Helga.

S. R. 213—6 v '05. 51° 59′ N., 11° 25′ W., soundings 119 fms., fine sand. Dredge.—One.

S. R. 220—11 v '05. 53° 39′ N., 12° 24′ W., soundings 185 fms., fine sand and shells. Trawl.—Two.

S. R. 222—12 v '05. 53° 1′ N., 14° 34′ W., soundings 293 fms., fine sand. Trawl.—Four.

S. R. 227—13 v '05. 53° 20′ N., 13° 00′ W., soundings 164 fms., fine sand. Trawl.—One.

S. R. 321—1 v '06. 50° 58′ N., 11° 17′ W., soundings 208–480 fms., fine sand. Trawl.—Nine.

S. R. 327—8 v '06. 51° 40′ 30″ N., 12° 16′ 30″ W., soundings 550–800 fms., ooze. Trawl.—One.

S. R. 329—9 v '06. 51° 21′ 30″ N., 11° 34′ W., soundings 215–415 fms. Trawl.—Forty-two.

S. R. 333—10 v '06. 51° 37′ N., 12° 9′ W., soundings 557–579 fms., ooze. Trawl.—One.

S. R. 338—13 v '06. 51° 28′ 30″ N., 11° 39′ W., soundings 291–330 fms., mud. Trawl.—Five.

S. R. 351—5 viii '06. 50° 19′ 30″ N., 11° 6′ W., soundings 230–250 fms., fine sand. Trawl.—Fourteen.

S. R. 353—6 viii '06. 50° 38′ 30″ N., 11° 32′ W., soundings 250–542 fms., muddy sand. Trawl.—Eleven.

S. R. 360—8 viii '06. 52° 4′ N., 11° 27′ W., soundings 108–120 fms., fine sand. Trawl.—Four.

S. R. 361—8 viii '06. 51° 49′ 30″ N., 11° 42′ W., soundings 177–213 fms., fine sand. Trawl.—Five.

S. R. 362—9 viii '06. 51° 34′ 30″ N., 11° 27′ W., soundings 145–160 fms., fine sand. Trawl.—Very many.

S. R. 367—11 viii '06. 51° 38′ N., 11° 37′ W., soundings 287–332 fms., muddy sand. Trawl.—Eight.

S. R. 368—11 viii '06. 51° 38′ N., 12° W., soundings 450–608 fms., fine sand. Trawl.—Four.

S. R. 379—1 xi '06. 50° 14′ N., 10° 53′ W., soundings 126–139 fms., fine sand and shells. Trawl.—Several.

S. R. 380—1 xi '06. 50° 30′ N., 11° 0′ W., soundings 142–214 fms., fine sand. Trawl.—Ca. forty.

S. R. 384—6 xi '06. 51° 54′ 30″ N., 11° 37′ W., soundings 162–218 fms., fine sand. Trawl.—Ca. thirty.

S. R. 397—2 ii '07. 51° 46′ N., 12° 5′ W., soundings 549–646 fms., ooze. Trawl.—Three.

S. R. 400—5 ii '07. 51° 18′ N., 11° 50′ W., soundings 525–600 fms., ooze. Trawl.—One hundred and twenty.

S. R. 401—5 ii '07. 51° 14′ N., 11° 51′ W., soundings 600–660 fms. Trawl.—One.

S. R. 440—16 v '07. 51° 45′ N., 11° 49′ W., soundings 350–389 fms. Trawl.—Five.

S. R. 447—18 v '07. 50° 20′ N., 10° 57′ W., soundings 221–243 fms., fine sand. Trawl.—Several.

S. R. 448—18 v '07. 50° 21′ N., 11° 0′ W., soundings 343–346 fms. Trawl.—Many.

Helga.

S. R. 477—28 VIII '07. 51° 15′ N., 11° 47′ W., soundings 707–710 fms., ooze. Trawl.—Two.

S. R. 480—28 VIII '07. 51° 23′ N., 11° 38′ W., soundings 468 fms., stones. Dredge.—Three.

S. R. 484—30 VIII '07. 51° 35′ N., 11° 57′ W., soundings 602–610 fms. Trawl.—One.

S. R. 487—3 IX '07. 51° 36′ N., 11° 57′ W., soundings 540–660 fms., ooze and stones. Trawl.—Four.

S. R. 490—7 IX '07. 51° 57′ 30″ N., 12° 7′ W., soundings 470–491 fms., ooze. Trawl.—Two.

S. R. 493—8 IX '07. 51° 58′ N., 12° 25′ W., soundings 533–570 fms. Trawl.—One.

S. R. 494—8 IX '07. 51° 59′ N., 12° 32′ W., soundings 550–570 fms. Trawl.—Two.

S. R. 501—11 IX '07. 50° 49′ N., 11° 22′ W., soundings 447–625 fms. Trawl.—Two.

S. R. 502—11 IX '07. 50° 46′ N., 11° 21′ W., soundings 447–515 fms. Trawl.—Ca. forty.

S. R. 504—12 IX '07. 50° 42′ N., 11° 18′ W., soundings 627–728 fms., coral. Trawl.—Six large, few small.

S. R. 505—12 IX '07. 50° 39′ N., 11° 14′ W., soundings 464–627 fms. Trawl.—Forty-five.

S. R. 592—6 VIII '08. 50° 39′ N., 11° 25′ W., soundings 400–510 fms., ooze. Trawl.—Four.

S. R. 744—13 V '09. 50° 38′ N., 11° 18′ W., soundings 390–538 fms., ooze. Long lines.—Two.

S. R. 753—17 V '09. 51° 24′ N., 11° 59′ 30″ W., soundings 561–572 fms., ooze. Trawl.—Nineteen.

S. R. 805—14 VIII '09. 51° 50′ 30″ N., 12° 14′ W., soundings 539–544 fms., ooze. Trawl.—Few.

S. R. 807—17 VIII '09. 51° 37′ 30″ N., 11° 6′ W., soundings 105 fms., fine sand. Trawl.—One.

S. R. 1005—12 VIII '10. 51° 22′ N., 11° 30′ 30″ W., soundings 249 fms., fine sand. Dredge.—Thirty.

Cidaris papillata was taken forty-six times during the period dealt with on all sorts of ground between 82½ and 707 fathoms. The former depth seems to be the lowest on record for the west coast of Ireland, though the species is recorded in 56–147 fathoms to the north and north-east of Shetland (Sussbach and Brechner, 1911).

Porocidaris purpurata, Wyv. Thoms.

Porocidaris purpurata, Wyv. Thoms., 1874.
Cidaris gracilis, Sladen, 1891.
Cidaris purpurata, Bell, 1892.
Porocidaris purpurata, Mortensen, 1903.

Helga.

S. R. 331—9 V '06. 51° 12′ N., 11° 55′ W., soundings 610–680 fms., ooze. Trawl.—Eight.

Helga.

S. R. 477—28 VIII '07. 51° 15′ N., 11° 47′ W., soundings 707–710 fms., ooze. Trawl.—One.

S. R. 499—11 IX '07. 50° 55′ N., 11° 29′ W., soundings 666–778 fms. Trawl.—One.

S. R. 506—12 IX '07. 50° 34′ N., 11° 19′ W., soundings 661–672 fms. Trawl.—Four.

S. R. 593—6 VIII '08. 50° 31′ N., 11° 31′ W., soundings 670–770 fms., ooze. Trawl.—Five.

There seems to be no doubt that the species described by Sladen (1891) as *C. gracilis* from off the south-west coast of Ireland is the same as *C. purpurata*, which was taken several times by the *Helga*, always in water of over 650 fathoms in depth. Most of the specimens were of small size, but one, from station S. R. 499, measured 5 cm. in diameter.

Family *ECHINOTHURIIDAE.*

Phormosoma placenta, Wyv. Thoms.

Phormosoma placenta, Bell, 1892.

Helga.

S. R. 188—3 II '05. 51° 53′ N., 11° 59′ W., soundings 320–372 fms., mud. Trawl.—Ca. 50.

S. R. 212—6 V '05. 51° 54′ N., 11° 57′ W., soundings 411 fms., fine muddy sand. Trawl.—Fifteen.

S. R. 327—8 V '06. 51° 46′ N., 12° 14′ 30″ W., soundings 550 fms., ooze. Trawl.—One hundred.

S. R. 331—9 V '06. 51° 12′ N., 11° 55′ W., soundings 610–680 fms., ooze. Trawl.—Twenty-two.

S. R. 333—10 V '06. 51° 37′ N., 12° 9′ W., soundings 557–579 fms., ooze. Trawl.—Five.

S. R. 334—10 V '06. 51° 35′ 20″ N., 12° 26′ W., soundings 500–520 fms. Trawl.—One.

S. R. 353—6 VIII '06. 50° 38′ 30″ N., 11° 52′ W., soundings 250–542 fms. Trawl.—Seventy.

S. R. 359—8 VIII '06. 52° 0′ N., 12° 6′ W., soundings 465–492 fms., ooze. Trawl.—Twenty-five.

S. R. 363—10 VIII '06. 51° 22′ N., 12° 0′ W., soundings 695–720 fms., ooze. Trawl.—Seven.

S. R. 364—10 VIII '06. 51° 23′ 30″ N., 11° 47′ W., soundings 620–695 fms., ooze. Trawl.—One.

S. R. 387—7 XI '06. 51° 47′ N., 12° 12′ W., soundings 530–535 fms., ooze. Trawl.—Eighteen.

S. R. 397—2 II '07. 51° 46′ N., 12° 5′ W., soundings 549–646 fms., ooze. Trawl.—Two hundred.

S. R. 400—5 II '07. 51° 18′ N., 11° 50′ W., soundings 525–600 fms., ooze. Trawl.—Six.

S. R. 440—16 V '07. 51° 45′ N., 11° 49′ W., soundings 350–389 fms. Trawl.—Three.

Helga.

S. R. 477—28 VIII '07. 51° 15′ N., 11° 47′ W., soundings 707–710 fms., ooze. Trawl.—Three.

S. R. 487—3 IX '07. 51° 36′ N., 11° 57′ W., soundings 540–660 fms., ooze and stones. Trawl.—Five.

S. R. 489—4 IX '07. 51° 35′ N., 11° 55′ W., soundings 720 fms. Trawl.—Thirty-one.

S. R. 490—7 IX '07. 51° 57′ 30″ N., 12° 7′ W., soundings 470–491 fms., ooze. Trawl.—Thirty.

S. R. 491—7 IX '07. 51° 57′ 30″ N., 12° 13′ W., soundings 491–520 fms. Trawl.—Many.

S. R. 493—8 IX '07. 51° 58′ N., 12° 25′ W., soundings 533–570 fms. Trawl.—Ca. one hundred.

S. R. 494—8 IX '07. 51° 59′ N., 12° 32′ W., soundings 550–570 fms. Trawl.—Ca. Two hundred.

S. R. 496—8 IX '07. 51° 54′ N., 12° 54′ W., soundings 473–500 fms. Trawl.—Eighteen.

S. R. 497—10 IX '07. 51° 2′ N., 11° 36′ W., soundings 775–795 fms., ooze. Trawl.—Six.

S. R. 499—11 IX '07. 50° 55′ N., 11° 29′ W., soundings 666–778 fms. Trawl.—Ca. sixty.

S. R. 500—11 IX '07. 50° 52′ N., 11° 26′ W., soundings 625–666 fms. Trawl.—One.

S. R. 501—11 IX '07. 50° 49′ N., 11° 22′ W., soundings 447–625 fms. Trawl. Thirty.

S. R. 502—11 IX '07. 50° 46′ N., 11° 21′ W., soundings 447–515 fms. Trawl.—Ca. one hundred.

S. R. 504—12 IX '07. 50° 42′ N., 11° 18′ W., soundings 627–728 fms., coral. Trawl.—Thirty.

S. R. 506—12 IX '07. 50° 34′ N., 11° 19′ W., soundings 661–672 fms. Trawl.—Twenty-four.

S. R. 590—3 VIII '08. 51° 50′ N., 12° 9′ W., soundings 480–493 fms., ooze. Trawl.—Twenty-four.

S. R. 592—6 VIII '08. 50° 39′ N., 11° 25′ W., soundings 400–510 fms., ooze. Trawl.—Several.

S. R. 593—6 VIII '08. 50° 31′ N., 11° 31′ W., soundings 670–770 fms., ooze. Trawl.—Several.

S. R. 746—14 V '09. 51° 32′ N., 12° 13′ W., soundings 620–658 fms., ooze. Trawl.—Four.

S. R. 752—16 V '09. 51° 48′ N., 12° 11′ 30″ W., soundings 523–595 fms., ooze. Mesoplankton trawl on bottom. —Twenty-two.

S. R. 753—17 V '09. 51° 24′ N., 11° 59′ 30″ W., soundings 561–572 fms., ooze. Trawl.—Three.

S. R. 805—14 VIII '09. 51° 50′ 30″ N., 12° 14′ W., soundings 539–544 fms., ooze. Trawl.—Many.

S. R. 944—17 V '10. 51° 22′ N., 12° 41′ W., soundings 982 fms., ooze. Trawl.—Seventy-six.

Taken on thirty-seven occasions at depths between 411 and 982 fathoms. The number of specimens present varied from

1 to 200. Young individuals of two or three centimetres in diameter were several times taken, but most of those found were full-grown, measuring from eight to ten centimetres across.

Sperosoma Grimaldii, Koehler.

Sperosoma Grimaldii, Koehler, 1898.
Sperosoma Grimaldii, Mortensen, 1903, 1907.

Helga.

S. R. 477—28 VIII '07. 51° 15′ N., 11° 47′ W., soundings 707–710 fms., ooze. Trawl.—One.

This specimen is undoubtedly referable to Koehler's species, the large size of the accessory ambulacral plates and the form of the pedicellariae, which have broad flat valves, being unmistakable. It is not improbable that this species was taken on two other occasions also, as there are records in the fishing log-books of the capture of a purple and a mauve *Asthenosoma* on stations S. R. 497, 775–795 fms., and S. R. 593, 670–770 fms., but the actual specimens have, unfortunately, not been preserved.

This is the first record of *S. Grimaldii* from the British and Irish area, although it is known to extend from the Faeroes to the Cape Verde Islands.

Araeosoma hystrix, Wyv. Thoms.

Calveria hystrix, Wyv. Thomson, 1872.
Asthenosoma hystrix, Agassiz, 1872.
Asthenosoma hystrix, Bell, 1892.
Calveria hystrix, Mortensen, 1903.
Asthenosoma hystrix, Kemp, 1905.
Araeosoma hystrix, Mortensen, 1907.
Araeosoma hystrix, Agassiz and Clark, 1909.
Calveria hystrix, Mortensen, 1910.

Helga.

S. R. 331—9 V '06. 51° 12′ N., 11° 55′ W., soundings 610–680 fms., ooze. Trawl.—One.

S. R. 359—8 VIII '06. 52° 0′ N., 12° 6′ W., soundings 465–492 fms., ooze. Trawl.—One.

S. R. 364—10 VIII '06. 51° 23′ 30″ N., 11° 47′ W., soundings 620–695 fms., ooze. Trawl.—Four.

S. R. 368—11 VIII '06. 51° 38′ 30″ N., 12° 0′ W., soundings 450–608 fms., fine sand. Trawl.—Sixteen.

S. R. 387—7 XI '06. 51° 47′ N., 12° 12′ W., soundings 530-535 fms., ooze. Trawl.—Two.

S. R. 397—2 II '07. 51° 46′ N., 12° 5′ W., soundings 549–646 fms., ooze. Trawl.—Ninety-three.

S. R. 400—5 II '07. 51° 18′ N., 11° 50′ W., soundings 525–600 fms., ooze. Trawl.—Eighty-three.

S. R. 401—5 II '07. 51° 14′ N., 11° 51′ W., soundings 600–660 fms. Trawl.—One.

Helga.

S. R. 479—28 VIII '07. 51° 20′ N., 11° 41′ W., soundings 468–560 fms. Trawl.—One.

S. R. 483—30 VIII '07. 51° 37′ N., 11° 56′ W., soundings 610–664 fms., muddy sand. Trawl.—One hundred and sixty-seven.

S. R. 486—3 IX '07. 51° 37′ 30″ N., 12° 0′ W., soundings 600–660 fms., stones. Trawl.—Eight.

S. R. 487—3 IX '07. 51° 36′ N., 11° 57′ W., soundings 540–660 fms. Trawl.—Thirty-seven.

S. R. 489—4 IX '07. 51° 35′ N., 11° 55′ W., soundings 720 fms. Trawl.—Nineteen.

S. R. 500—11 IX '07. 50° 52′ N., 11° 26′ W., soundings 625–666 fms. Trawl.—Three.

S. R. 592—6 VIII '08. 50° 39′ N., 11° 25′ W., soundings 400–510 fms., ooze. Trawl.—Eleven.

S. R. 752—16 V '09. 51° 51′ N., 12° 13′ W., soundings 523–595 fms., ooze. Trawl.—Two.

S. R. 753—17 V '09. 51° 24′ N., 11° 59′ 30″ W., soundings 561–572 fms., ooze. Trawl.—Forty-one.

S. R. 754—17 V '09. 51° 26′ N., 11° 57′ 30″ W., soundings 544–572 fms., ooze. Trawl.—Few.

S. R. 1004—12 VIII '10. 51° 22′ 30″ N., 11° 44′ 30″ W., soundings 636–641 fms., fine sand. Trawl.—Two.

The specimens from the nineteen stations recorded above were not always preserved, but the colour was noted on every occasion as red or scarlet. The species seems, off the Irish coast, to be a characteristic inhabitant of the ooze between 500 and 700 fathoms.

Araeosoma fenestratum (Wyv. Thoms.).

Asthenosoma fenestratum, Agassiz, 1872.
Calveria fenestrata, Wyv. Thoms., 1874.
Araeosoma fenestratum, } Mortensen, 1903, 1910.
Araeosoma violaceum, }
Asthenosoma hystrix (pars), Kemp, 1905.

Helga.

S. R. 222—12 V '05. 51° 3′ N., 14° 34′ W., soundings 293 fms., fine sand. Trawl.—Three hundred and eighty.

Although they do not agree exactly with the original description of *A. fenestratum*, the following considerations have led me to record these specimens under that name:—

In 1903 Dr. Mortensen described as *A. violaceum* an Echinothurid, allied to *A. fenestratum*, from specimens taken by the *Helga* on the Porcupine Bank in 199 fathoms. (To prevent mistakes it may be mentioned that these specimens are recorded by Kemp (1905) as *Asthenosoma hystrix*.) The principal characters were the colour—a deep dark violet—and the presence of a form of pedicellaria in which the blade is not involved below (also

found occasionally in *A. fenestratum*). In the original records of the capture of these specimens in 1901 they are recorded as being of a chocolate colour, and some of the specimens in spirit might at the present date (1912) be described as of a very dark chocolate with a violet tinge.

In 1905 the *Helga*, fishing near the same locality, on the south-west slope of the Porcupine Bank in 293 fathoms, made a large haul of *Aracosoma* of a light mauve colour. These specimens showed the fenestrated structure of the test, and also possessed the non-involute type of pedicellaria, and except for their colour could not be separated from *A. violaceum*. Dr. Mortensen, to whom I sent specimens, agrees with me in thinking that *A. violaceum*, depending solely on its colour, cannot longer be maintained, and that both it and the present form should be referred to *A. fenestratum*. If this is so it would seem that *A. fenestratum*, unlike *A. hystrix*, shows considerable variation in its colour, being found in light brown, deep chocolate brown with a violet tinge and pale mauve. It remains to be seen whether these colours represent three distinct types, or whether intermediate forms are to be found. A few of the remarkable quadridentate pedicellaria, first described by Wyville Thomson as occurring on *A. fenestratum* were found at the bottom of a jar which contained some of the *Helga* specimens, but prolonged search failed to reveal them in situ.

It will be seen that there is a gap of 200 fathoms between the bathymetric range of this species and that of *A. hystrix* on the west coast of Ireland, the least depth at which the latter was certainly found being 492 fathoms.

Family *ECHINIDAE*

Echinus acutus, Lamk.

Echinus acutus, Bell, 1892.

Helga.

S. R. 185—30 I '05. 50° 20′ N., 10° 20′ W., soundings 82½ fms., fine sand and shells. Trawl.—Few.

S. R. 188—3 II '05. 51° 53′ N., 11° 59′ W., soundings 320–372 fms., mud. Trawl.—Three.

S. R. 196—11 II '05. 54° 42′ N., 10° 34′ W., soundings 242 fms., stones. Dredge.—One.

S. R. 211—5 V '05. 50° 20′ N., 10° 20′ W., soundings 81 fms., coarse sand. Trawl.—Sixty.

S. R. 212—6 V '05. 51° 54′ N., 11° 57′ W., soundings 375–411 fms., fine muddy sand. Trawl.—Fifteen.

S. R. 215—9 V '05. 52° 01′ N., 11° 21′ W., soundings 106 fms., fine sand. Trawl.—One.

S. R. 216—9 V '05. 52° 21′ N., 11° 54′ W., soundings, 143–164 fms., fine sand. Trawl.—Very many.

S. R. 217—9 V '05. 52° 44′ N., 12° 30′ W., soundings 208 fms., fine sand. Trawl.—Several hundred.

Helga.

S. R. 220—11 v '05. 53° 39′ N., 12° 24′ W., soundings 185 fms., fine sand and shells. Dredge.—Few. Trawl.—Several hundred.

S. R. 222—12 v '05. 53° 1′ N., 14° 34′ W., soundings 293 fms., fine sand. Trawl.—One.

S. R. 225—13 v '05. 53° 2′ N., 13° 48′ W., soundings 105–109 fms., fine sand and shells. Trawl.—Fifteen.

S. R. 227—13 v '05. 53° 20′ N., 13° 0′ W., soundings 164 fms., fine sand. Trawl.—Many.

S. R. 321—1 v '06. 50° 58′ N., 11° 17′ W., soundings 208–480 fms., fine sand. Trawl.—Twelve.

S. R. 329—9 v '06. 51° 21′ 30″ N., 11° 34′ W., soundings 215–415 fms. Trawl.—Three.

S. R. 330—9 v '06. 51° 16′ N., 11° 37′ W., soundings 374–415 fms., fine sand. Trawl.—Twenty-four.

S. R. 331—9 v '06. 51° 12′ N., 11° 55′ W., soundings 610–680 fms., ooze. Trawl.—Two.

S. R. 338—13 v '06. 51° 28′ 30″ N., 11° 39′ W., soundings 291–330 fms., mud. Trawl.—Many.

S. R. 353—6 viii '06. 50° 38′ 30″ N., 11° 32′ W., soundings 250–532 fms., muddy sand. Trawl.—Very many.

S. R. 359—8 viii '06. 51° 59′ N., 12° 9′ W., soundings 492 fms., ooze. Trawl.—Several.

S. R. 361—8 viii '06. 51° 49′ 30″ N., 11° 42′ W., soundings 177–213 fms., fine sand. Trawl.—Twenty.

S. R. 362—9 viii '06. 51° 34′ 30″ N., 11° 27′ W., soundings 145–160 fms., fine sand. Trawl.—Net full.

S. R. 365—10 viii '06. 51° 25′ N., 11° 32′ W., soundings 385–440 fms., sand and stones. Trawl.—Many.

S. R. 367—11 viii '06. 51° 38′ N., 11° 37′ W., soundings 287–332 fms., muddy sand. Trawl.—Few.

S. R. 368—11 viii '06. 51° 38′ 30″ N., 12° 0′ W., soundings 450–608 fms., fine sand. Trawl.—Several.

S. R. 384—6 xi '06. 51° 54′ 30″ N., 11° 37′ W., soundings 162–218 fms., fine sand. Trawl.—Several.

S. R. 397—2 ii '07. 51° 46′ N., 12° 5′ W., soundings 549–646 fms., ooze. Trawl.—One hundred and sixty.

S. R. 399—5 ii '07. 51° 28′ N., 11° 33′ 30″ W., soundings 342 fms., mud and stones. Dredge.—Three.

S. R. 400—5 ii '07. 51° 18′ N., 11° 50′ W., soundings 525–600 fms., ooze. Trawl.—Twenty-five.

S. R. 447—18 v '07. 50° 20′ N., 10° 57′ W., soundings 221–343 fms., fine sand. Trawl.—Many.

S. R. 448—18 v '07. 50° 21′ N., 11° 0′ W., soundings 343–346 fms. Trawl.—Several.

S. R. 477—28 viii '07. 51° 15′ N., 11° 47′ W., soundings 707–710 fms., ooze. Trawl.—Six.

S. R. 479—28 viii '07. 51° 20′ N., 11° 41′ W., soundings 468–560 fms. Trawl.—Nine.

Helga.

S. R. 480—28 VIII '07. 51° 23′ N., 11° 38′ W., soundings 468 fms., stones. Dredge.—Sixteen.

S. R. 483—30 VIII '07. 51° 37′ N., 11° 56′ W., soundings 610–664 fms., muddy sand. Trawl.—Nineteen.

S. R. 487—3 IX '07. 51° 36′ N., 11° 57′ W., soundings 540–660 fms., ooze and stones. Trawl.—Eight.

S. R. 490—7 IX '07. 51° 57′ 30″ N., 12° 7′ W., soundings 470–491 fms., ooze. Trawl.—Fifty.

S. R. 491—7 IX '07. 51° 57′ 30″ N., 12° 13′ W., soundings 491–520 fms. Trawl.—Few.

S. R. 493—8 IX '07. 51° 58′ N., 12° 25′ W., soundings 533–570 fms. Trawl.—Five.

S. R. 494—8 IX '07. 51° 59′ N., 12° 32′ W., soundings 550–570 fms. Trawl.—Two.

S. R. 496—8 IX '07. 51° 54′ N., 12° 54′ W., soundings 473–500 fms. Trawl.—Two.

S. R. 501—11 IX '07. 50° 49′ N., 11° 22′ W., soundings 447–625 fms. Trawl.—Thirty.

S. R. 502—11 IX '07. 50° 46′ N., 11° 21′ W., soundings 447–515 fms. Trawl.—About one thousand.

S. R. 505—12 IX '07. 50° 39′ N., 11° 14′ W., soundings 464–627 fms. Trawl.—Nineteen.

S. R. 506—12 IX '07. 50° 34′ N., 11° 19′ W., soundings 661–672 fms. Trawl.—Thirty.

S. R. 528—7 XI '07. 50° 21′ 30° N., 10° 24′ W., soundings 85 fms., sand and shells. Dredge.—Five.

S. R. 590—3 VIII '08. 51° 50′ N., 12° 9′ W., soundings 480–493 fms., ooze. Trawl.—Ten.

S. R. 592—6 VIII '08. 50° 39′ N., 11° 25′ W., soundings 400–510 fms., ooze. Trawl.—Several.

S. R. 753—17 V '09. 51° 24′ N., 11° 59′ 30″ W., soundings 561–572 fms., ooze. Trawl.—Nine.

S. R. 754—17 V '09. 51° 26′ N., 11° 57′ 30″ W., soundings 544–572 fms., ooze. Trawl.—Six.

S. R. 807—17 VIII '09. 51° 37′ 30″ N., 11° 6′ W., soundings 105 fms., fine sand. Trawl.—Nineteen.

S. R. 944—17 V '10. 51° 22′ N., 12° 41′ W., soundings 982 fms., ooze. Trawl.—Twelve.

S. R. 1004—12 VIII '10. 51° 22′ 30″ N., 11° 44′ 30″ W., soundings 636–641 fms., fine sand. Trawl.—Two.

Almost all the specimens from the fifty-two stations given above belonged to the var. *norvegicus*. but in a few instances the var. *microstoma* was present, and occasionally a larger, uniformly coloured, golden-brown, long spined form, measuring from six to seven centimetres in diameter, was found.

A very large specimen (diam. 12·3 cm., height 9·0 cm.), taken on station S. R. 222, seems to approach the species known as *E. melo*. The test was much more globular than is usual in large *E. acutus*, and of a greenish colour, paler along the

median ambulacral and inter-radial sutures, the markings forming zig-zag lines of darker and lighter shades of green parallel to the sutures. The spines were moderately long, and of a green colour, paler towards the base. Primary spines were absent from every second plate on the upper two-thirds of the inter-ambulacral area. The specimens from S. R. 225, on the Porcupine Bank, were typical *E. acutus* of large size (10 to 11 cm. in diam.), but showing great variation in the height of the test.

Echinus elegans, Düb. and Kor.

Echinus elegans, Bell, 1892.

Helga.

S. R. 504—12 IX '07. 50° 42′ N., 11° 18′ W., soundings 627–728 fms., coral. Trawl.—Ten.

The specimens varied in the colour of their spines from rose pink to yellowish buff, the tips of the primary spines being white in all cases. The ground colour of the test was pure white in the pink specimens, and white with a yellowish tinge in the buff. The colour, after five years preservation in spirit, appears to be unaltered. In shape they are more globular than is usual, but Dr. Mortensen, who has examined one of them, informs me that, apart from this, he considers it to be a typical *E. elegans*.

The measurements in mm. of the two largest specimens are :—

Diam. of Test.	Height of Test.	Diam. of Peristome.	Diam of Periproct.	Longest Spine.
72	52	23	7	26
65	41	21	5·5	25

In Kemp's paper on the Echinoderms of the deep water off the west coast of Ireland (1905, p. 199) this species was referred to, by a clerical error, as *Echinus gracilis*. Mortensen (1907) has already called attention to the mistake.

Echinus esculentus, Linn.

Echinus esculentus, Bell, 1892.

Helga.

S. R. 591—4 VIII '08. 51° 46′ N., 10° 44′ 30″ W., soundings 73–78 fms., sand. Trawl.—Two.

The occurrence of the common urchin below fifty fathoms seems to be exceptional.

Family *FIBULARIIDAE.*

Echinocyamus pusillus (O. F. M.).

Echinocyamus pusillus, Bell, 1892.

Helga.

S. R. 226—13 V '05. 53° 12′ N., 13° 57′ W., soundings 93 fms., coarse sand and gravel. Net on dredge.—One alive, thirteen dead.

The above record, from the Porcupine Bank, is the only one from below fifty fathoms; but the species, owing to its small size, may have avoided capture on other occasions.

Family *SPATANGIDAE.*

Hemiaster expergitus, Lov.

Hemiaster expergitus, Loven, 1875.
Hemiaster expergitus, Mortensen, 1907.

Helga.

S. R. 499—11 IX '07. 50° 55′ N., 11° 29′ W., soundings 666–778 fms. Trawl.—One.

S. R. 506—12 IX '07. 50° 34′ N., 11° 19′ W., soundings 661–672 fms. Trawl.—Four.

S. R. 752—16 V '09. 51° 48′ N., 12° 11′ 30″ W., soundings 523–595 fms., ooze. Mesoplankton trawl on bottom. —About fifty.

S. R. 944—17 V '10. 51° 22′ N., 12° 41′ W., soundings 984 fms., ooze. Trawl.—Three.

This species is now added to the British and Irish fauna, and appears to be by no means uncommon. It is not surprising that it has been overlooked, as its small size and extreme fragility and its habit of living buried in soft ooze at considerable depths all tend to prevent its capture. The large number of specimens from station S. R. 752 were obtained from the mesoplankton trawl fished just touching the surface of the ooze. The specimens were of all sizes from 24 mm. in length to about 3 mm., and were found in company with numbers of *Bryssopsis lyrifer* of similar sizes.

Spatangus purpureus, O. F. M.

Spatangus purpureus, Bell, 1892.

Helga.

S. R. 185—30 I '05. 50° 20′ N., 10° 20′ W., soundings 82½ fms. Dredge.—Five. Trawl.—Several.

S. R. 226—13 V '05. 53° 12′ N., 13° 57′ W., soundings 93 fms. Dredge.—Eight.

The specimens on station S. R. 185 were taken along with a large number of *S. Raschi*, but on S. R. 226, on the Porcupine Bank, *S. Raschi* was not present. The depths of 80 and 90 fathoms may be taken as the limits within which the two species may be expected to occur in company on the west coast of Ireland.

S. purpureus seems never to be found in such great abundance as is *S. Raschi.*

Spatangus Raschi, Loven.

Spatangus Raschi, Bell, 1892.

Helga.

S. R. 185—30 I '05. 50° 20′ N., 10° 20′ W., soundings 82½ fms., fine sand and shells. Trawl.—Many, very large.

S. R. 188—3 II '05. 51° 53′ N., 11° 59′ W., soundings 320–372 fms., mud. Trawl.—Very many.

S. R. 196—11 II '05. 54° 42′ N., 10° 34′ W., soundings 242 fms., stones. Dredge.—Fragments.

S. R. 212—6 V '05. 51° 54′ N., 11° 57′ W., soundings 375–411 fms., fine muddy sand. Trawl.—One hundred and seventy-eight.

S. R. 213—6 V '05. 51° 59′ N., 11° 25′ W., soundings 119 fms., fine sand. Dredge.—Forty.

S. R. 215—9 V '05. 52° 01′ N., 11° 21′ W., soundings 106 fms., fine sand. Trawl.—Very abundant.

S. R. 216—9 V '05. 52° 21′ N., 11° 54′ W., soundings 143–164 fms., fine sand. Trawl.—Several hundred.

S. R. 217—9 V '05. 52° 44′ N., 12° 30′ W., soundings 208 fms., fine sand. Trawl.—Hundreds.

S. R. 220—11 V '05. 53° 39′ N., 12° 24′ W., soundings 185 fms., fine sand and shells. Trawl.—Many.

S. R. 225—13 V '05. 53° 2′ N., 13° 48′ W., soundings 105½ fms., fine sand and shells. Dredge.—Seventeen. Trawl.—One hundred and eighty-nine.

S. R. 227—13 V '05. 53° 20′ N., 13° 00′ W., soundings 164 fms., fine sand. Dredge.—Twenty. Trawl.—Three hundred and fifty.

S. R. 321—1 V '06. 50° 58′ N., 11° 17′ W., soundings 208–480 fms., fine sand. Trawl.—Ca. two hundred.

S. R. 329—9 V '06. 51° 21′ 30″ N., 11° 34′ W., soundings 215–415 fms. Trawl.—Twenty-eight.

S. R. 330—9 V '06. 51° 16′ N., 11° 37′ W., soundings 374–415 fms., fine sand. Trawl.—Forty-two.

S. R. 338—13 V '06. 51° 28′ 30″ N., 11° 39′ W., soundings 291–330 fms., mud. Trawl.—Ca. fifty.

S. R. 351—5 VIII '06. 50° 19′ 30″ N., 11° 6′ W., soundings 230–250 fms., fine sand. Trawl.—One hundred and fifty-four.

S. R. 353—6 VIII '06. 50° 38′ 30″ N., 11° 32′ W., soundings 250–542 fms., muddy sand. Trawl.—One hundred.

S. R. 359—8 VIII '06. 52° 0′ N., 12° 6′ W., soundings 465–492 fms., ooze. Trawl.—One hundred and ten, large.

S. R. 360—8 VIII '06. 52° 4′ N., 11° 27′ W., soundings 108–120 fms., fine sand. Trawl.—One hundred and thirty.

S. R. 361—8 VIII '06. 51° 49′ 30″ N., 11° 42′ W., soundings 177–213 fms., fine sand. Trawl.—Fourteen.

Helga.

S. R. 362—9 VIII '06. 51° 34′ 30″ N., 11° 27′ W., soundings 145–160 fms., fine sand. Trawl.—Many.

S. R. 368—11 VIII '06. 51° 38′ 30″ N., 12° 0′ W., soundings 450–608 fms., fine sand. Trawl.—Many large.

S. R. 379—1 XI '06. 50° 14′ N., 10° 53′ W., soundings 126–139 fms., fine sand and shells. Trawl.—Many.

S. R. 380—1 XI '06. 50° 31′ N., 11° 0′ W., soundings 142–214 fms., fine sand. Trawl.—Ca. thirty.

S. R. 384—6 XI '06. 51° 54′ 30″ N., 11° 37′ W., soundings 162–218 fms., fine sand. Trawl.—Ca. two hundred and fifty.

S. R. 397—2 II '07. 51° 46′ N., 12° 5′ W., soundings 549–646 fms., ooze. Trawl.—One hundred.

S. R. 440—16 V '07. 51° 45′ N., 11° 49′ W., soundings 350–389 fms. Trawl.—Very many.

S. R. 447—18 V '07. 50° 20′ N., 11° 57′ W., soundings 221–343 fms., fine sand. Trawl.—Very many.

S. R. 448—18 V '07. 50° 21′ N., 11° 0′ W., soundings 343–346 fms. Trawl.—Many.

S. R. 487—3 IX '07. 51° 36′ N., 11° 57′ W., soundings 540–660 fms., ooze and stones. Trawl.—Ca. two hundred.

S. R. 490—7 IX '07. 51° 57′ 30″ N., 12° 7′ W., soundings 470–491 fms., ooze. Trawl.—Ca. fifteen hundred.

S. R. 491—7 IX '07. 51° 57′ 30″ N., 12° 13′ W., soundings 491–520 fms. Trawl.—Moderate.

S. R. 493—8 IX '07. 51° 58′ N., 12° 25′ W., soundings 533–570 fms. Trawl.—One.

S. R. 494—8 IX '07. 51° 59′ N., 12° 32′ W., soundings 550–570 fms. Trawl.—One.

S. R. 495—8 IX '07. 52° 0′ N., 13° 10′ W., soundings 346–400 fms., ooze. Trawl.—Ten.

S. R. 501—11 IX '07. 50° 49′ N., 11° 42′ W., soundings 447–625 fms. Trawl.—Forty-five.

S. R. 502—11 IX '07. 50° 46′ N., 11° 21′ W., soundings 447–515 fms. Trawl.—Many hundreds.

S. R. 505—12 IX '07. 50° 39′ N., 11° 14′ W., soundings 464–627 fms. Trawl.—Ca. eight hundred.

S. R. 528—7 XI '07. 50° 21′ 30″ N., 10° 24′ W., soundings 85 fms., sand and shells. Trawl.—Eighteen.

S. R. 590—3 VIII '08. 51° 50′ N., 12° 9′ W., soundings 480–493 fms., ooze. Trawl.—Two hundred and fifty.

S. R. 592—6 VIII '08. 50° 39′ N., 11° 25′ W., soundings 400–510 fms., ooze. Trawl.—Ca. two hundred.

S. R. 753—17 V '09. 51° 24′ N., 11° 59′ 30″ W., soundings 561–572 fms., ooze. Trawl.—Eleven.

S. R. 754—17 V '09. 51° 26′ N., 11° 57′ 30″ W., soundings 544–572 fms., ooze. Trawl.—Many.

S. R. 755—19 V '09. 52° 3′ N., 11° 20′ W., soundings 92–100 fms., fine sand. Trawl.—Very many.

Helga.
S. R. 805—14 VIII '09. 51° 50′ 30″ N., 12° 14′ W., soundings 539–544 fms., ooze. Trawl.—Few.
S. R. 807—17 VIII '09. 51° 37′ 30″ N., 11° 6′ W., soundings 105 fms., fine sand. Trawl.—Twenty-eight.
S. R. 1005—12 VIII '10. 51° 22′ N., 11° 30′ 30″ W., soundings 249 fms., fine sand. Dredge.—One.

This species is abundantly and almost uniformly distributed from 80 to 560 fathoms, the latter depth being the greatest at which it was certainly taken by the *Helga*. It is by far the most abundant echinoderm at the depths named, for although the records of *Echinus acutus* are slightly more numerous, yet that species is only locally abundant, whereas there are few localities on the west coast of Ireland where *S. Raschi* does not form the greater part of the contents of the trawl, to the detriment of its other occupants.

Echinocardium pennatifidum, Norman.

Echinocardium pennatifidum, Bell, 1892.

Helga.
S. R. 226—13 V '05. 53° 12′ N., 13° 57′ W., soundings 93 fms., gravel and shells. Dredge.—One.

This species seems to be very scarce on the west coast of Ireland, although it is probable that a more frequent use of the dredge in place of the trawl would have added to the number of records. Station 226 is on the Porcupine Bank.

Echinocardium flavescens (O. F. M.).

Echinocardium flavescens, Bell, 1892.
Echinocardium flavescens, Mortensen, 1907.

Helga.
S. R. 185—30 I '05. 50° 20′ N., 10° 20′ W., soundings 82½ fms., fine sand and shells. Dredge.—One.

Like *E. pennatifidum* this species is not very liable to capture in a trawl.

Bryssopsis lyrifer (Forbes).

Bryssopsis lyrifer, Bell, 1892.
Bryssopsis lyrifer, Mortensen, 1907.

Helga.
S. R. 477—28 VIII '07. 51° 15′ N., 11° 47′ W., soundings 707–710 fms., ooze. Trawl.—Two.

Helga.

S. R. 590—3 VIII '08. 51° 51′ 30″ N., 12° 8′ W., soundings 480 fms., ooze. Mesoplankton trawl on bottom.—One.

S. R. 752—16 V '09. 51° 48′ N., 12° 11′ 30° W., soundings 523–595 fms., ooze. Mesoplankton trawl on bottom. —Many.

All these deep water specimens are of small size, the average length being about 7 mm. The largest specimen, from S. R. 752, measured 2·7 cm. in length.

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EXPLANATION OF PLATES.

Plate I.

Fig. 1.—*Benthopecten armatus.*

Fig. 2.—*Henricia abyssicola.*

Fig. 3.—*Zoroaster fulgens* var. *Ackleyi.*

Plate II.

Fig. 1.—*Culcita borealis*, actinal view.

Fig. 2.— ,, ,, . abactinal view (another specimen).

Fig. 3.—*Stichaster roseus* var. *ambiguus.*

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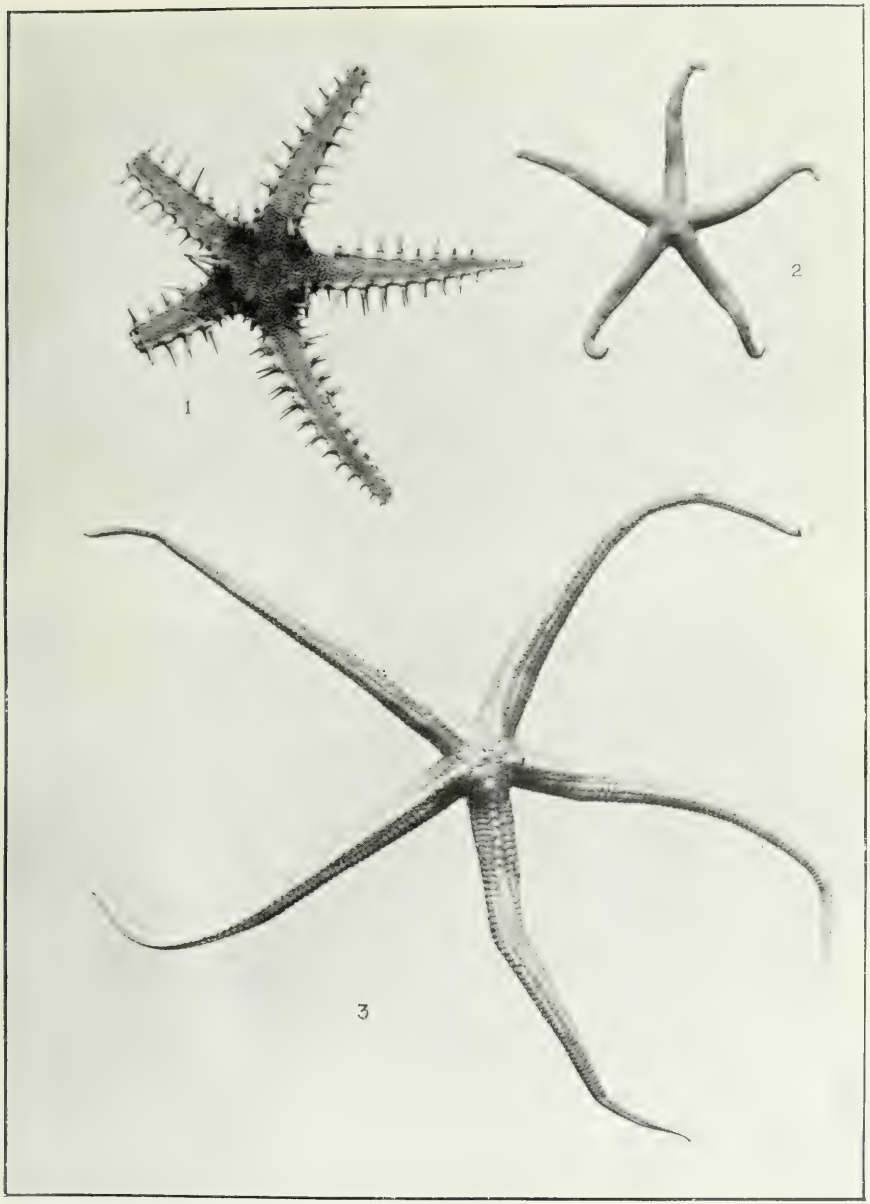

1. Benthopecten armatus.
2. Henricia abyssicola.
3. Zoroaster fulgens var. Ackleyi.

1, 2. Culcita borealis.
3. Stichaster roseus var. ambiguus.

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To the series of "Scientific Investigations" for the Year 1912, published by the Department of Agriculture and Technical Instruction for Ireland.

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CONTENTS.

A NEW BRITISH COMMENSAL HYDROID, *PERIGONIMUS ABYSSI*, SARS.

BY

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In 1876, Dr. Gwyn Jeffreys described a minute Lamellibranch Mollusc found at great depths (200–1,470 fathoms) in the Bay of Biscay and North Atlantic Ocean, as *Leda pustulosa*. The specific name, signifying "full of blisters," referred to the epidermis of the shell which had a "peculiar blistered appearance," sufficient, according to Jeffreys, to help in distinguishing it from its nearest ally, *L. frigida*. On at least two occasions since 1876 *Leda*, now *Nuculana pustulosa*, has been recorded, but no further reference has been made to the blistered epidermis. Recently, however, the Irish Department of Agriculture and Technical Instruction has obtained specimens of this species, which agree with the original description in their blistered appearance. Detailed examination has shown that the "blistering" is not a normal condition of the shell, that indeed the epidermis is not actually blistered, but that the appearance is due to the presence of the stolons of a Hydroid ramifying on the surface. The mollusc was identified and forwarded to me on account of its Hydroid associate by Miss A. L. Massy, of the Fisheries Branch of the Department.

Each stolon consists of a very narrow tube of coenosarc surrounded by a much wider tube of transparent, colourless chitin, 0.03 mm. in diameter, and scattered over with fine particles of sand. In the younger stages of growth the stolons are much branched, and form an open mesh-work; but there is little chance that at this stage they could fail to be recognised, for they appear as simple tubes, circular in section, clearly lying on the surface of the epidermis, and they are generally accompanied by fairly numerous polyps. With increased age, however, the network spreads over the whole surface and becomes closer, and in the shelter of the sides of the stolon-tubes a fine débris collects, partially filling up the meshes. In this case, it is difficult at first to recognise that the tubes are upon, and not included by, the epidermis. The illusion of blistering in such a case is often heightened by the scarcity of polyps. A third and still more advanced case may be mentioned: the actual contact of the stolon with the surface, continued during the growth of the shell, has produced an effect of its own—in reflected light the

tract which lay beneath a stolon appears smoother and darker, and of a bluish-grey colour, the uncovered portions of the shell being rather of a chalky white.

The polyps are exceedingly small—almost invisible to the naked eye. They consist of a proportionately long unbranched stem, narrow where it meets the stolon and widening upwards to the hydranth. The surface is protected by a soft chitinous coat continued over the hydranth to the base of the tentacles and covered with fine grains. On the stalk it is thick and slightly crumpled, but shows no sign of distinct annulation, and on the hydranth body, it is thin, loose and much and deeply wrinkled.

Perigonimus abyssi, Sars, from off S.W. of Ireland, × 200.

The hydranth body rises gradually from the widened summit of the stalk, resembles the head of an Indian club, bears a whorl of four to six short tentacles, five being most common, and is surmounted by a long proboscis, conical when closed. Its length is half of, or in some cases equal to, that of the stalk. As has been remarked, the polyps are exceedingly small, their size agreeing with Stechow's maximum of 0.5 mm. rather than with Sars' "scarcely 1 mm."

Unfortunately, no trace of gonosome was present.

Dimensions—

Stolon, diameter	0.02—0.035	mm.
Stalk, length	0.10—0.23	,,
,, average diameter ..	0.025—0.04	,,
Hydranth, length	0.15—0.19	,,
,, maximum diameter	0.09	,,

Locality—On valves of *Nuculana pustulosa* from S.R. 851, 9. XI. '09, M.O.T., 900 fathoms—Lat. N., 50° 48′; Long. W., 11° 41′—to the South-West of Ireland.

The localities from which *P. abyssi* has previously been recorded are scattered in the Arctic Ocean, and off the subarctic coast of Scandinavia.

Arctic Records—Storfjord, Spitsbergen, 0–10 metres (Broch 1909); Lat. N. 74.2°, Long. E. 20.30° (north of Bear Island), 165 metres (Bonnevie, 1899); and specimens perhaps belonging to this species have been found in the neighbourhood of Cape Bismark, and Storm Bay, Greenland, from 20 to 40 metres (Kramp, 1911).

Scandinavian Records—*Norway*—Bergen (Bonnevie, 1901, Stechow 1912); Hardanger Fjord, 150–400 fms. (Sars, 1873); Stavanger to Hardanger Fjord, 100–600 metres (Bonnevie, 1899); Hvitingsö, 80-100 fathoms (Sars, 1873): *Sweden*—Koster Island, 180 metres (Segerstedt, 1889).

The species, however, according to the present record from off the South-West corner of Ireland, extends from arctic and subarctic into temperate seas. It appears to be most common in deep water, occurring in Irish waters at a depth of 900 fathoms, far beyond its previously known limit of 400 fathoms in Hardanger Fjord.

Perigonimus abyssi is symbiotic with living mollusca, forming a network on the external surface of the shells. That its occurrence there is not altogether a chance one is perhaps hinted at by the narrow range of its commensalism. Apart from examples observed by Sars on shells of *Dentalium*, it has been found only (judging by published records) on minute shells of *Nuculidae*; on *Nucula nucleus* (Linn.) by Segerstedt and by Jäderholm; on *Nucula tumidula*, Malm, by Sars and by Bonnevie; and on *Nuculana pustulosa* (Jeffreys), in the present instance.

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NOTES ON THE EVIDENCE OF AGE AFFORDED BY THE GROWTH RINGS OF OYSTER SHELLS

BY

ANNE L. MASSY.

Plates I–XI.

It is rather commonly believed that the age of an oyster can be ascertained by counting the rings or groups of rings on its deep shell, each group of rings being supposed to represent a year's growth. An opportunity of testing the value of this method of computation, as applied to oysters reared under artificial conditions, occurred in the selection for the National Museum of a number of samples from the Department's oyster station at Ardfry, near Oranmore, at the head of Galway Bay, and from a former oyster station at Burren, in Muckinish Bay (an arm of the sea joining Galway Bay).[1] This station was abandoned in 1903, and the stock removed to Ardfry, where the spat is collected in a natural sea pond or saleen of about seven acres, which can be closed at will by lock gates. The collectors used are tiles coated with mortar, stacked in crates after the usual French system. The spat of one year is detached from the tiles during the autumn or winter of the year following, and subsequently kept either in *caisses ostréophiles* of the usual French pattern or in hanging baskets of wire netting, as devised by Wollebaek.[2]

The caisses and baskets are numbered, and all changes are entered in a register, so that mistake as to contents is practically impossible, and any stray oyster that may chance to establish itself by natural means in a caisse or basket can be detected as an intruder, because it lacks the fragment of mortar derived from the tile.

I understand that the experiments carried out at Ardfry since 1904 go to show that growth in caisses and baskets is in general more rapid than on the natural ground, though the latter is quite suitable for oysters. If this be so, the failure of growth which will be noticed in some of the specimens dealt with below, cannot be ascribed to general unsuitability of conditions; and, though it may to some extent be due to overcrowding and starvation of certain individuals and preservation of other

[1] *Ann. Rep. Fish. Ireland*, 1902-3, Pt. II, App. VIII [1905].

[2] *Ann. Rep. Fish. Ireland*, 1901, Pt. II, App. VI [1903].

weakly individuals from their natural enemies, it seems likely that wild oysters also manifest very marked differences in rate and evidence of growth.

Nothing can be deduced from the material tabulated below as to the proportion of oysters of a given age which exhibit so many rings or have reached a particular size, because the samples were taken without any regard to the total number of the brood to which they belonged.

The deep valve of an oyster exhibits externally a series of overlapping concentric lamellae, with more or less definite free edges. Closely examined, each lamella is seen to be made up of fine concentric elements, representing the accretions by which the growth of the lamella proceeds. The projecting edge of a lamella obviously represents some sort of interruption of growth, but does not necessarily indicate a cessation thereof, since (cf. Plate I, figs. 10 and 12) one may find more than one distinct lamella in what is obviously the accretion of a single season, i.e., from April or early May to about the beginning of October on our western coast. Often, and I suppose typically, the external surface of the shell is at once divisible into zones of lamellae or groups of lamellae, which are, in fact, annual growth rings or shoots, as may be seen in Plate IV, fig. 1, and Plate VII, fig. 2, which depict specimens in which the obvious growth-rings correspond exactly to the known age; in others (cf. Plate VII, fig. 1; IX, fig. 1; and XI, fig. 1) the rings are more complex. Such specimens have been used as a guide in determining the number of rings in the lists below, i.e., a specimen stated to have two rings is one which has two zones of shell which resemble what is really an annual ring in a typical specimen.

Petersen[1] says, "certainly the zones of growth on the shells have something to do with growth periods (years), but it is often not easy to determine them with certainty." I heartily agree with the latter statement; the difficulties which present themselves are apparent to anyone attempting the work, although not easy to describe. All I can honestly say I have learnt from a patient scrutiny of over 600 samples of various ages from eighteen months to six years, is that an oyster of eighteen months or two summers appears to possess at least 2 rings, but may have as many as 5. One of three summers has at least 2 rings, and may have 6. A four-year-old oyster may have only 3 rings or may possess 7 or 8. It is obvious, therefore, that if I have been at all correct in determining the number of rings (the photographs will allow the reader to judge of this), it is not of much use to apply the study of growth rings in ascertaining the age of a wild oyster. Wollebaek's[2]

[1] *Rept. Danish Biol. Stat.*, XV and XVIII. Copenhagen, 1908, p. 31.
[2] *Ann. Rep. Fish. Ireland*, 1901, Pt. II, App. VI [1903].

interesting series of photographs seems to show that Norwegian oysters are also somewhat vague as to the number of growth rings at a particular age. Petersen[1] found, after applying the measurement method to ascertain the age and growth of the oysters in the Lim Fjord, that it could only show "that an oyster of *ca.* 6–7 cm. is, as a rule, three summers old, and that the oyster begins to grow more slowly in length at 6–7 cm." In the list of measurements given below, it will be found that some of our specimens of three and four years of age measure only 21–22 mm. from hinge to margin.

Our Plates will be found to illustrate examples of oysters of various ages from the spat stage of one season to five-and-a-half years; in some cases normal growth is depicted, and in others the specimens appear to be remarkably stunted. Two types of shell growth are conspicuous, the first possesses a shell with a very few broad rings corresponding exactly with the known age, in the explanation of plates this kind of shell is referred to as "type *a*"; the second type, hereafter referred to as "type *b*," is represented by a shell in which the growth of each season contains more than one lamella. Frequently specimens of what is here called type *a* partake slightly of the characters of type *b*. and the converse also prevails; that both types may occur under the same conditions is shown in Plate I, where fig. 10 belongs to type *a*, and fig. 11 to type *b*; Plate IV, where fig. 1 is type *a*, and figs. 3, 4, 5, and 6 are type *b*; and Plate VII, where figs. 1 and 4 are type *a*, and fig. 2 is type *b*.

Ardfry does not seem to possess the wonderful fattening qualities of some of the Norwegian pools; Wollebaek (loc. cit. Plate IX) illustrates oysters of fourteen months measuring 67–75 mm. from hinge to ventral margin; oysters of one-and-a-half years (Plate VIII) measuring *ca.* 80 mm.; a specimen of two-and-a-half years fattened in the Nyhammer Pool for a year-and-a-half (Plate VII) measures *ca.* 105 mm.; and specimens of three-and-a-half years (Plate X) measure 90–97 mm.

Our largest samples of oysters of one-and-a-half years measure 60–65 mm.; of two-and-a-half years 65–70 mm.; and of three-and-a-half years 75 mm.

[1] *Loc. cit.*, p. 33.

MEASUREMENTS OF LOWER VALVES OF 638 OYSTERS.

BURREN SPAT, 1902. Specimens collected, March, 1906.

Hinge to ventral margin in mm.	30.	45.	57.	60.	63.	65.
Number of rings.	*3.*	*3.*	*4.*	*5.*	*4.*	*4.*

BURREN SPAT, 1902. Specimens collected 23rd January, 1907.

Hinge to ventral margin in mm.	70.	70.	70.	73.
Number of rings.	*5.*	*4.*	*7.*	*4.*

ARDFRY SPAT, pond closed for spatting season, 20th July, 1903.
Specimens collected, March, 1906.
Ref. No. Ex C 250 and N.B. 4.

Hinge to ventral margin in mm.	28.	30.	32.	40.	43.	44.	45.	46.	47.	50.	50.	55.
Number of rings.	*3.*	*3.*	*3.*	*4.*	*3.*	*3.*	*3.*	*3.*	*3.*	*4.*	*5.*	*3.*

Hinge to ventral margin in mm.	55.	60.	60.	62.	62.	65.					
Number of rings.	*3.*	*4.*	*3.*	*3.*	*3.*	*3.*					

ARDFRY SPAT, pond closed for spatting season, 20th July, 1903.
Specimen collected, January, 1907.
Ref. No. 33 D.

Hinge to ventral margin in mm.	67.
Number of rings	*5.*

ARDFRY SPAT, pond closed for spatting season, 25th June, 1904.
Specimens collected 23rd January, 1907.

Hinge to ventral margin in mm.	33.	43.	46.	50.	50.	50.	51.	52.	53.	55.	55.	56.
Number of rings	*3.*	*3.*	*3.*	*3.*	*3.*	*5.*	*3.*	*3.*	*4.*	*3.*	*3.*	*4.*

Hinge to ventral margin in mm.	56.	56.	57.	58.	58.	60.	60.	60.	62.	62.	65.	65.
Number of rings	*3.*	*4.*	*3.*	*3.*	*3.*	*3.*	*3.*	*3.*	*3.*	*3.*	*3.*	*5.*

ARDFRY SPAT, pond closed for spatting season, 8th July, 1905.
Specimens collected, 26th January, 1907.
Ref. No. C 34.

Hinge to ventral margin in mm.	23.	26.	27.	30.	30.	35.	35.	38.	40.	42.	45.	45.
Number of rings	*2.*	*2.*	*2.*	*2.*	*2.*	*2.*	*2.*	*5.*	*2.*	*3.*	*2.*	*4.*

Hinge to ventral margin in mm.	46.	46.	48.	52.	53.	55.	58.	60.			
Number of rings	*3.*	*3.*	*5.*	*3.*	*4.*	*4.*	*3.*	*3.*			

ARDFRY SPAT, pond closed for spatting season, 8th July, 1905.
Specimens collected 26th January, 1907.
Ref. No. C 15 B.

Hinge to ventral margin in mm.	38.	50.	50.	50.	53.	56.	56.	56.	57.	57.	60.	65.					
Number of rings	2.	3.	2.	2.	2.	3.	4.	2.	3.	3.	3.	4.					

ARDFRY SPAT, pond closed for spatting season, 8th July, 1905.
Specimens collected, 26th January, 1907.
Ref. No. C 15.

Hinge to ventral margin in mm.	37.	38.	38.	38.	38.	38.	42.	50.	50.	50.	46.	47.	48.	50.	53.	53.	53.	54.
Number of rings	2.	2	3.	3.	4.	3.	2.	3.	2.	3.	2.	2.	2.	3.	4.	4.	3.	3.
55.	55.																	
3.	3.																	

ARDFRY SPAT, pond closed for spatting season, 8th July, 1905.
Specimens collected, 21st February, 1908.
Ref. No. 212 B.

Hinge to ventral margin in mm.	22.	25.	30.	32.	33.	35.	36.	38.	38.	40.	40.	42.	42.	42.	44.	45.	45.	45.
Number of rings	3.	3.	3.	3.	3.	3.	3.	4.	3.	3.	3.	3.	3.	3.	3.	4.	4.	3.
45.	45.	46.	46.	46.	49.	49.	49.	52.	54.	55.	56.							
3.	3.	3.	3.	3.	3.	4.	3.	3.	4.	4.	3.							

ARDFRY SPAT, pond closed for spatting season, 8th July, 1905.
Specimens collected, 21st February, 1908.
Ref. No. 212 A.

Hinge to ventral margin in mm.	35.	37.	40.	40.	40.	40.	40.	40.	40.	42.	42.	45.	47.	48.	48.	50.	50.	50.
Number of rings	3.	3.	4.	3.	4.	3.	3.	3.	5.	3.	4.	3.	4.	5.	4.	5.	3.	4.
52.	52.	52.	53.	55.	56.	56.	58.	60.	60.	62.	63.	65.	65.	60.				
4.	4.	4.	4.	5.	5.	5.	5.	4.	4.	5.	6.	3.	5.	4.				

ARDFRY SPAT, pond closed for spatting season, 8th July, 1905.
Specimens collected, 21st February, 1908.
Ref. No. 213 C.

Hinge to ventral margin in mm.	30.	35.	42.	43.	40.	43.	44.	45.	45.	45.	46.	47.	47.	52.	52.	52.	53.	53.
Number of rings	2.	2.	4.	2.	2.	3.	3.	4.	3.	5.	3.	3.	3.	3.	4.	5.	3.	3.
58.																		
3.																		

ARDFRY SPAT, pond closed for spatting season, 8th July, 1905.
Specimens collected, 21st February, 1908.
Ref. No. 212 C.

Hinge to ventral margin in mm.						23.	25.	30.	33.	33.	35.
Number of rings						*3.*	*3.*	*3.*	*3.*	*3.*	*3.*
35.	35.	37.	37.	37.	39.	40.	40.	40.	44.	45.	45.
3.	*3.*	*3.*	*4.*	*4.*	*3.*	*4.*	*3.*	*3.*	*4.*	*3.*	*3.*
45.	45.	45.	45.	45.	47.	47.	50.	50.	50.	52.	
4.	*5.*	*3.*	*4.*	*3.*	*3.*	*6.*	*4.*	*4.*	*5.*	*4.*	

ARDFRY SPAT, pond closed for spatting season, 8th July, 1905.
Specimens collected, 21st February, 1908.
Ref. No. 213 A.

Hinge to ventral margin in mm.						40.	40.	42.	44.	44.	45.
Number of rings						*3.*	*3.*	*3.*	*3.*	*3.*	*5.*
45.	45.	45.	46.	47.	47.	48.	48.	48.	48.	50.	50.
3.	*3.*	*3.*	*4.*	*3.*	*4.*	*4.*	*3.*	*3.*	*3.*	*3.*	*3.*
50.	50.	50.	50.	52.	52.	55.	55.	55.	55.	55.	56.
5.	*3.*	*3.*	*4.*	*3.*	*4.*	*3.*	*3.*	*3.*	*3.*	*4.*	*4.*
56.	57.	57.	57.	60.	60.	60.	67.	70.			
4.	*4.*	*3.*	*3.*	*4.*	*4.*	*3.*	*4.*	*3.*			

ARDFRY SPAT, pond closed for spatting season, 8th July, 1905.
Specimens collected, 2nd March, 1908.
Ref. No. Ex N.H. Laying.

Hinge to ventral margin in mm.						35.	37.	38.	39.	43.	45.
Number of rings						*3.*	*3.*	*4.*	*5.*	*3.*	*4.*
45.	48.	50.	50.	50.	50.	52.	53.	62.	63.	65.	77.
5.	*4.*	*5.*	*4.*	*5.*	*4.*	*5.*	*5.*	*3.*	*5.*	*4.*	*6.*

ARDFRY SPAT, pond closed for spatting season, 8th July, 1905.
Specimens collected, 19th March, 1908.
Ref. No. C. 239, C 240, C 241, C 279.

Hinge to ventral margin in mm.						23.	24.	25.	26.	26.	27.
Number of rings						*2.*	*3.*	*2.*	*3.*	*3.*	*2.*
28.	30.	32.	45.	50.	50.	56.	62.	62.	62.	65.	66.
3.	*3.*	*4.*	*6.*	*4.*	*5.*	*3.*	*3.*	*4.*	*5.*	*6.*	*4.*
67.	72.	72.	73.								
5.	*4.*	*6.*	*4.*								

ARDFRY SPAT, pond closed for spatting season, 8th July, 1905.
Specimens collected, 16th January, 1909.
Ref. No. N.B. 29.

Hinge to ventral margin in mm.						44.	45.	45.	50.	53.	55.
Number of rings						*4.*	*3.*	*4.*	*4.*	*4.*	*3.*
55.	55.	56.	60.	62.	65.	65.	70.	70.			
3.	*3.*	*3.*	*5.*	*4.*	*3.*	*4.*	*5.*	*5.*			

ARDFRY SPAT, pond closed for spatting season, 8th July, 1905.
Specimens collected, February, 1909.
Ref. No. Laying 32.

Hinge to ventral margin in mm.	43.	45.	46.	46.	48.	48.	50.	53.	54.	56.	67.	70.
Number of rings	*3.*	*3.*	*3.*	*5.*	*3.*	*3.*	*6.*	*5.*	*3.*	*6.*	*4.*	*6.*

ARDFRY SPAT, pond closed for spatting season, 8th July, 1905.
Specimens collected, 2nd February, 1909.
Ref. No. Caisse 333 A.

Hinge to ventral margin in mm.	62.	65.	65.	70.	77.	80.	80.	80.
Number of rings	*4.*	*5*	*5*	*7.*	*6*	*5*	*5.*	*4.*

ARDFRY SPAT, pond closed for spatting season, 8th July, 1905.
Specimens collected, 2nd February, 1909.
Ref. No. Caisse 333 B.

Hinge to ventral margin in mm.	35.	44.	44.	45.	46.	46.	48.	50.	50.	52.	55.	55.	57.	57.	60.	60.
Number of rings	*2.*	*3.*	*3.*	*4.*	*3.*	*4.*	*3.*	*3.*	*3.*	*6.*	*3.*	*4.*	*5.*	*6.*	*4.*	*4.*

Hinge to ventral margin in mm.	63.	65.	72.	77.								
Number of rings	*5.*	*5.*	*3.*	*4.*								

ARDFRY SPAT, pond closed for spatting season, 8th July, 1905.
Specimens collected, 2nd February, 1909.
Ref. No. Caisse 333 C.

Hinge to ventral margin in mm.	36.	40.	40.	43.	45.	46.	48.	48.	48.	50.	50.	50.
Number of rings	*3.*	*3.*	*4.*	*2.*	*4.*	*5.*	*4.*	*4.*	*6.*	*5.*	*4.*	*6.*

Hinge to ventral margin in mm.	52.	52.	55.	57.	60.	65.	74.					
Number of rings	*5.*	*4.*	*5.*	*4.*	*5.*	*4.*	*6.*					

ARDFRY SPAT, pond closed for spatting season, 8th July, 1905.
Specimens collected, 2nd February, 1909.
Ref. No. Ex 333 C.

Hinge to ventral margin in mm.	62.	70.	73.	75.	75.
Number of rings	*3.*	*5.*	*5.*	*5.*	*7.*

ARDFRY SPAT, pond closed for spatting season, 8th July, 1905.
Specimens collected, February, 1909.
Ref. No. C 171 A and C.

Hinge to ventral margin in mm.	46.	50.	50.	50.	50.	52.	53.	54.	55.	56.	60.	60.
Number of rings	*3.*	*3.*	*4.*	*5.*	*3.*	*4.*	*5.*	*3.*	*4.*	*4.*	*4.*	*5.*

Hinge to ventral margin in mm.	60.	65.	65.	70.	86.						
Number of rings	*5.*	*4.*	*5.*	*6.*	*7.*						

ARDFRY SPAT, pond closed for spatting season, 8th July, 1905.
Specimens collected, February, 1909.
Ref. No. 173 A. and 176 A.

Hinge to ventral margin in mm.	39.	40.	40.	42.	45.	45.
Number of rings	*5.*	*2.*	*2.*	*3.*	*3.*	*3.*

60.	63.	64.	75.
4.	*4.*	*4.*	*5.*

ARDFRY SPAT, pond closed for spatting season, 8th July, 1905.
Specimens collected, February, 1909.
Ref. No. 173 C. and 176 C.

Hinge to ventral margin in mm.	45.	45.	48.	50.	73.	75.
Number of rings	*3.*	*3.*	*3.*	*3.*	*8.*	*6.*

ARDFRY SPAT, pond closed for spatting season, 8th July, 1905.
Specimens collected, February, 1909.
Ref. No. C 175 A.

Hinge to ventral margin in mm.	35.	38.	38.	39.	40.	41.
Number of rings	*3.*	*3.*	*3.*	*3.*	*4.*	*3.*

43.	45.	45.	45.	47.	49.	50.	51.	53.	53.	55.
3.	*3.*	*3.*	*4.*	*4.*	*4.*	*4.*	*4.*	*4.*	*4.*	*4.*

ARDFRY SPAT, pond closed for spatting season, 8th July, 1905.
Specimens collected, February, 1909.
Ref. No. 175 B.

Hinge to ventral margin in mm.	60.	61.	63.	65.	70.	70.
Number of rings	*5.*	*7.*	*4.*	*4.*	*5.*	*6.*

76.	78.	80.
4.	*6.*	*4.*

ARDFRY SPAT, pond closed for spatting season, 8th July, 1905.
Specimens collected, February, 1909.
Ref. No. C 352, 353, 354.

Hinge to ventral margin in mm.	22.	23.	27.	33.	35.	48.
Number of rings	*3.*	*3.*	*3.*	*3.*	*3.*	*4.*

50.	50.	55.	55.	55.	57.	60.	62.	63.	68,	70.	70.
3.	*4.*	*3.*	*4.*	*3.*	*3.*	*3.*	*4.*	*5.*	*3.*	*4.*	*4.*

70.	75.	75.	75.	75.	75.	79.	80.	80.	84.
5.	*5.*	*4.*	*5.*	*4.*	*5.*	*5.*	*3.*	*5.*	*5.*

ARDFRY SPAT, pond closed for spatting season, 13th July, 1906.
Specimens collected, 18th March, 1908.
Ref. No. C 193.

Hinge to ventral margin in mm.	20.	23.	25.	27.	28.	28.
Number of rings	*2.*	*2.*	*2.*	*2.*	*3.*	*3.*

30.	35.	38.	40.	40.	42.	42.	44.	45.	48.
2.	*2.*	*3.*	*3.*	*3.*	*2.*	*4.*	*3.*	*2.*	*5.*

ARDFRY SPAT, pond closed for spatting season, 13th July, 1906.
Specimens collected, 18th March, 1908.
Ref. No. C 149.

Hinge to ventral margin in mm.	15.	22.	25.	26.	29.	31.					
Number of rings	*2.*	*2.*	*2.*	*3.*	*2.*	*2.*					
31.	37.	37.	40.	42.	43.	45.	45.	46.	46.	46.	47.
3.	*3.*	*3.*	*3.*	*2.*	*2.*	*3.*	*4.*	*3.*	*3.*	*3.*	*2.*

ARDFRY SPAT, pond closed for spatting season, 13th July, 1906.
Specimens collected, 16th January, 1909.
Ref. No. N.B. 52 and 53.

Hinge to ventral margin in mm.	26.	37.	37.	40.	42.	42.						
Number of rings	*3.*	*4.*	*4.*	*3.*	*3.*	*3.*						
42.	45,	47.	51.	57.	57.	60.	60.	60.	60.	63.	64.	
4.	*3.*	*3.*	*4.*	*3.*	*5.*	*4.*	*5.*	*4.*	*5.*	*5.*	*6.*	
65.	66.	66.	67.	67.	72.	76.						
5.	*5.*	*5.*	*5.*	*5.*	*4.*	*6.*						

ARDFRY SPAT, pond closed for spatting season, 13th July, 1906.
Specimens collected, February, 1909.
Ref. No. C 337, 174, 195.

Hinge to ventral margin in mm.	70.	70.	75.	80.
Number of rings	*4.*	*3.*	*4.*	*4.*

ARDFRY SPAT, pond closed for spatting season, 13th July, 1906.
Specimens collected, February, 1909.
Ref. No. C 350, C 351.

Hinge to ventral margin in mm.	21.	21.	23.	25.	50.	53.						
Number of rings	*3.*	*3.*	*3.*	*3.*	*5.*	*6.*						
60.	60.	62.	62.	62.	62.	63.	64.	66.	68.	68.	70.	
4.	*6.*	*6.*	*4.*	*4.*	*4.*	*7.*	*4.*	*5.*	*4.*	*5.*	*3.*	
70.												
3.												

ARDFRY SPAT, pond closed for spatting season, 13th July, 1906.
Specimens collected, March, 1909.
Ref. No. C 149, C 40, C 110, C 136.

Hinge to ventral margin in mm.	62.	65.	66.	77.
Number of rings	*3.*	*3.*	*5.*	*4.*

ARDFRY SPAT, pond closed for spatting season, 13th July, 1906.
Specimens collected, March, 1909.
Ref. No. C 332 B.

Hinge to ventral margin in mm.	25.	37.	38.	38.	39.	40.
Number of rings	*2.*	*4.*	*3.*	*4.*	*5.*	*3.*
41.	47.	57.	57.	62.		
4.	*3.*	*3.*	*4.*	*3.*		

ARDFRY SPAT, pond closed for spatting season, 13th July, 1906.
Specimens collected, March, 1909.
Ref. No. C 332 C.

Hinge to ventral margin in mm.						29.	31.	32.	34.	35.	37.
Number of rings						*3.*	*3.*	*3.*	*3.*	*3.*	*5.*
40.	40.	40.	40.	40.	45.	47.	48.	50.	50.	51.	55.
3.	*4.*	*3.*	*5.*	*3.*	*3.*	*3.*	*4.*	*3.*	*6.*	*4.*	*4.*
60.	60.	72.									
3.	*4.*	*4.*									

ARDFRY SPAT, 1906, from New Harbour caisses: also spat of 1906 after nine months in Norway basket; pond closed for spatting season, 13th July, 1906.
Specimens collected, 16th and 18th March, 1910.

Hinge to ventral margin in mm.						37.	37.	38.	40.	40.	44.
Number of rings						*3.*	*4.*	*3.*	*3.*	*3.*	*3.*
45.	45.	45.	52.	53.	55.	55.	60.	60.	60.	63.	65.
3.	*3.*	*4.*	*3.*	*4.*	*4.*	*5.*	*4.*	*4.*	*5.*	*6.*	*4.*
65.	65.	66.	68.	69.	70.	70.	71.	72.	75.	75.	75.
4.	*6.*	*5.*	*5.*	*6.*	*4.*	*4.*	*5.*	*5.*	*7.*	*5.*	*3.*
76.	77.	80.	95.								
6.	*6.*	*5.*	*7.*								

ARDFRY SPAT, pond closed for spatting season, 13th July, 1906.
Specimens collected, 25th April, 1912.

Hinge to ventral margin in mm.	50.	70.	85.	90.
Number of rings	*4.*	*6.*	*9.*	*10.*

ARDFRY SPAT, pond closed for spatting season, 25th July, 1910.
Specimens collected, 25th April, 1912.

Hinge to ventral margin in mm.						15.	20.	29.	32.	32.	35.
Number of rings						*2.*	*2.*	*2.*	*2.*	*3.*	*3.*
35.	38.	50.	50.	50.	53.	54.	55.	56.	58.	60.	64.
3.	*2.*	*2.*	*3.*	*3.*	*4.*	*4.*	*4.*	*3.*	*4.*	*4.*	*4.*
66.											
5.											

EXPLANATION OF PLATES.

Plate I.

Figs. 1–6, Spat of 1905, specimens collected immediately gates opened, September, 1905.

Figs. 7–12, Eighteen months' oysters, spat 1905. Ref. No. C 34, specimens collected 26th January, 1907; figs. 8 and 9 illustrate stunted growth, and figs. 7, 10, 11 and 12 represent normal growth; fig. 11 is a characteristic example of type *a* and fig. 10 of type *b*.

Plate II.

Figs. 1–4, Seventeen months' oysters, spat 1906. Ref. No. C 193, specimens collected 18th March, 1908; figs. 1 and 4, normal growth, type *a*; figs. 2 and 3, stunted growth.

Figs. 5–9, Twenty-one months' oysters, spat 1910, specimens collected 25th April, 1912; figs. 5, 8 and 9, stunted growth; figs. 6 and 7, better growth, type *a*.

Plate III.

Figs. 1–4. Two-and-a-half years' oysters, spat 1905. Ref. No. 212 A, specimens collected 21st February, 1908; figs. 1, 2 and 4, normal growth; fig. 3, stunted growth; fig. 1, type *b*, and figs. 2 and 3, type *a*; fig. 4 shows the growth of 1907 clearly, while that of the spat year and 1906 seems merged in one.

Plate IV.

Figs. 1–6, Two-and-a-half years' oysters, spat 1905. Ref. No. 212 B, specimens collected 21st February, 1908; figs. 1, 4, 5 and 6, normal growth; figs. 2 and 3, stunted growth; fig. 1, type *a*; figs. 3, 4 and 5, type *b*.

Plate V.

Figs. 1–6, Two years and eight months' oysters, spat 1905. Specimens collected 19th March, 1908; figs. 1, 2, 5 and 6, average growth; figs. 3 and 4, very stunted growth; fig. 5, type *a*; figs. 1 and 2, in many respects resembling type *a*; fig. 6, type *b*.

Plate VI.

Figs. 1–5, Two years and eight months' oysters, spat 1906. Ref. No. Ex. C 332 C, specimens collected March, 1909; figs. 2 and 5, normal growth; figs. 1, 3 and 4, stunted growth; figs. 2 and 4, type *a*; figs. 1, 3 and 5, growth of each season not clear.

Plate VII.

Fig. 1–5, Two-and-a-half years' oysters, spat 1906. Ref. No. C 350, C 351, specimens collected February, 1909; figs. 2, 3 and 4, average growth; fig. 1, small; fig. 5, remarkably stunted; fig. 2, type *a*; figs. 1, 3 and 4, type *b*.

Plate VIII.

Figs. 1–5, Three-and-a-half years' oysters, spat 1905. Ref. No. Ex. C 333 B, specimens collected 2nd February, 1909, ; figs. 2 and 5, average growth ; figs. 3 and 4, small ; fig. 1 is very stunted and possesses such fine lamellae that the growth of the different seasons cannot be defined ; figs. 2, 3, 4 and 5, type *b*.

Plate IX.

Figs. 1–4, Three-and-a-half years' oysters, spat 1905. Ref. No. Caisse 333 C, specimens collected 2nd February, 1909 ; figs. 1 and 4, normal ; figs. 2 and 3, stunted ; fig. 4, in many respects resembling type *a* ; figs. 1, 2 and 3, type *b*.

Plate X.

Figs. 1–4, Three-and-a-half years' oysters, spat 1905. Ref. No. Ex. C 352, 353, 354, specimens collected February, 1909 ; figs. 1, 3 and 4, normal, type *b* ; fig. 2, stunted, type *a*.

Plate XI.

Figs. 1–4, Five-and-a-half years' oysters, spat 1906. Specimens collected 25th April, 1912 ; figs. 1, 3, and 4, normal ; fig. 2, stunted ; all belong to type *b*.

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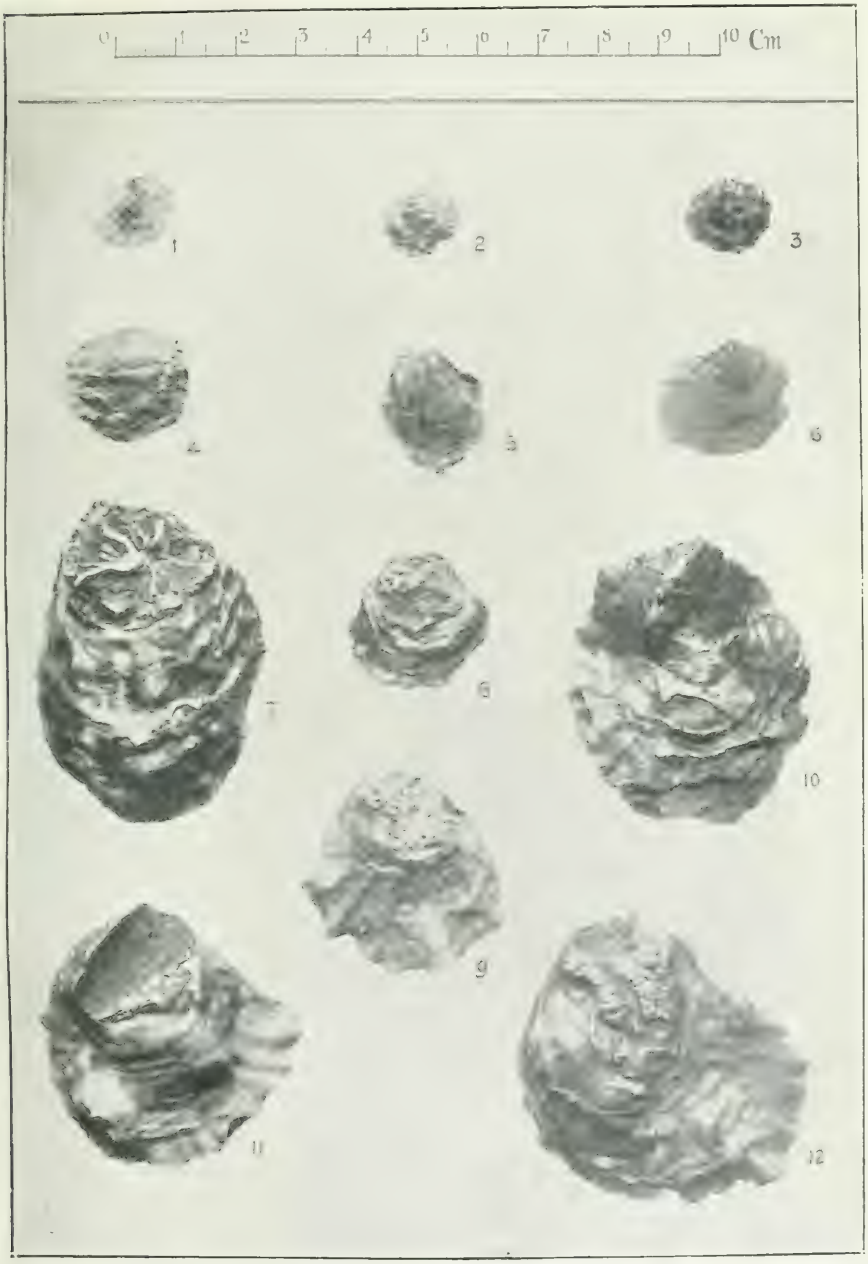
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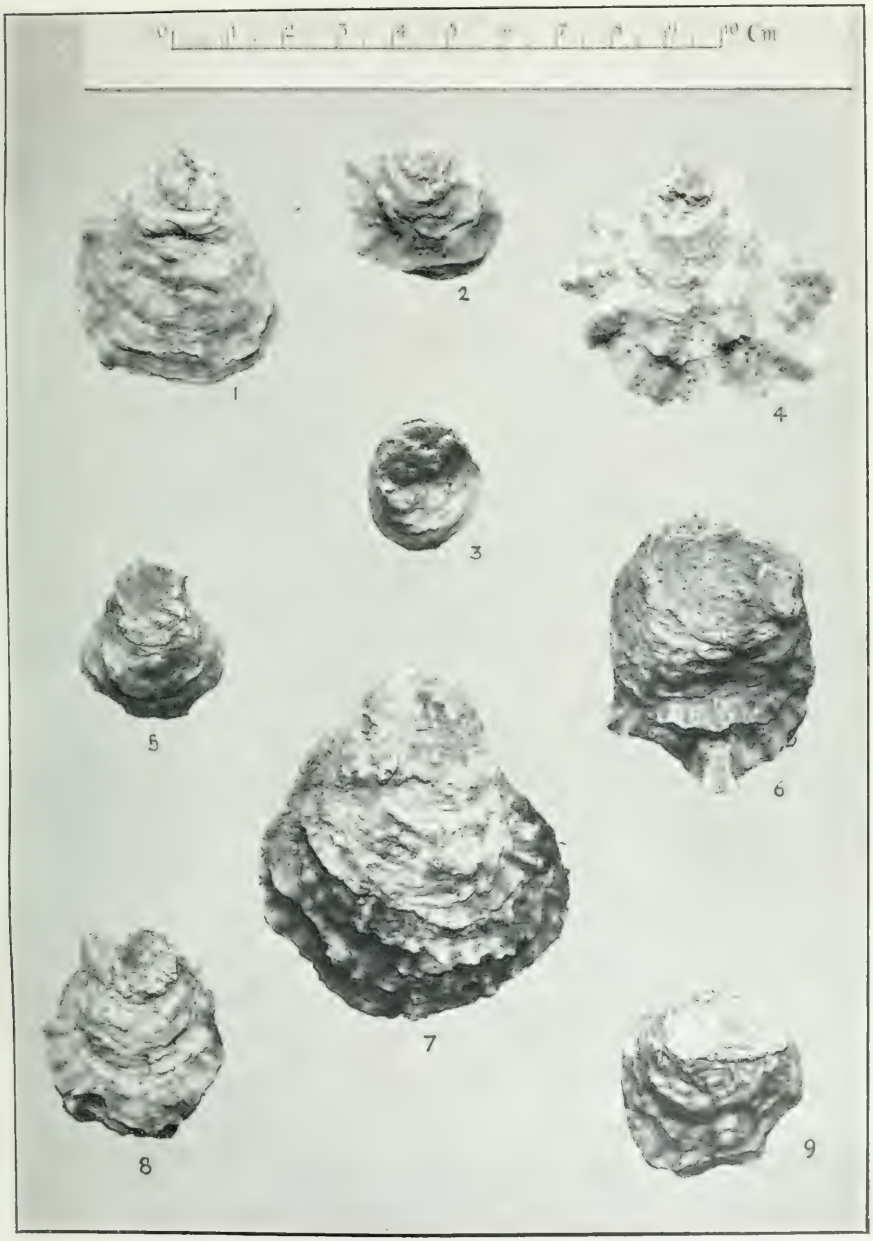
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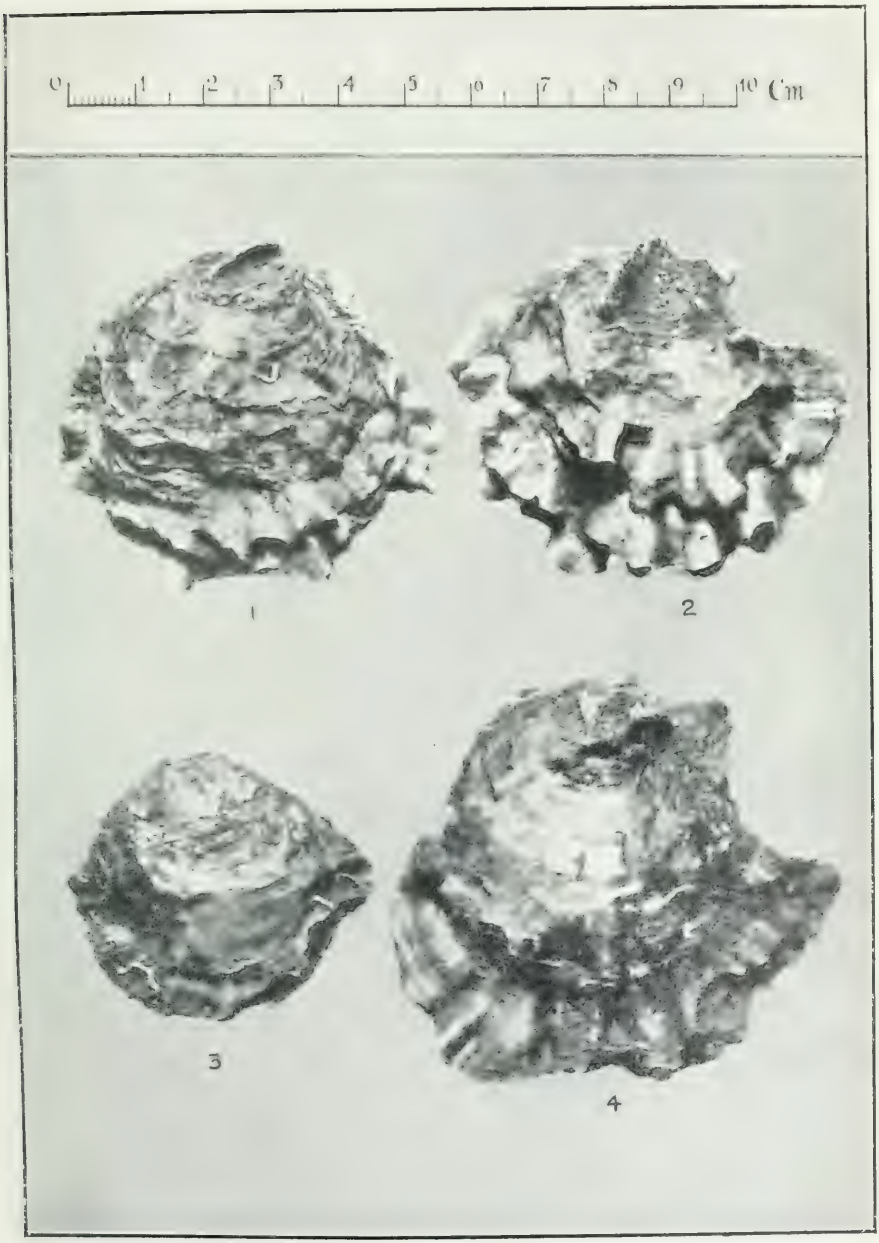
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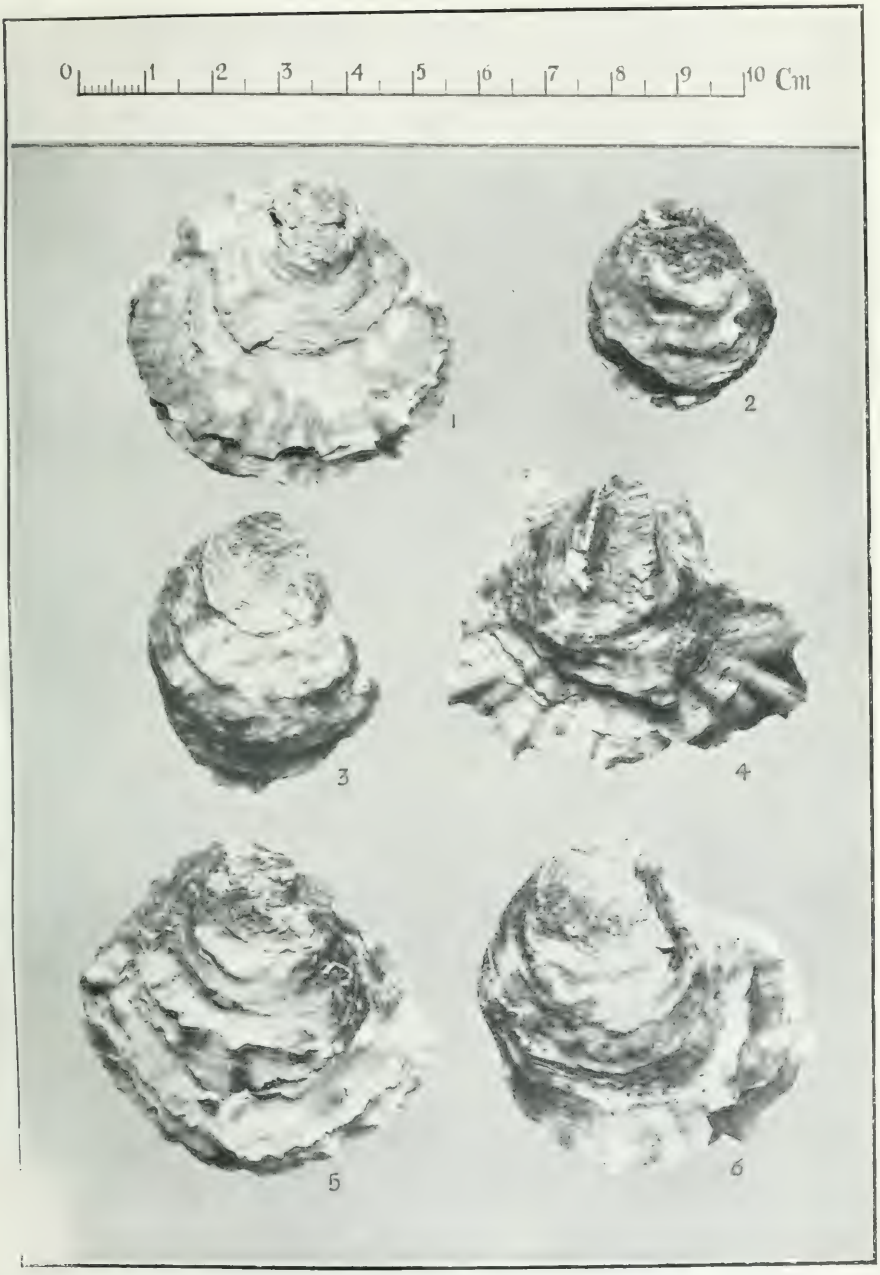
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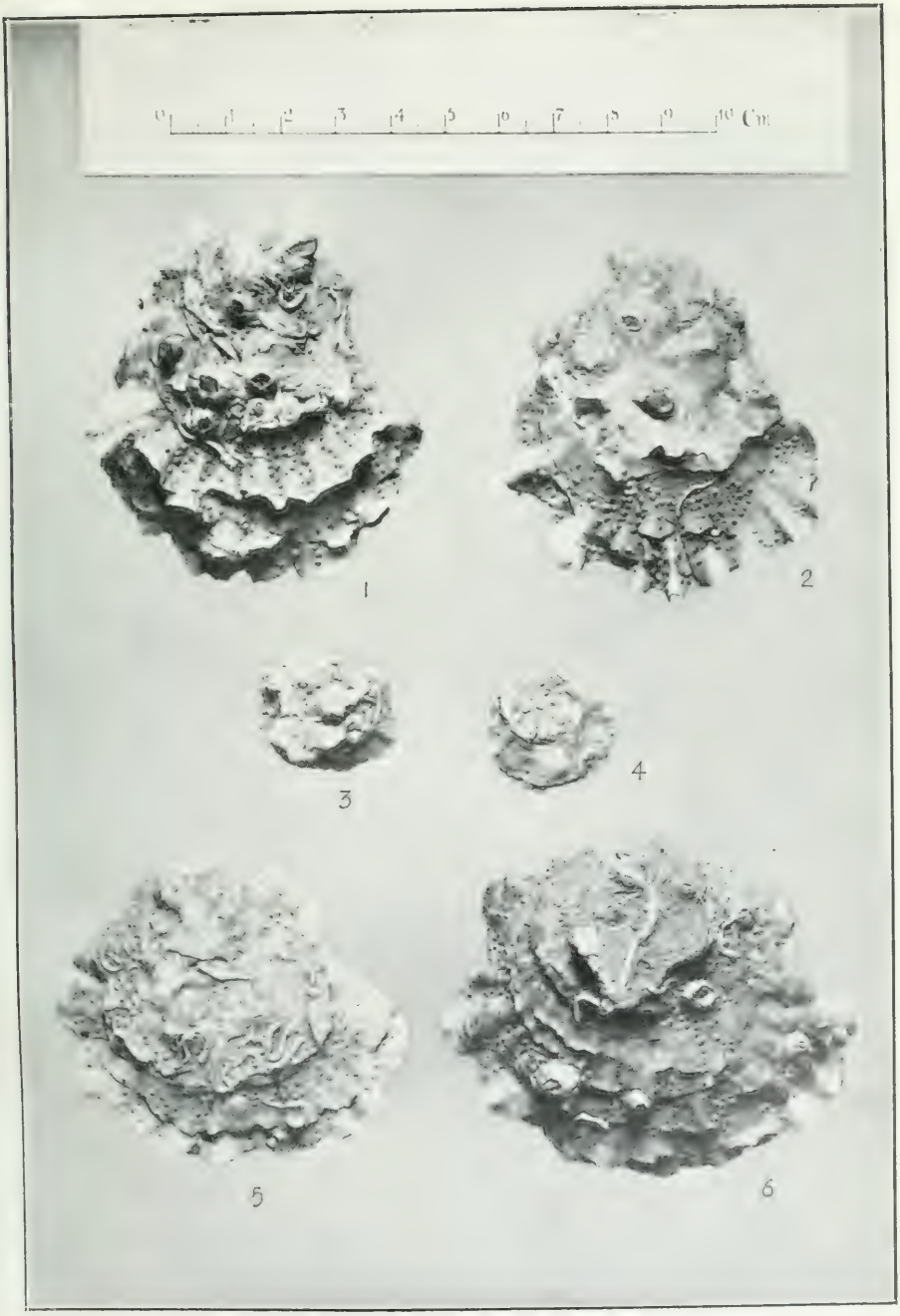
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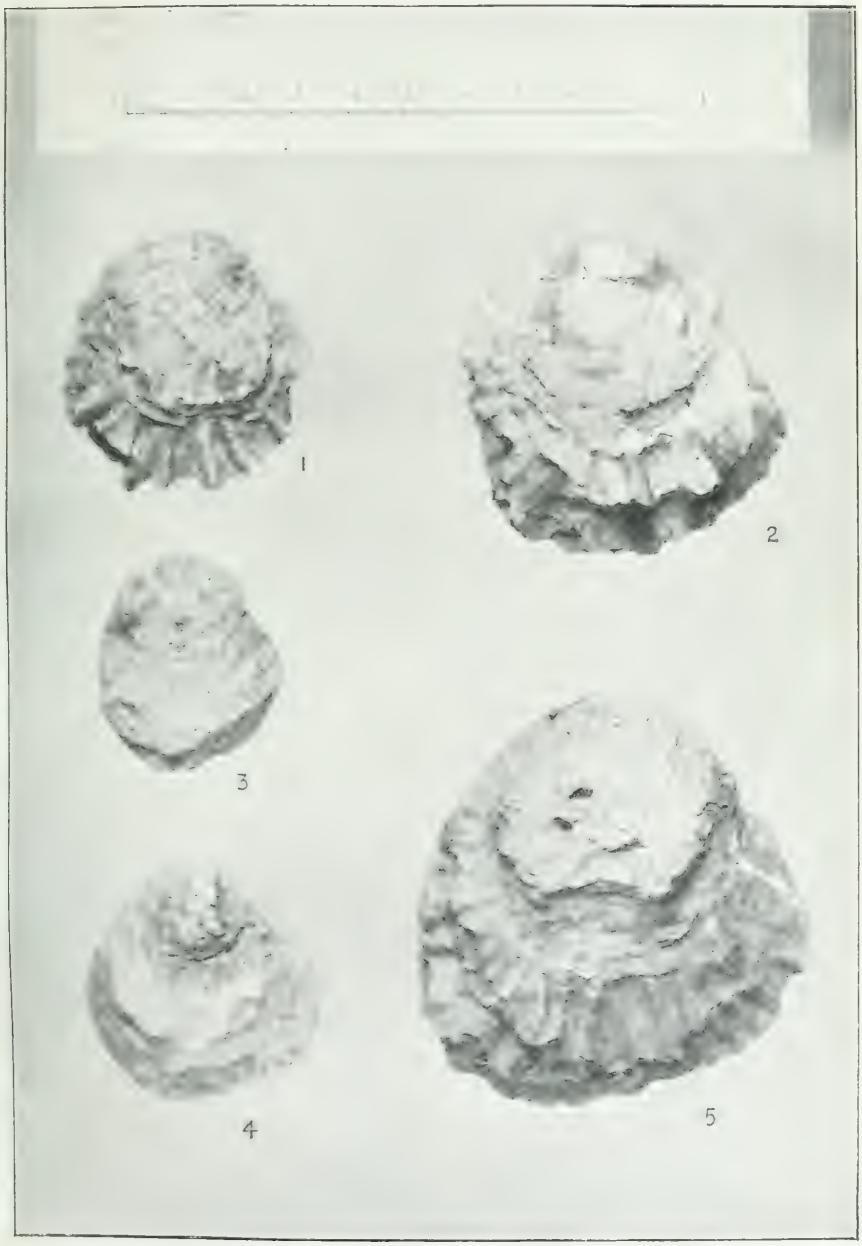
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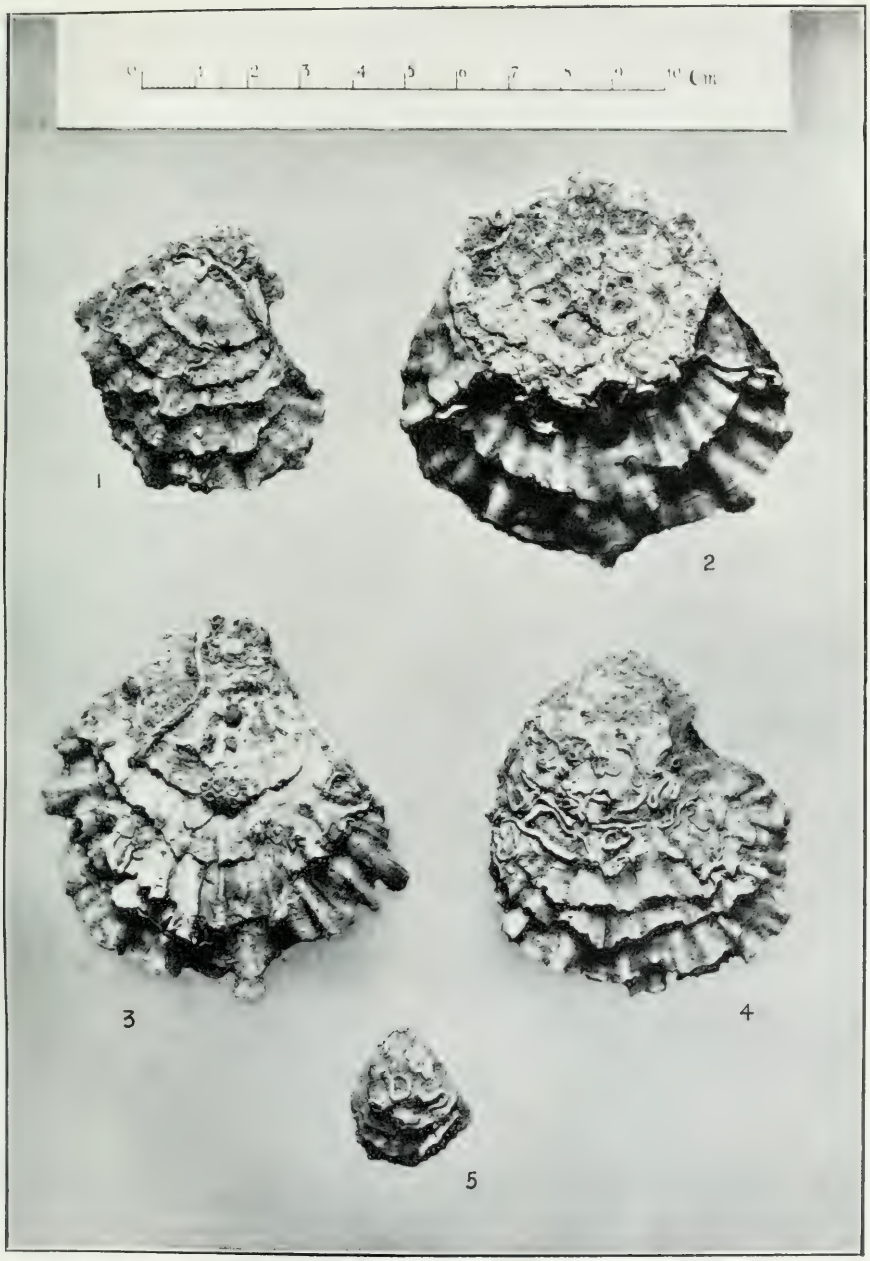
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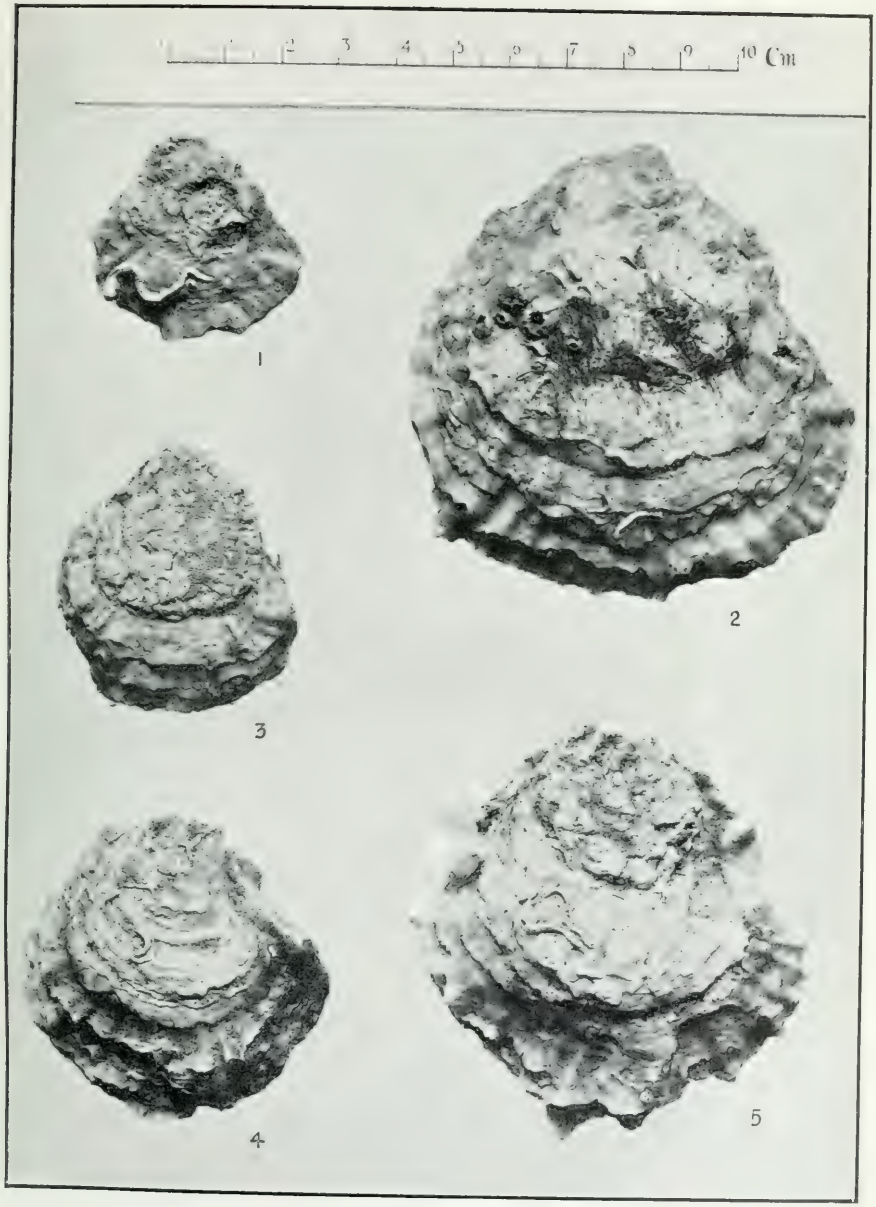
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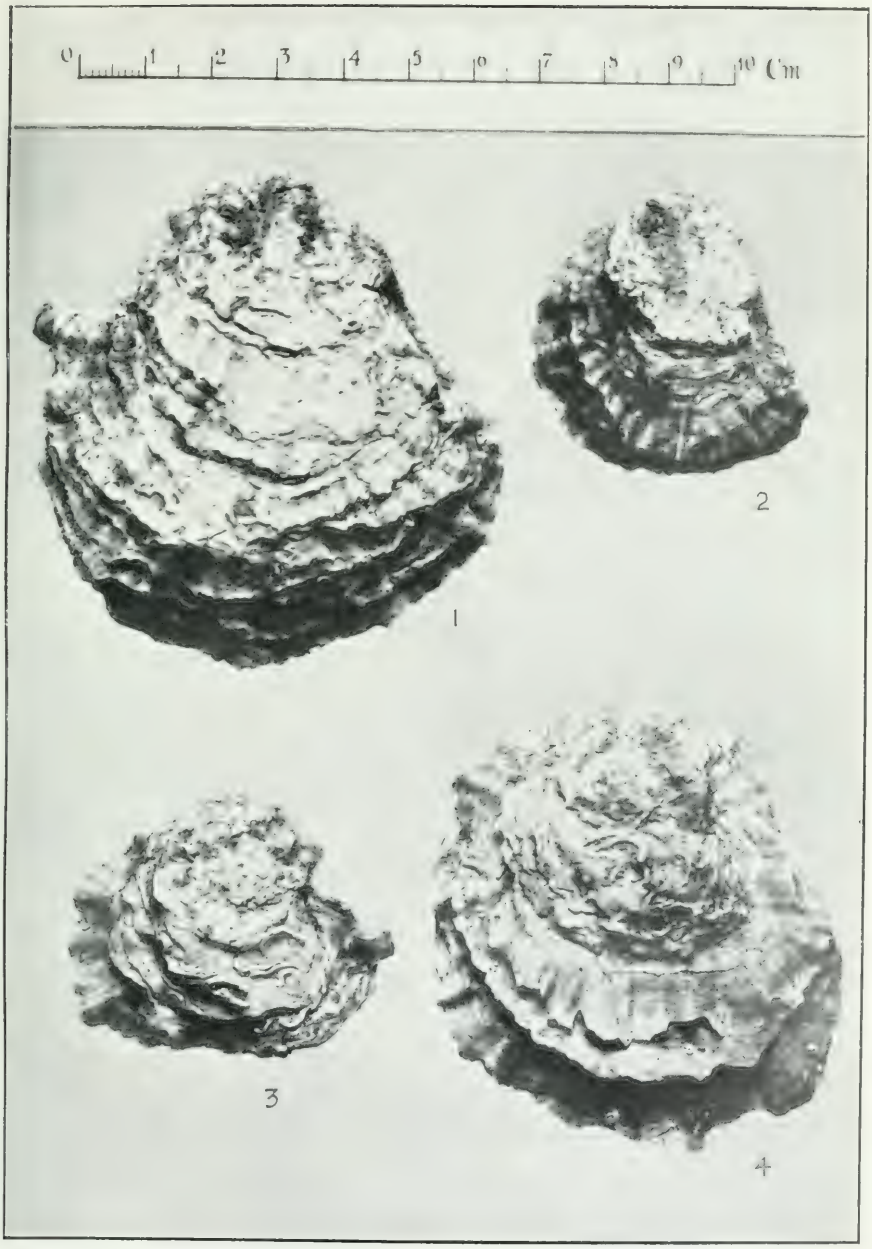
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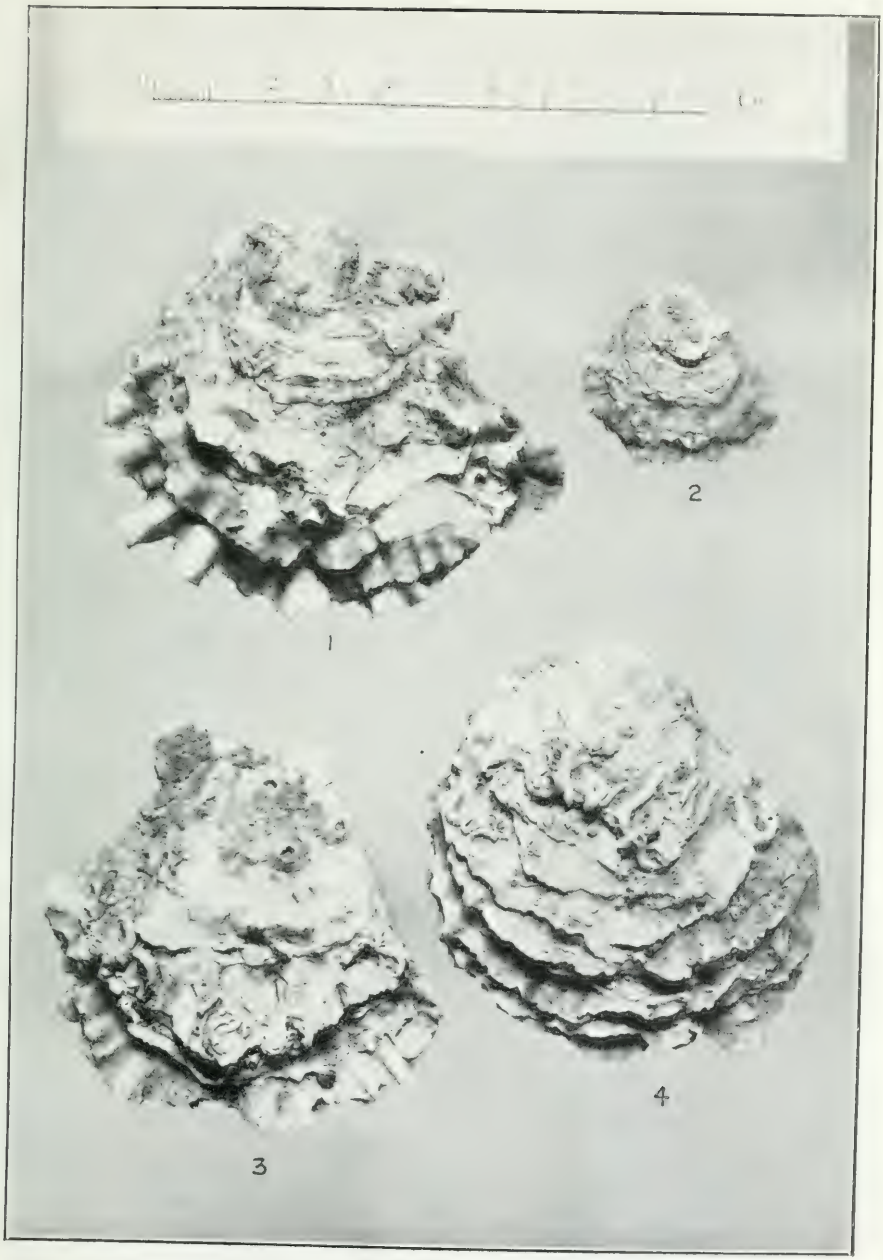
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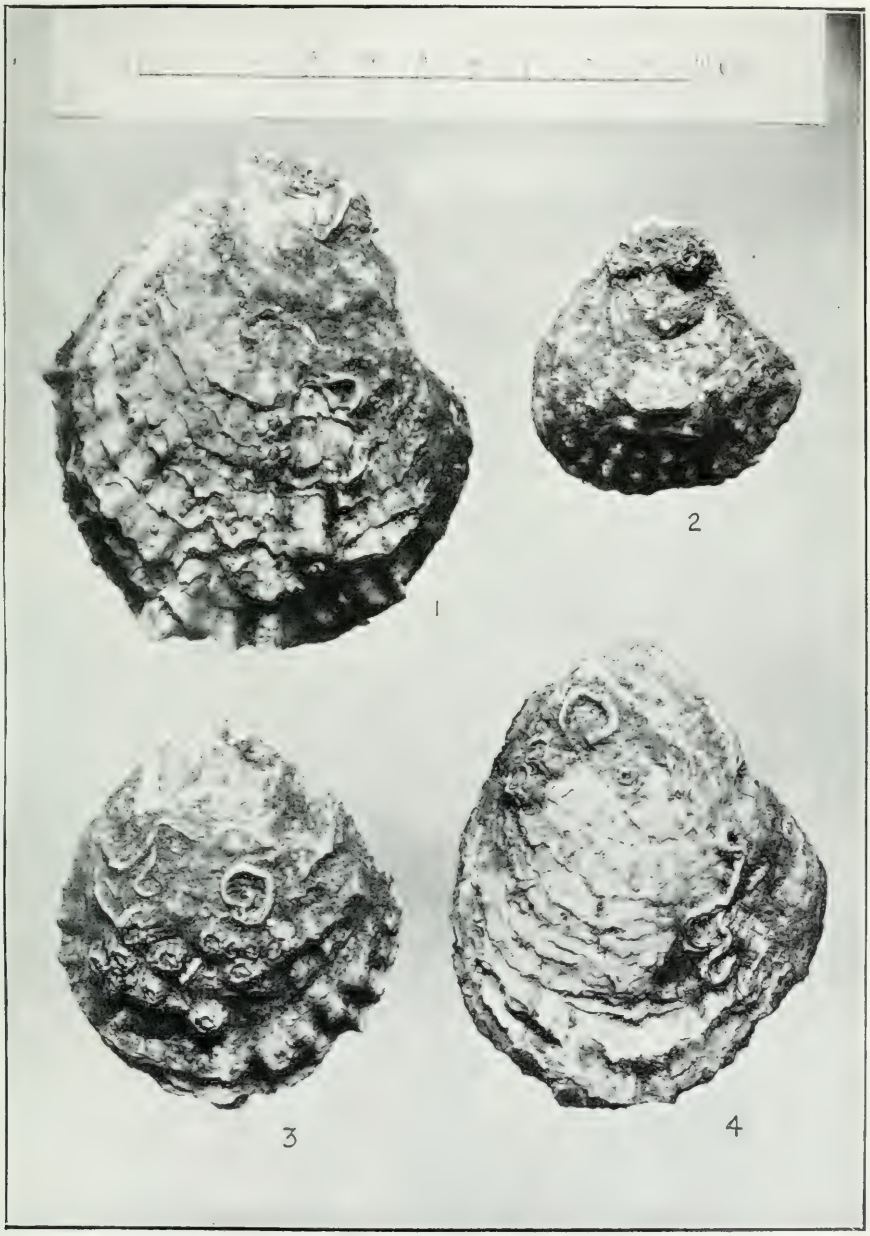
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HYDROCOELE EMBRYONALIS

BY

L. von Betegh, Fiume.

[Translated by Anne L. Massy, and published with the permission of the author and of the editors of the *Centralblatt für Bakteriologie, Parasitenkunde und Infektionskrankheiten*, Jena.]

Plate I.

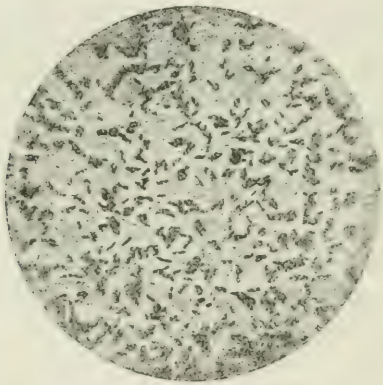
Only a few of the epidemic diseases to which alevins in fish breeding establishments are liable are at present known. The most widely spread is yolk-sac dropsy. The aetiology of this dangerous malady has not been made wholly clear, and but little special literature on the subject exists. Hofer,[1] as touching the cause of the sickness, mentions that observations of fish breeders agree that this condition is arrived at in consequence of pressure or shock to the eggs; as regards the aetiology, however, he remarks that nothing at present is certain. I have repeatedly observed this sickness in the biological station at Fiume and as the result of thorough investigations have arrived at the conviction that it is an infectious disease caused by some specific agent. The first observations date from 1907; having, however, at that time but little material available, I had to postpone exhaustive study to a later period. In that year I observed also another epidemic illness in trout alevins, which I described as *Tympanites embryonalis.*[2] I shall here mention this disease also, but reserve to myself the right of reporting fully thereon at the conclusion of the experiments.

The yolk-sac dropsy appeared again later a few times but sporadically, and destroyed many thousands of alevins. It was precisely this circumstance that first led me to think that we might be dealing with an infectious malady, since concussion or pressure would be more likely to kill the embryo than cause dropsy. Surely the circumstance that the sickness suddenly appears all at once points to this. At first the otherwise well developed alevins swim normally, after one or two days the enlarged yolk-sac attracts notice; the stricken alevins arise no longer to the surface, but, weighed down by the much enlarged

[1] Hofer, *Handbook of Fish Diseases*, p. 260.
[2] Betegh, *Tympanites embryonalis* (Halászat, 1907).

yolk-sac, move on the bottom of the hatchery box; after one or two days the sac bursts and the fish dies after a few hours.

The contents of the sac consist of a serous fluid mass which at the commencement of the sickness is quite transparent, and later, towards the end, becomes somewhat turbid. A slender *Diplobacillus* of about 2–3μ in length and 0,4—0,6μ in thickness can be isolated from the contents of the sac and moreover is in existence in the sac in pure culture. On artificial culture medium the bacillus grows after 24 hours. At first the colonies are transparent and opalescent, later grey-white and united to form a moist diffused mass. Growth is optimum at 20° C., but at 37° C. there is no growth. On gelatine the colonies after 24 hours become visible as fine, punctiform, transparent drops, which in a short time become confluent.



They develop along the course of the needle just as well as on the surface; it is characteristic that the gelatine is liquefied. On slanting gelatine, according to the nature and manner of arrangement of the particular colonies, furrows arise out of which the liquefied gelatine flows off and collects at the bottom of the tube, where the bacteria form a turbid grey-white suspension. On weak alkaline agar the colonies are also punctiform and grey-white, converging later to a moist incrustation, which causes the condensation water to become turbid. Neither in gelatine nor agar is any gas formed. The growth is similar whether at the surface or bottom of the agar. On glycerine agar the bacteria grow exactly as on ordinary agar, except somewhat more slowly. It would seem that 5% glycerine somewhat inhibits the growth of the bacteria. Morphologically, however, no distinction can be shown between such as grow on ordinary and on glycerine agar. After 24 to 36 hours the broth becomes uniformly turbid and after some days a thin scum forms on its surface.

Structure and biochemistry of the bacillus.

By dark field illumination the bacteria present are seen sharply outlined and in various stages of development. Fresh cultures show a very lively activity. The youngest bacterial forms are short and rounded at both ends. The bacterial protoplasm is homogeneous. The bacteria are short bacilli and often arranged in pairs (diplobacillus). At either pole of the bacillus the protoplasm is somewhat refractile and occasionally roundish granules are perceptible. Such little granules, which also show lively movement, are especially abundant in the condensation water of older agar cultures. Investigation by the Burri method reveals, especially in older cultures, typical *Diplobacilli*. By this method the pole granules are also quite perceptible and the granules present outside the cells are also clearly traceable. By intra vitam staining the protoplasm of the bacteria is stained uniformly and no fine structure is traceable. In bacteria stained by the Giemsa method a central part intensely coloured and a pale envelope weakly tinged, are visible. About in the centre of every organism an ovoid sharply-outlined spore-like body is visible. Whether this is a spore or nucleus must at present remain undecided. The *Diplobacilli* can be stained similarly by carbol-fuchsin: the organisms staining uniformly. In old culture the above-mentioned spore-like form is also visible and stains well with carbol-fuchsin. By the Gram method the bacillus decolorises; it is thus gramnegative and neither acid—alcohol—nor alkali—fast. On consideration of the qualities mentioned, and further the circumstances that in all the embryos examined the same micro-organism was perceptible in great quantity, it must naturally be regarded as the specific cause of the sickness. I propose to name it *Diplobacillus liquefaciens piscium*. Further experiments with this bacillus are in progress and will be reported upon later.

I shall now report briefly on the malady alluded to at the beginning of this paper, *Tympanites embryonalis*. I first observed it in 1907, since then I have only observed it epidemic this spring. Shortly after the appearance of the yolk-sac epidemic, it made its advent spontaneously. The station conduit had to be closed for some hours; when re-opened a quite turbid water began flowing in which only after many hours again became clear. Previous to this not a single case of *Tympanites* had occurred, but some thousand embryos had been affected by yolk-sac dropsy. After this occurrence in the conduit *Tympanites* suddenly set in. Only such alevins as were fully developed and were 15 days old and had completely absorbed their yolk-sac became affected by the disease.

The photographs testify clearly that the fish were distinctly more developed than those suffering from yolk-sac dropsy. It is characteristic of *Tympanites* that the whole gastric region

becomes enormously distended, so that the young fish in consequence of the pressure of gas becomes bent. The disease develops very rapidly; at first the fish can still swim actively. After 6 or 8 hours the body swells up, the belly walls are tight and the interior is filled with gas. The fish breathe with difficulty; they can no longer dive, but swim with the ventral part uppermost. Finally the body wall bursts and the fish sinks dead to the bottom. The aetiology of this epidemic disease is at present the object of investigation. In all probability a micro-organism is the cause of the formation of gas. On the adjoining photograph a case of double infection is represented, viz., a young fish is seen in which *Tympanites* is beginning and two tolerably large air bubbles are present in the yolk-sac.

I am indebted to Herr Prof. von Gauss, Director of the Royal Biological Station for Marine Investigation, for kindly providing me with the material for investigation.

EXPLANATION OF PLATE I.

Fig. 1.—*Hydrocoele embryonalis*: different stages of the development of the sickness. In the centre of the picture alevins in which the disease has reached its maximum are shown. The yolk-sac is enormously enlarged and filled with serous fluid.

Fig. 2.—*Tympanites embryonalis*: Young fish of about 10—12 days, which have been attacked by *Tympanites*. The ventral wall is very tense, from the body cavity being filled with gas and the body is strongly bent dorsally. Below at the right hand side is seen a fish which has a double infection of yolk-sac dropsy and *Tympanites*; the latter is present as a secondary infection, two tolerably large air bubbles mark the commencement of the formation of gas.

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Fig. 1.

v. Betegh, Phot. Fig. 2.

THE SALINITY AND TEMPERATURE OF THE IRISH CHANNEL AND THE WATERS SOUTH OF IRELAND.

BY

DONALD J. MATTHEWS.

PLATES I–XV.

The investigations on which this report is founded were commenced in February, 1903, and include observations up to the end of May, 1912. They consist of determinations of temperature and salinity during the months of February, May, August and November made on board the *Helga* and of observations made at all times of the year up to 1907 at three lightships and one lighthouse, and thereafter at one lightship.

APPARATUS.

On the four quarterly cruises Ekman reversing waterbottles with messengers have been used, generally in series, for observations below the surface and on occasion at the surface also. They are fitted to carry two thermometers of the reversing type but as a rule only one has been used. The thermometers were of the pattern made by Richter of Berlin, with which it is possible to read to the second place of decimals, but the temperatures cannot be considered accurate to this extent as differences as great as ·05° have been found between simultaneous readings of two instruments after applying all corrections. The fact that the thermometers have not been used in pairs also throws a certain doubt on the results, as these instruments are liable to sudden changes in the breaking-off point of the mercury thread, which may give rise to errors of considerable magnitude. Large errors are, of course, easily detected by the irregularity in the resulting temperature curve, but small ones may be overlooked if a second thermometer is not used as a control. An examination of the observations makes it almost certain that no large errors have occurred, but the small differences mentioned above are probably due to such changes.

During the earlier years of the investigations maximum-minimum thermometers were chiefly used and also reversing thermometers of Negretti and Zambra's older model. The latter were graduated to half degrees and were unprovided with auxiliary thermometers, and temperatures could only be recorded to the nearest tenth of a degree. As regards the maximum-minimum thermometers, since in the areas in which

they were used the temperature generally changes continually in one direction, the readings were probably accurate except for errors caused by the index slipping in the bore, and there is no reason to suppose that this has taken place to any important extent.

Surface temperatures and water samples on the cruises have been taken as a rule by means of a bucket, and this method has of course been used at the lightships. All thermometers have been provided with a certificate showing errors, either from the National Physical Laboratory, or, in the case of Richter's thermometer, from Charlottenburg, and all, except the capsizing ones, have since 1904 been periodically compared with the standards in the Physical Laboratory of Trinity College, Dublin.

Determination of Salinity.

The water samples have been preserved in 6 oz. milk bottles with porcelain stoppers, rubber washers and spring catches. As a rule these have given very good results. A few have been broken in transit, and in some cases an abnormally high salinity has been found to be due to a leaky washer or a cracked bottle. Such causes of error are however easily detected, and very few salinities of doubtful accuracy have been used for this report; when such have been used attention has been drawn to them.

Some of the samples taken at the lightships have been found to contain so much sulphuretted hydrogen as to be useless; this is probably due to the accidental enclosure of a piece of weed or other organic matter.

For various reasons I do not consider that the observations of salinity taken previous to 1909 are so wholly reliable as to eliminate the possibility of serious error in the deduction of mean isohalines. I have therefore confined consideration in this paper to salinities determined by myself or by my assistant Mr. C. W. Frost. The samples were titrated by Mohr's method against the International Standard Water, and the results have been calculated by means of *Knudsen's Hydrographical Tables, 1901.* The pipette, of Knudsen's model, held about 16 cc., and the burette was of the bulb form, drawn out to a fine jet at the upper end. Under suitable conditions, that is, with small variations of light and temperature, one titration for each analysis has been found sufficient in the case of the upper layers, but in nearly every case samples taken at a depth of one hundred fathoms or more have been titrated in duplicate. In hot sunny weather, however, the temperature often changes so rapidly that it is necessary to make all titrations in duplicate; this was particularly the case during the summer of 1911.

For the deeper samples the salinity has often been calculated from first principles in order to avoid the slight error due to the use of Knudsen's Titration Tables, owing to the rounding off of the corrections. It is expressed in parts per thousand

of salt by weight, that is, the number of grammes of total solids contained in a thousand grammes of water, and is calculated from the chlorine content by the formula $S=0{\cdot}03+1{\cdot}8050\ Cl$.

Method of Calculating the Mean Values.

Almost the whole of the observations during the quarterly cruises are vertical series, and those from the surface only are so few that they have been disregarded.

In order, as I am informed by the officer responsible, to avoid giving a specious appearance of identity to Stations which, owing to weather and other circumstances, were not in fact exactly identical in position, the Irish observing Stations have received a serial number only. For purposes of tabulation the following procedure has therefore been adopted. A chart was prepared for each of the four months, on which were plotted in their correct position all the serial numbers from the beginning for the month in question. It was seen that though the observations tended to fall into groups, yet the area of these groups varied considerably, and some observations were completely isolated. In one or two instances the stations for a cruise had been so placed that they fell midway between the groups formed by the majority; in this case a section was drawn for these observations and from this was interpolated the most probable value at the centre of each group; such values were then used as if they had been actually observed. Of course such a method is open to objection, but it is the only one possible short of neglecting the observations entirely, which would probably have given rise to even greater errors. The charts were then carefully examined and pencil lines were drawn to include all positions which fell sufficiently closely together, the size of the group being varied according to the position; in the North Channel, for instance, the group would have to be very much smaller than in the area close to the south-east coast if the probable error is to be the same in each case.

The mean date, position, depth, and temperature and salinity for various strata were then calculated for each of these groups, by interpolation from a curve when observations at a selected depth were missing. In the rather numerous cases where the *sprungschict* or surface of separation between two bodies of water of different temperature and salinity fell near the missing observation the interpolation is of course extremely uncertain, and to avoid error due to any preconceived idea as to its shape the curve has been drawn here as a straight line.

To calculate the mean conditions for the whole year a number was given to each of these groups, and these numbers were plotted again on a fifth chart. Another series of groups was thus obtained, and a final number was given to them when they contained at least two years' observations for each of the

four cruises, or when they were new positions which will probably be investigated regularly in the future. Below is given a list of the more important of these mean positions.

MEAN POSITIONS OF IRISH STATIONS, WITH THE NUMBERS USED FOR REFERENCE IN THIS PAPER.

No.	Lat. N.	Long. W.	No.	Lat. N.	Long. W.
1	54° 33½′	5° 20′	35	52° 10′	6° 8′
2	54° 36′	5° 8′	36	52° 8′	5° 51′
3	54° 37′	4° 56½′	37	52° 6′	5° 36′
4	54° 16′	5° 20′	38	52° 4′	5° 20′
5	54° 21′	4° 54′	39	51° 54′	6° 48′
6	54° 31′	4° 46′	40	51° 36′	6° 38′
7	54° 0′	5° 49′	41	51° 17′	6° 28′
8	54° 0′	5° 32′	43 (E 30)	50° 57′	6° 21′
9	54° 0′	5° 14′	44	51° 20′	6° 59′
10	54° 0′	4° 58′	45	51° 25′	7° 30′
12	53° 40′	5° 48′	46	51° 36′	8° 14′
13	53° 40′	5° 31′	52	51° 14′	9° 43′
14	53° 40′	5° 14′	53	50° 56′	9° 56′
15	53° 41′	4° 56′	54	50° 19′	10° 21′
16	53° 22′	5° 46′	56	50° 35′	11° 19′
17	53° 21′	5° 30′	57	50° 52′	11° 6′
18	53° 21′	5° 12′	58	51° 10′	10° 54′
19	53° 21′	4° 55′	59	51° 27′	10° 43′
21	53° 2′	5° 45′	60	51° 38′	11° 1′
22	53° 3′	5° 30′	61	51° 31′	11° 28′
23	53° 2′	5° 12′	62	51° 23′	11° 51′
24	53° 3′	4° 56′	63	52° 2′	10° 56′
26	52° 41′	5° 53′	64	52° 0′	11° 11′
27	52° 41′	5° 37′	65	51° 58′	11° 27′
31	52° 29′	6° 0′	66	51° 56′	11° 43′
32	52° 27′	5° 45′	67	51° 54′	11° 58′
33	52° 26′	5° 27′	68	51° 50′	12° 14′
34	52° 24′	5° 10′			

As has been mentioned, the groups often cover a considerable area, even when the intention was to make the observations at one point on all cruises. Off the south-west coast where the steamer is out of sight of land for some time and the weather may make an astronomical fix impossible, it is of course unavoidable that errors should occur in making the position of a station, which cannot be discovered until the next landfall. On the other hand, in the Irish Sea, the depths are so irregular that an error of a mile in position may lead to a considerable change of the depth; thus it happens that stations which by dead reckoning were made at identical positions show a difference of depth of twenty or thirty fathoms. As will be seen from the sections, the depth has a great influence on the salinity and temperature, and this variation in the depths recorded gives rise to some uncertainty in calculating the means, and in the case of the bottom water the temperature in places is probably

Ordnance Survey, Southampton, 1914.

too high and the salinity too low. The most difficult section to draw on this account has been No. IX. Here the depth increases very rapidly seawards outside the 200-fathom line and it appears from the soundings made on the various cruises that the line of stations runs out along a submarine valley pushing up to the coast from the deeper water. Identical depths may be found here at the bottom of the valley at its shoreward end and on its slopes much further seawards; but as will be shown later, there is strong reason to suppose that the isohalines and isotherms are tilted up the sides of the valley and so the salinity and temperature would not be the same at the two positions in spite of the agreement of the depths.

The Plymouth and Liverpool Observations.

In order to make the report as complete as possible use has been made of the results obtained in connection with the International Fishery Investigations by the Marine Biological Association at Plymouth and by the Liverpool Marine Biological Committee.

The Plymouth observations consist of five stations (E on the charts) (Plates XI to XV), on the western side of the Irish Channel and south of the latitude of the Smalls Light, and of a series of surface observations at the Cardigan Bay and Seven Stones Lightships, of which the former is now removed.

Of these stations, E6 has been worked on all quarterly cruises except one, from the beginning of the investigations in February 1903 to November 1909, the last cruise before the work was transferred to the Board of Agriculture and Fisheries. Stations E26 to E30 have been worked twice in February and three times in May, August, and November; E30 has since been adopted as an Irish Station so that in some cases there are four sets of observations from this position.

In the Irish Sea the Liverpool Marine Biological Committee has a line of stations running westwards from Morecambe Bay, along the fifty-fourth parallel, to the Isle of Man, and then turning southwards a short distance to the east of the easterly Irish stations. There are here sets of observations for each of the quarterly cruises, for the years 1907 to 1910 inclusive; on some cruises only surface observations have been made, and in order to calculate the mean bottom salinity and temperature the missing values have been interpolated by calculation of the difference between the surface and bottom for the dates when observations at both are available. There is therefore some uncertainty as to the true bottom conditions, but the character of the water changes so rapidly as we cross from the shallows of Liverpool Bay to the deep water westward of the meridian of the Isle of Man that the error in the charts is negligible. It will be seen that in some cases the isohaline or isotherm running through these Liverpool Stations is shown by a broken line, indicating some doubt; this is not intended to convey that the observations here are doubtful, but that they are not such that the course of any one isohaline can be accurately traced.

The Charts and Sections.

The tabulated means show that the differences between surface and bottom over a large part of the area lying between Wales and Ireland are very small, so that no sections are necessary here.

The charts were constructed by plotting the mean values and then drawing isotherms and isohalines among them. When an isotherm or isohaline fell between two stations its position was calculated on the assumption that the value changed linearly, but this calculated position was not always used if it gave rise to sharp bends in the curve. This was particularly the case as regards the salinities; it often happened that stations with only two years' observations fell among others with three or more years results, and a strict adherence to the calculated values would have given a very complicated and improbable picture. The isohaline of 34·50 per thousand at its northern extremity, is on the whole the most doubtful for this reason.

As a rule, the chart isohalines have been drawn for 33·90, 34·00, 34·25, 34·50, 34·75, 35·00, and then for every 0·10 increase, but in special cases others have been used where they give a clearer idea of the distribution. The isotherms are drawn for every degree, often for every half degree.

Sections.

Owing to the varying depths found on different cruises the sections have not always the same bottom outline, but on the whole the difference is small.

The isotherms are drawn for every degree or half degree according to circumstances, but it has not been possible to use the same isohalines as on the charts. In all cases those have been drawn, which give the clearest idea of the position of the various water layers. On the sections the position of the mean stations are shown by short vertical lines with the number of the mean station above it. It should be remembered that the position of the mean stations (see page 4) is not exactly the same as that of the corresponding mean station for any given month, but for present purposes the difference is negligible.

The position of the stations is shown on the inset charts on the plates of sections.

The mean salinities and temperatures at the surface and bottom are given on the sections. It will be found that in a few cases there is a slight discrepancy between the charts and the sections as regards salinity. The latter show the actual calculated values depending perhaps on two years' work only; the former the more probable course of the various lines when everything is taken into consideration.

Lightship and Lighthouse Observations.

Reliable salinity observations are available from the Coningbeg Lightship from March 1909 to July 1912, and temperature observations from the beginning of 1904 to September

1912. The salinities were observed at half tide, about every seven days on the average, but there are many blanks.

Temperatures are also available from the Skulmartin and South Arklow Lightships and the lighthouse on the Fastnet Rock, for three years 1904, 1905, and 1906.

All the temperatures have been taken daily at half tide, but they vary very much in value. At the Fastnet, observations cannot be made in rough weather, and sometimes not even one is to be had during a ten-day period; and at no time were they taken more than once a day. At the other positions observations are possible in rough weather, but their value is somewhat diminished by a want of uniformity. In some cases only one observation has been made each day, but this has been the mean of several readings made within a few minutes of each other. At other times the temperature has been recorded twice a day, but in some cases only during the daylight hours, in others at all times during the twenty-four hours. All the records suffer from the fact that they have been taken at half tide, for we cannot be certain that this will give a true daily average. In the case of those from the Coningbeg Lightship the average values are founded on a larger number of years.

The chart showing the mean surface temperature for the whole year is founded on four months in each year only. In order to get some idea of how closely such a mean agrees with the true mean, the mean yearly temperatures at the Lightships and the Fastnet Rock have been calculated both from the mean values for each ten-day period throughout the year and from the first ten days of each of the cruise months. The results are shown below, and it will be seen that the differences are very small except in the case of the Fastnet Rock, where the weather has made the records very incomplete. It is not strictly permissible to argue from shore waters to the open sea, but still there is very good reason for supposing that the mean temperature charts are very close to the truth, especially in the case of that for the bottom, where the daily change is small or negligible.

YEARLY MEAN TEMPERATURES.

	Skulmartin.	South Arklow.	Coningbeg.	Fastnet.
Calculated from all observations . .	9·72°	10·53°	10·76°	10·56°
Calculated from the first ten-day periods of February, May, August, and November . . .	9·80°	10·60°	10·75°	10·83°
Difference . . .	+0·08°	+0·07°	—0·01°	+0·27°

The Defects of the Method of Mean Values.

It should be remembered that the use of mean values at times tends to hide important and regularly recurring phenomena. This is particularly the case where a sharp division into two layers always occurs at a given time, but at depths varying from year to year. The mean section and curve will not show a sharp division at one depth but a more gradual transition between the two layers.

The Tides of the Irish Channel.[1]

It will be shown in the sequel that the tides exert a great influence on the distribution of salinity and temperature in the Irish Channel and a short account of their chief features may be given here with advantage.

The tidal wave is a vertical undulation of the water and is to be distinguished from the *tidal stream* to which it gives rise when checked by decreasing depths or the conformation of the land. It approaches the south-west coast of Ireland from the Atlantic in an approximately north-easterly direction, so that its crest reaches Cape Clear and Ushant at about the same time. Off the former place it divides into two portions. The western half travels northwards along the west coast of Ireland, and following the line of the shore passes southwards through the North Channel to meet the other branch in the latitude of the Isle of Man. The easterly half moves in a north-easterly and northerly direction into the Bristol Channel and through the St. George's Channel into the Irish Sea; its height is everywhere greater at its eastern than at its western extremity, so that the spring rise is on the average eleven feet higher on the English and Welsh coasts than on those of Ireland.

The tidal stream is a horizontal movement of the water resulting from the checking of the velocity of the tidal wave by shallows or the form of the coast; consequently its strength will vary considerably from place to place according to the opposition offered to the wave, and the Irish Channel shows these variations extremely well. As has been said, the two branches of the tidal wave meet between Carlingford Lough and the Isle of Man, where the two resulting streams, flowing in opposite directions, neutralize one another, while the heights of the two waves are added together; accordingly the stream is here almost imperceptible, while the spring rise is from 16 feet to 20 feet. On the other hand off Arklow there is little resistance to the wave, and the spring rise is only four feet, though the speed of the stream reaches four knots or more.

The changes in the tidal stream are referred to the time of high water at the entrance to Liverpool Bay as a standard,

[1] The Irish Channel is the whole of the sea lying between Ireland and the opposite coast of Great Britain. The "southern entrance" to the Irish Channel is in this report that part of it which lies southwards of the latitude of the Tuskar.

though as it happens the time of high water at Dover is so nearly the same that it can be used for reference for most purposes, as is done in the charts of the tidal streams in the English and Irish Channels published by the Hydrographic Office.

At high water at Liverpool Bay there is slack water over nearly the whole of the North Channel and Irish Sea, though weak shore streams are perceptible. In the St. George's Channel the ebb has already begun to flow southwards, and in the Bristol Channel it is just ending; that is, the ebb of the Irish Sea coincides with the flood of the Bristol Channel.

As the water falls at Liverpool Bay it ebbs northwards through the North Channel and southwards through the St. George's Channel. The latter part divides into two branches; the easterly one flows round the south-west coast of Wales to form the flood tide of the northern half of the Bristol Channel, and at the same time the ebb of the English Channel turns to the north-east round Land's End and flows along the north coasts of Cornwall and Devon to become the flood tide of the southern half of the Bristol Channel. Shortly, the flood tide of the Bristol Channel coincides with and is in great part derived from the ebb tides of the English Channel on one side and the St. George's Channel on the other.

The western half of the ebb of the St. George's Channel flows south-westwards along the south-east coast of Ireland to join the stream which has already been running westwards past Cape Clear for three hours.

At three hours after high water at Liverpool Bay the tide begins to set to the north-east and east on the south-east coast of Ireland, but elsewhere the ebb continues unchanged until low water at Liverpool Bay, when again there is slack water over the whole area north of the latitude of the Tuskar, neglecting as before the weak coastal streams. In the Bristol Channel, and in its southern half in particular, the last of the flood is still running.

As the water rises at Liverpool Bay the ebb sets out of the Bristol Channel, south-westwards towards Land's End, and westward and north-westwards into the St. George's Channel, where the flood is now running. The flood in the latter tends to flow to the east of north, and northwards of the latitude of Anglesey it turns almost due east to Morecambe Bay. At the same time the flood tide in the North Channel which has been running since low water at Liverpool Bay, bends eastwards to the north of the Isle of Man to meet the southern flood in Morecambe Bay, where the united effect of the two streams causes a rise as great as twenty-eight feet at spring tides.

The Irish Channel contains two areas where the stream is almost imperceptible and where the power of the tide to cause vertical mixing of the water is almost *nil*. One of these, to the westward of the Isle of Man, has already been mentioned. The other lies off the entrance to the Bristol Channel. Its position changes slightly with the state of the tide, the centre

moving from about 51° N. Lat. and 6° W. Long. to a point not far from the opposite coast of Ireland. In both these areas we find a bottom consisting largely of mud which is able to deposit here owing to the small scour, and as will be shown, the relatively undisturbed state of the water is particularly favourable to the formation of horizontal layers of different salinities and temperatures.

On the other hand, in the area to the westward of Cardigan Bay the stream flows with great rapidity and the water is so thoroughly mixed that as a rule it is homogeneous from surface to bottom, as is the case in the region of strong tides in the eastern half of the English Channel.

Off the south-west coast of Ireland the tidal movement is fairly simple, the current setting backwards and forwards along the shore about six hours each way. Its strength is not great and owing to the configuration of the bottom there is no great tendency to vertical mixing. Consequently horizontal layers are well developed here at times.

Before proceeding to the detailed discussion of the varying conditions of the Irish Channel attention may be drawn to the chief causes of changes in the temperature and salinity, so far as they are of importance for the region in question. It will be seen that the fluctuations in salinity and temperature are to a certain degree dependent on one another so that it is impossible to draw a sharp line between them.

Insolation.—By far the most important source of heat for the surface both of the land and the sea is the sun. When the solar rays reach the earth's atmosphere a portion is totally reflected, and another portion is scattered and absorbed in the air: the remainder reaches the surface and is largely absorbed. There is however an important difference between the effect on dry land and on a water surface. The rays do not penetrate far into soil, and the heating effect is consequently confined to a layer of very small depth; as a result the rise of temperature is relatively great. The sea however allows the solar rays to penetrate to some distance, and a much larger volume of water will be warmed but to a far less degree. Of the heat which has been absorbed by the atmosphere a certain amount will be continually radiated to the earth at all times; but the much more important fraction of the whole heat supply, that derived directly from the penetration of the sun's rays, ceases as soon as the sun is below the horizon and is very largely reduced by cloud. There is therefore a daily and a yearly period in the amount of heat received from the sun. *Radiation of heat to space* occurs at all times, but is very much weakened by a cloudy sky. When as in the spring and summer the loss of heat by radiation is less than the gain from insolation the temperature of the surface rises; in the autumn and winter on the other hand the conditions are reversed and the temperature falls.

Admixture.—Changes of temperature also arise from admixture with warmer or colder water from another source. Thus

the warm current entering the southern Irish Channel between the Scilly Isles and Land's End close to the land causes a considerable rise of temperature locally, and the water often gets colder as one proceeds seawards from the north coast of Cornwall. Similar changes on a smaller scale occur where water, highly heated in bright summer weather or strongly cooled in winter, drains off shallow sandy flats.

Finally there is the rarer case where there are strong vertical currents which either bring to the surface the cold water of great depths or carry the warm surface waters downwards. No instance of the ascending movement of any importance seems to occur in the Irish area, but on the other hand there appears to be evidence for the existence of descending currents off the south-west of Ireland, due to the banking up against the land of the warm water carried shorewards by the prevailing drift from the south and west.

Changes of salinity are due either to the relative strength of evaporation and precipitation or to admixture with fresher or salter water. In the Irish Channel the prevailing phenomenon is a steady decrease of salinity as we travel away from the open Atlantic, a change which is obviously due to the addition of fresher water, partly derived from local precipitation, but chiefly from land drainage. The change is complicated and is best described in connection with the discussion of the charts.

The Mean Conditions in the Irish Area.

In the following pages are given some of the more important results of the Irish hydrographical observations. It will be noticed that the larger part of the area lying eastwards of the meridan of the Isle of Man has not been included. The conditions here do not resemble those in the western part of the Irish Sea, and have already been described by Dr. Bassett in various reports of the Liverpool Marine Biological Committee.

In the description of the conditions observed in the various months statements often occur, such as, that the mean temperature is highest in a certain month, as August, This is not to be taken as referring to every month in the year, but only to the cruise months, February, May, August, and November, unless the contrary is distinctly expressed, as in the discussion of the lightship observations.

The Mean Temperature of the Sea in the Irish Area.

On Plates IX, X and XV will be found sections and charts showing the mean temperature for the whole year. Taking first the surface chart, it will be seen that the mean temperature increases slowly as we move southwards from about 10° in the North Channel to 11° in St. George's Channel and to 12° off the northern coast of Cornwall and the south-west coast of

Ireland. In the waters lying between Ireland and Great Britain the higher temperature is found on the eastern side, while in the open ocean it increases seawards.

The bottom water shows another temperature distribution; it is everywhere colder than on the surface, but north of St. George's Channel (sections I to V) the difference is not great. In the broader southern part of the Irish Channel quite other conditions are found. The bottom temperature is highest near the Cornish coast and decreases seawards to an isolated area of less than 9° (see section VII, station 41), surrounded on all sides by warmer water. Off the south-west of Ireland the temperature rises slowly seawards from about 9·6° to over 10°, and then falls again to less than 9° as the depth rapidly increases. There is a marked division into layers of different temperature, and in the Irish Channel proper the isotherms dip towards the English side (see section VII). To the south-west of the Fastnet the isotherms dip seaward, in spite of slowly increasing depths, so that the inshore waters are slightly colder than those of the open sea (section VIII).

Section IX is drawn in a direction slightly south of west (true) out over the edge of the continental plateau, depths as great as 600 fathoms being found at the most westerly station. The isotherms of from above 12° to that of 10·5° are crowded together near the surface and follow a nearly horizontal course, dipping towards the open sea. The isotherm of 10·5° is found at a depth of about 80 to 100 fathoms except near the shore; below this the temperature changes very slowly, 10° degrees being reached at a depth of from 250 to 300 fathoms and 9° at nearly 500 fathoms. The bottom water at about 540 fathoms has a temperature of 8·7°; near the shore it is under 10°, and between the two regions lies a band of bottom water with a temperature of a little over 10°.

The Mean Salinity in the Irish Area.

The same plates show the mean salinity for the whole year. The *surface* salinity increases from north to south, and from the shore seawards, between the North Channel and the Tuskar, a condition which would be expected, as the chief source of low salinity is to be found in drainage from the land while the supply of salt oceanic water is at the southern end. The surface isohalines bend to north and east so that the highest salinity, like the highest temperature, is found on the eastern side, from Anglesey southwards. South of the Tuskar-Strumble Head line the conditions are more complicated. The salinity is higher on the Cornish coast than on the opposite coast of Ireland, and near the centre of the southern entrance of the Irish Channel the chart shows a large area, marked by a dotted line, of water of 34·93 per thousand. This is due to a cyclonic circulation of the surface water and will be referred to again. The isohaline of 34·93 per thousand is not drawn; it would of

course extend east and west from the dotted line. To the south-west of Ireland the surface salinity increases fairly rapidly seawards from 35·00 per thousand to 35·40 per thousand and then more slowly to 35·45 thousand cent.

The *bottom* salinities are higher than those at the surface in the North Channel and southwards as far as section III; from here to the Tuskar there is very little difference between surface and bottom, and over the whole area there is a tendency for the higher salinity to be found on the eastern side, excluding the shallows to the eastward of a line drawn north and south through the Isle of Man. In the southern entrance, division into layers again appears, with the higher salinities on the eastern side, but the difference between surface and bottom is nowhere much greater than 0·10 per thousand.

Off the south-west and west of Ireland the division into layers is strongly marked and the isohalines dip shorewards owing to the presence of layers of fresher water which reach the bottom near the coast but rapidly become thinner seawards. On the Tearaght line (section IX) the difference between surface and bottom nearly vanishes at a distance of about forty miles from the coast, the water having a salinity of about 35·45 per thousand, increasing to 35·50 per thousand at about 500 fathoms.

Mean Temperature and Salinity in February.

Plates I, II and XI.

At any one place there is relatively little difference between the surface and bottom temperature and salinity, on account of the thorough mixing caused by wave action and by the descending currents arising from surface cooling. The isotherms and isohalines therefore run nearly vertically except close to the shore and in the deep water off the south-west coast of Ireland (Plate XI.). The horizontal distributions of temperature and salinity at the *surface* resemble one another closely; that is, they both increase from north to south and from the shore seawards, the higher values being found slightly on the eastern side in the Irish Channel. The position of the *bottom* isohaline of 34·50 per thousand is somewhat uncertain on account of the small number of observations available at some of the stations; it is possible that its northern extremity should have been shown as an isolated patch of salt water surrounded on all sides by fresher water.

In the broad southern entrance the isohalines are worth a detailed study (that of 35·10 per thousand at the surface in particular) as they show signs of a cyclonic circulation which will be discussed more fully later.

Off the south-west coast of Ireland the conditions are very simple; it should be noted however that the isohaline of 35·60 per thousand is founded on one set of observations only.

The *surface* temperature is lower in February than at the time of the other three cruises, except in a small area in mid-channel, off Anglesey, where the coldest cruise month is May. The difference between the February and May surface temperature is often only a few tenths of a degree.

In shallow water the *bottom* temperature is lowest in February; in the deeper parts, from the North Channel to the St. George's Channel, the minimum falls in May. In the southern entrance the coldest water is also found in February except in deep central area of weak tides, and along the south and south-west coast of Ireland where the minimum is delayed till May.

The maximum surface salinity of the year falls in February in the area south of section I. and north of the line of stations 31 to 34. In the North Channel and in the southern entrance the maximum salinity occurs earlier in the winter, about the time of the November cruise. Where the surface maximum falls in February the bottom maximum generally falls in the same month or in May. A November maximum at the surface is generally accompanied by one on the bottom also.

Along the north coasts of Cornwall and Devon the conditions are more irregular, and even show in places a February minimum.

Mean Temperature and Salinity in May.

Plates III, IV and XII.

Compared with February, the *surface* temperature has risen everywhere except in the small area off Anglesey where a May minimum occurs.

The *bottom* temperature in May is less than that on the surface, and it is at its lowest value for the year over the whole of the deep water in the central line of the Irish Channel, except along the Cornish side.

In the southern entrance the surface and bottom isotherms differ considerably and the bottom chart shows a deep current of relatively warm water flowing northwards on the eastern side with colder water round it.

The *surface* salinity has fallen since February except at the two outer stations on the Fastnet line (section VIII). In some places it has already reached its minimum, as in the North Channel, off Anglesey, and in the southern part of the St. George's Channel.

The *bottom* salinity is also lower than in February on the whole, but there are a few stations to the west and south-west of the Isle of Man where it is at its maximum.

There are some striking differences between the charts for February and May; for instance, the 34·75 per thousand line has retreated on the surface, from near Bardsey Island to well south of the Tuskar-Strumble Head line, and the isohalines of

35·00 per thousand and 35·10 per thousand have been replaced by those of 34·90 and 35·00 per thousand respectively. The bottom changes are somewhat similar, but do not show so well, as the observations make the position of the 34·75 per thousand line uncertain.

The cyclonic circulation shows itself rather more strongly in the surface patch of low salinity in the centre of the southern entrance (section VII) and also, but not so well, in the form of the surface isohaline of 34·90 per thousand.

There is now a distinct division into layers of different salinity and temperature, and in the Irish Channel the higher salinities tend to occur on the eastern side; this arrangement is probably due to the earth's rotation, which causes currents to bend to the right in the northern hemisphere.

Off the south coast of Ireland (section VIII) the lower salinities near shore are found below the surface instead of at it, as if the prevailing south-westerly winds had caused a strong surface drift towards the shore; this explanation seems the most probable one, but the conditions may be due in part to a current along the shore.

Section IX shows the fresher shore water stretching seawards as far as station 65.

Mean Temperature and Salinity in August.

Plates V, VI and XIII.

August is pre-eminently the month of high temperatures and low salinities.

The *surface* temperature is higher than at the time of the other quarterly cruises, the increase since May being in many cases considerable; thus the 8° line of May has been replaced by that of 13° or more, the 9° line by the 14° line, and in the southern entrance where the water had a temperature of a little over 10° it is now 15° or 16°. Off the south-west coast of Ireland, where the conditions are nearly oceanic, the rise is not so great.

The surface chart shows two distinct types of temperature distribution. In the narrower region, northwards of the Tuskar-Strumble Head line, the warmest water is found on the coastal shallows; southwards of this line the oceanic type begins to manifest itself, and the temperature increases seawards owing to the drift of warm water from the south-west. The course of the 14° isotherm shows the transition from one type to the other very distinctly.

On the *bottom* the isotherms are crowded together and large temperature differences are encountered in a small horizontal distance as a result of changing depths. The shallower water is being warmed more quickly by the sun's rays than the deep central tract, and so we find such phenomena as the isolated cold bottom area south-westwards of the Isle of Man.

In the southern area the warm current on the Cornish coast and the cyclonic circulation show themselves in the course of the bottom isotherms, which run northwards on the eastern side and then turn westwards towards the Irish coast.

In the deepest part of the southern area, where section VI crosses it, the temperature is as low as 8·5°. This cold layer is probably of very small extent and has no connection with the deeper water of the same temperature to the southwards, as the Plymouth observations have shown.

The sections show isotherms which are generally horizontal, or, in the Irish Channel, dip eastwards. In many places, as for instance on section VII or at the shoreward end of section IX the upper ten or twenty fathoms are fairly uniform in temperature; below them comes a layer in which the temperature decreases very rapidly, and below this again a layer in which the temperature falls slowly to the bottom. At station 43 (E 30) the change is 2° between 20 metres and 30 metres (11 fathoms and 16 fathoms), and 2·9° between 30 metres and 40 metres (16 fathoms and 22 fathoms). These are mean values; in a single series of observations the fall may be much greater; at the same station in August 1909 it was 4·5°, from 30 metres to 40 metres, a drop of 0·45° per metre or 0·8° per fathom.

This discontinuity layer (*sprungschict*) is more strongly developed than appears on the sections, as it has often been necessary to omit alternate isotherms in order to prevent them becoming illegible.

The *surface* salinity is lower than during the other three cruises except in the North Channel, the southern part of St. George's Channel, and at two stations off the Cornish coast.

The lowest *bottom* salinity generally occurs in August; when it falls in November it is in regions where the August fresh surface water can mix downwards only slowly. In the northern part of the Irish Channel the surface and bottom salinity charts are fairly similar, but in the region southwards of the 34·50 per thousand isohaline the difference is well marked.

The saltest surface water enters off the west of Cornwall at a distance of only five or six miles from the shore, and flows northwards with continually falling salinity as a result of admixture with the surrounding fresher water. The 34·90 per thousand isohaline is divided into two parts one of which runs in a northeast-southwest direction on the western edge of the current, while the other encloses a surface area of over 34·90 per thousand off Strumble Head. The 34·75 per thousand line shows a peculiar loop towards the south-west, and the course of the 34·65 per thousand line, projecting south-eastwards from the Irish coast, is even more striking.

On the bottom the salt current follows a much more direct course, flowing northwards into the St. George's Channel with no backward bends.

The peculiar shape of the isohalines at the surface can be explained as follows. The salt surface current flows northwards

till off Lundy Island, where it meets the outflow from the Bristol Channel and undergoes considerable dilution, the salinity falling to less than 34·90. It now divides into two parts. One flows northwards into the St. George's Channel and as it enters the region of strong tidal action its salinity is raised by admixture with the salter bottom water, and the surface isohaline of 34·90 per thousand appears again on the chart. The other branch is turned, by the narrowing of the Channel, first westwards, then southwestwards, and finally southeastwards as shown by the course of the 34·65 per thousand isohaline. Its salinity falls continually as it leaves the neighbourhood of the Bristol Channel, so the remarkably low values on station 43 in the tidal slack cannot be due to the fresh water from the latter source, but must be attributed to shore water from the south-east coast of Ireland. That the low salinity of the central area is not due to a direct current in a south-westerly direction from the Bristol Channel is shown by the English surface observations taken every ten miles between the fixed stations. Unless we assume that the fresh surface water has managed in some way to dive beneath the continuous salt surface water between the English stations, it is certain that the waters of the Bristol Channel are separated by a vertical wall of salter water from the low salinities at the centre of this cyclonic eddy.

The shore water is distinctly shown on the south-west coast of Ireland, where the 35·30 per thousand line has taken the place of the 35·50 per thousand line shown on the February surface chart.

The isohalines, like the isotherms, are largely horizontal, and in places there is a well developed discontinuity layer in in the salinity as well as in the temperature (see section VI, station 41; section VII does not show it so distinctly as some of the isohalines have been omitted for the sake of clearness).

The low surface salinities and high surface temperatures unite in preserving a sharply marked surface layer, as each gives rise to a stratum of low density which only mixes with difficulty with the heavier water beneath.

Mean Temperature and Salinity in November.

Plates VII, VIII and XIV.

As will be seen from the charts, the mean surface temperature in November is not very much lower than in August in the region north of the Tuskar-Strumble Head line; southwards of this the fall is greater. The reason is probably this: in the first place the maximum surface temperature falls later than the August cruise, which generally takes place during the first half of the month; secondly, northwards of the Tuskar the tidal mixing is much greater than in the southern entrance, and the waters in the latter region are relatively superheated but

only to a very moderate depth. For instance, at station 23 the mean surface temperature in August is 13° and the mean bottom temperature in 60 fathoms is only 0·2° less. On the other hand, the depth of the highly heated surface layer south of the Tuskar-Strumble Head line is much smaller. The mean temperatures at station 40 are as follows: surface 15·2°, 20 fathoms 11·6°, bottom in 40 fathoms 10·7°; and at station 41, surface 15·7°, 10 fathoms 14·2°, 20 fathoms 9·6°, bottom in 62 fathoms 8·5°. At the northern station the layer of warm water extends to the bottom and is 60 fathoms thick; at the southern station its depth is not more than 10 or 20 fathoms. The shallow layer will lose its temperature much more quickly than the deeper one, and the cooling will appear to be much faster on the southern side of the Tuskar-Strumble Head line than on the northern.

As in August, the mean bottom temperatures in November are much more regularly distributed than those at the surface, and the isotherms are largely dependent on the depth.

From the North Channel to section IV the maximum *bottom* temperature for the four cruises is found in November, at a large number of stations, even when the depth is only 19 fathoms. From section IV to the Tuskar-Strumble Head line the maximum temperature falls in August as a result of the strong tidal mixing. Southwards and westwards where the tides are weaker the maximum occurs in November. This phase-delay takes place at varying depths. At stations 1 and 2 the maximum occurs in November even at the surface; between here and the Fastnet line of stations (section VIII) the November maximum is found at 20 fathoms and deeper; on the Fastnet and Tearaght (section IX) lines at 30 fathoms. It should be remembered that the Irish observations are made at every 10 fathoms, and the English at every 10 metres; the latter give 22 fathoms as the least depth at which the maximum is delayed to November.

The *surface* salinity chart shows a considerable rise since August, but the cyclonic circulation in the southern entrance is still strongly marked.

As in August the *bottom* isohalines follow a comparatively direct course. Northwards of section VII the division into horizontal layers is disappearing; in the southern entrance it is still fairly apparent, while on section VIII the shore water stretches seawards as an intermediate layer with salter water above and below it.

Surface Temperature and Salinity at Lightships.

Lightship observations suffer from the disadvantage of generally showing coastal conditions only; in some cases where the vessel is suitably placed, they may be very valuable, as at the Seven Stones and Cardigan Bay Lightships.

At the Skulmartin Lightship the three years' observations show a period of minimum mean temperature, 6·60°, occupying

the last ten days of February and the first two ten-day periods of March. The period of maximum temperature is in September, with mean values for the three ten-day periods of 13·12°, 13·04°, and 13·12°.

At the South Arklow Lightship again there are only three years' observations available. The minimum is during the first ten days of March, 6·72°, but the second ten days are almost as cold with a mean temperature of 6·75°. The maximum, 14·86°, falls in the first ten-day period of September.

The Coningbeg Lightship records extend over nine years. The lowest temperature for a ten-day period is 7·63°, for the first ten days of March; the second ten-day period, 7·66°, is almost as cold. The maximum temperature, 14·13°, occurs in the last ten day-period of August.

At the Fastnet Rock the rather incomplete records over a period of three years point to a minimum, 8·33°, in the second ten-day period of March, and a maximum of 13·53° in the first ten-day period of August.

Salinity observations, made on samples taken about once a week, are available for three years from the Coningbeg Lightship. They give a maximum of 34·77 per thousand in May, a minimum of 34·61 per thousand in July, another higher maximum of 34·80 per thousand in November followed by a sudden fall and a slow rise to the May maximum. Six years' salinity observations at the Cardigan Bay Lightship give maxima of 34·68 per thousand and 34·63 per thousand in November and January with 34·60 per thousand in December, and a June minimum of 34·12 per thousand. Observations at the Bahama Bank Lightship in the Irish Sea, 1904-1909, also give somewhat irregular results, but the maximum in November, 33·86 per thousand is fairly distinct, as is the April minimum of 33·53 per thousand. The temperature observations show that the February cruise gives average temperatures which are above the minimum, and the August cruise averages which are below the maximum. If we assume, as is generally true, that the quarterly observations are more nearly comparable with the first ten-day period of each month than with the second, we reach the conclusion that, in the coastal waters, the February averages are above the minimum by an amount ranging from 0·7° in the North Channel to 0·3° off the south coast of Ireland, and that the August averages are below the maximum by an amount ranging from 0·4° or 0·5° down to less than 0·1°. The observations however are not sufficiently numerous to allow of any certain deductions being drawn.

The yearly march of salinity at the Coningbeg Lightship is remarkable in that it gives a maximum in May as well as in November; at the other positions a winter maximum is the rule. This may be connected with a remarkable pulse of salt water below the surface which reaches the south-west coast of Ireland about May, which will be described in the following section.

On the General Circulation of the Water in the Irish Area.

A complete account of the circulation in the Irish area would require a more detailed knowledge of the changes in the surface drift in the open ocean to the south and west of Ireland than we yet possess. At present the only information available for every month in the year is derived from the analysis of surface samples collected continuously for several years on liners sailing between the English Channel and New York. These samples were taken for the Marine Biological Association in connection with the International Fishery Investigations and analysed by the present writer. The mean salinities have been calculated for every month and plotted on charts, and at the same time curves have been drawn for certain selected areas where the observations are sufficiently numerous. One of these areas lies in 50° N. Lat. between 11° W. Long. and 20° W. Long. and has a breadth of about ten miles in a north and south direction. It is therefore in the path of the surface drift current which flows approximately northwards to the west of Ireland. The curve shows a maximum of about 35·59 per thousand in February, falling regularly to 35·54 per thousand in May, rising again slightly in June, falling in July to about 35·50 per thousand, which value remains almost unaltered to September, and reaching a sharp minimum in October with 35·43 per thousand. After this there is a sudden rise to a secondary maximum towards the end of November, a slight fall in December and January, and then again the maximum in February. Shortly, there is a well defined and sharp minimum in October, and immediately following this a rise to a high and somewhat long drawn out maximum beginning in November and culminating in February. The Plymouth observations across the entrance to the English Channel show very similar results. The maximum is in January and February, and the minimum in the late summer, though it is somewhat irregular.

The charts published in this report show that the saltest water enters the Irish area between Land's End and the Scilly Islands, and detailed observations made along this line on several cruises at intervals of from half a mile to one mile on the Marine Biological Association's steamers have shown that the axis of highest salinity lies midway between the Longships Rock and the Seven Stones Lightship, that is, at a distance of only a few miles off Land's End. This current of salt warm water is derived from a current which has already entered the English Channel from a south-westerly direction, and has in part turned northwards and north-westwards to escape into the Irish Channel. It is practically certain that this water has come from the mouth of the English Channel and not directly from the open sea because further westwards a great area of lower surface salinity stretches southwards across the fairway

and prevents any such direct current. This fresh area is really the diluted remnant of this same salt warm current, so that a portion of the water here circulates in a closed curve. Gehrke[1] has shown on theoretical grounds that more water enters the English Channel from the westward than escapes through the Straits of Dover, after allowance has been made for the addition of fresh water from the land, and that a portion must therefore turn back and escape in a north-westerly direction.

This salt warm current gives rise to the peculiar cyclonic circulation which takes place in the southern entrance of the Irish Channel and which leads to some rather unusual physical conditions, such for instance as the fact that as we travel seawards from the north-west Cornish coast the salinity begins to fall at a comparatively short distance from the shore and may reach its lowest value in midchannel. The proof of this circulation depends on the combined Irish and Plymouth observations, and as it happens the stations have been so placed that the isohalines may be drawn in two ways. The inset charts on the section plates show a small area of triangular shape immediately south of section V in which there are no stations, and it is this lack of stations which give rise to the uncertainty. One way of drawing the isohalines, which would fit the mean results perfectly, has not been followed as it would necessitate the assumption of a strong current of low salinity flowing from St. George's Channel to far south of 50° N. Lat. Such a current would be inherently improbable, and there is no reason to suppose that it exists when there is a much simpler explanation to hand. This explanation is to be found in the cyclonic or counter-clockwise circulation which has already been described in detail in the discussion of the mean conditions for August. It is more extensive than the charts show, and the Plymouth observations have proved that it reaches at times as far south as 48½° N. Lat. Its cause is to be found in great measure in the configuration of the coast, which forces the stream to turn to the left of its direction ; but at the same time it would be always striving to turn to the right under the influence of the earth's rotation. While in the narrow waters it would not be able to do so to any extent, but once clear of the south coast of Ireland on the western edge of the circulation it might be expected that part at least should turn to the right. At times indeed this seems to occur ; a branch is thrown off westwards which is able to travel as far as the Fastnet before it is turned to the left and southwards by the west wind drift of the ocean. The first hint of such a cyclonic circulation is to be found, as far as the writer knows, in a suggestion by

[1] J. Gehrke : The mean velocity of the Atlantic currents running north of Scotland and through the English Channel. "*Pub. de Circonstance*," of the International Council for the Exploration of the Sea, No. 50 Copenhagen.

Nielsen[1] that there is an anticyclonic circulation round the south coast of Ireland, and later Gough,[2] in his discussion of the plankton collected by the Marine Biological Association, came to a somewhat similar conclusion.

This circulation may prove to be of considerable biological importance. The water off the south-east coast of Ireland, and in the southern edge of the cyclonic circulation off the fairway to the English Channel, has travelled a long distance since it last left the open ocean, and if, as seems probable, there is any difference, other than temperature and salinity, between oceanic and shore waters, then this water might be poorer in the minute constituents of oceanic water and richer in those of coastal water than would be expected on the ground of its distance from the open sea ; and if the strength of the cyclonic movement varies from year to year, so will the character of the water at any place within its influence, such as the areas of the drift net fishing off the mouth of the English Channel and off the south coast of Ireland.

That portion of the warm salt current which has escaped the cyclonic circulation, including the larger portion of the bottom water, flows northwards through the Irish Channel, bending a little to the right under the influence of the earth's rotation, and finally escapes through the North Channel in a much diluted condition.

Since the maximum salinity in the English Channel occurs in January and February, and the Irish Channel derives its saltest water from this source, it might be expected that the Irish waters would follow the same law. As has been shown, this is largely the case, but there are some important exceptions. Off the Cornish coast there is one period of maximum salinity in the year, about February, and off the south-east coast of Ireland we again find one maximum, but in November ; finally, at some of the stations off the south and southwest of Ireland there are two maxima in the year, one in August and another in May. This would point to two pulses of high salinity water, and it is not unlikely that two such pulses do exist. The winter maximum salinity is a well known phenomenon at the entrance to the English Channel, and is sufficient to account for the February maximum off the Cornish coast. For another pulse of high salinity water we must look elsewhere, and on the surface there is no distinct sign of it. At one of the newer Irish stations however, 62, which has only been worked in the last two years (1911–1912), an intermediate layer of high

[1] J. N. Nielsen : Contribution to the Hydrography of the North-eastern part of the Atlantic Ocean. *Meddelelser fra Kommissionen for Havundersögelser*: *Hydrografi I*, No. 9. Copenhagen 1907.

[2] L. H. Gough : On the distribution and the migrations of *Muggiaea atlantica* ; *Pub. de Circ.*, No. 29.

salinity has been found on each occasion in May.[1] The depth at which this layer occurs varies, from 50 to 120 fathoms, and in the first year it was so thin that it was shown by one observation only. The salinities were very high, as much as 35·71 per thousand, which precludes the possibility of the samples having been interchanged, for no such water has been found elsewhere in the Irish area. The other possibility, that the high salinities are due to leaky bottles, which allowed evaporation, is very improbable, as the rubber washers appeared perfectly sound, and it would be an extraordinary coincidence that such bottles should have been used in the same month and at the same station in each case. Traces of such an intermediate layer, much weakened, have been found in August also. It seems fairly certain therefore that such a pulse of high salinity has occurred in May on two occasions and may be a regular phenomenon. It would be sufficient to account for the double maximum already mentioned as taking place at some of the Irish stations, but its cause is still obscure. The Plymouth observations have shown that on the steamship route between Cape St. Vincent and Gibraltar there is a very well marked period in the surface salinity, with a maximum of 36·49 per thousand in September and a minimum of 35·15 per thousand in March. It is not impossible that this is connected in some way with the salt intermediate layer which flows out of the Mediterranean into the Atlantic, and that this layer too is subject to periodical fluctuations. The influence of this intermediate layer has been traced far to the northwards of the Straits, and it may be the source of the May maximum off the south-west of Ireland.

Dr. Bassett has published a paper in which he throws doubt on some of the conclusions arrived at by the writer in earlier papers on the English Channel. The most important point is the direction of the current through the Irish Channel. The present writer suggested that the low salinity surface water off the fairway to the English Channel was due to a southerly flow from the direction of the Irish Sea ; Dr. Bassett in his paper pointed out that the direction of the main flow is from south to north, as is certainly the case, but it was not suggested by the present writer that anything more than a local eddy existed. Dr. Bassett's suggestion that the source of this fresh water is to be found in the Bristol Channel has already been dealt with in the present paper, and seems to have been due to his having overlooked the observations published in the Quarterly Bulletins of the International Council.

Dr. Bassett has also published charts showing that the highest salinities enter the southern entrance in the middle line, and that the current bends to the right and finally escapes south-

[1] Since the above was written the observations for May, 1913, have been worked up. They show that in this year the intermediate layer did not reach such high salinities, but that it covered a much larger area, and was found nearer the surface.

wards between the Scilly Islands and Land's End. He appears to have founded this chart on a few observations made by officers of liners, and to have disregarded in their favour all the observations made by trained observers and in far greater number on special research steamers. It is quite possible that he only plotted such observations as concerned the area in question and neglected the thousands of others taken all over the Atlantic. If he had plotted these also he would have seen that for various reasons they are affected by many sources of inaccuracy, and that in these latitudes they are as a rule too high.

He has in the same way expressed some doubt as to the accuracy of the present writer's chart of surface salinity for August 1905 in this region. In his own chart he has shown water of over 36·00 per thousand in the southern Irish Channel. The liner observations went to show that such water was present, but on the other hand the Plymouth observations failed to find it and having regard to the tendency for salinities from liners to be too high, it seemed better to draw the isohaline of 36·00 per thousand in a generalized form off the fairway to the English Channel in order to direct attention to the undoubted existence of abnormally high salinities here without showing them in regions where they were only doubtfully present as isolated patches, if at all. Dr. Bassett appears in this case to have overlooked the explanation which the writer gave of the way in which the chart had been drawn up.

On the Annual Temperature Change in Deep Water.

Brennecke[1] has discussed the depth at which the annual change of temperature is no longer perceptible, and concludes from a consideration of four sets of observations made in the Bay of Biscay at different times of the year by the *Planet*, *Thor* and *Princesse-Alice* that this lies at about 150 metres (82 fathoms). The older observations of Aimé were made off Algiers in the Mediterranean, a nearly enclosed sea, and are not therefore strictly comparable with those made in the open Atlantic off the south-west coast of Ireland; he found a maximum range of 1° at 200 metres (109 fathoms) and of 0·0° at 350 metres (191 fathoms).

In 1909 the *Huxley*, of the Marine Biological Association, made four sets of observations in February, May, August, and November at a station in 47° 47′ N., 7° 52′ W., on the northern edge of the deep water in the Bay of Biscay. The temperatures recorded are open to a certain amount of doubt as they were made with a single reversing thermometer (Richter). The greatest depth from which comparable observations are available is 400 metres (218 fathoms); the results were as follows,

[1] Forschungsreise S.M.S. *Planet* 1906–1907. Band III., Dr. W. Brennecke, Ozeanographie; Reichs-Marine-Amt.

beginning with February, 10·64°, 10·50°, 11·16°, and 10·77°. This shows a maximum in August, while the more certain observations made with the Nansen-Petterson insulating water-bottle point to a November maximum from 70 metres to 200 metres (38 fathoms to 109 fathoms). The lowest and highest values at the latter depth were May 10·62°, November 11·18°. The *Huxley* observations do not therefore prove that the annual change reaches a greater depth than a little over 100 fathoms.

A larger number of observations are available from the deep water off the south-west coast of Ireland. The outermost of the Irish stations, No. 68 in about 51° 50′ N., 12° 14′ W., has been worked three times in February and November, five times in August, and six times in May. It is somewhat difficult to arrive at an accurate mean value for the various depths as it has not always been possible to fix the position with sufficient accuracy, and the shape of the bottom, which here slopes quickly seaward, causes the various water strata to tilt up the sides of the submarine valley over which the station lies. In the following table are given a few of the mean values which were calculated without comparing one month with another so that they are at any rate free from bias.

F.	M.	February.	May.	August.	November.	Mean.
0	0	10·41	11·83	16·36	12·39	12·75
20	37	10·37	11·09	14·06	12·38	11·97
30	55	10·35	10·65	12·19	12·34	11·38
50	91	10·31	10·49	10·79	11·80	10·85
250	457	10·21	10·10	10·09	10·23	10·16
350	640	9·95	9·77	9·73	9·93	9·84
		8·54	8·61	8·79	8·84	8·69
Near Bottom		543F. 993M.	531F. 971M.	530F. 969M.	533F. 975M.	534F. 977M.

The actual depths for which the bottom temperatures have been calculated are given in the two last lines.

Down to 20 fathoms the maximum temperatures occurs in August, from 30 fathoms to 250 fathoms in November, and in about 535 fathoms again in November. The mean range at 50 fathoms is 1·49°, at 100 fathoms 0·52°, at 150 fathoms 0·27°, at 250 fathoms 0·14°, at 350 fathoms 0·20°, and near the bottom 0·30°. The results are somewhat surprising, as they show that the range decreases down to about 250 fathoms and then increases again. Though instrumental errors must certainly be present, yet the changes are too regular to be due to this cause alone, and it seems probable that the explanation is to be found in two widely separated phenomenon. As the depth increases the date of the maximum temperature is progressively delayed,

and at 30 fathoms it falls nearer to the November than to the August cruise. The yearly change is clearly shown at 150 fathoms, with a range of 0·27°, but below this it becomes uncertain, the range falling to 0·14° at 250 fathoms (457 metres). Below this the range increases, and this can hardly be due to any local change arising at the surface. The range of 0·30° near the bottom, with a maximum in August, is almost certainly to be attributed to horizontal currents which have received their varying temperatures near the surface at some distance, possibly hundreds of miles away.

EXPLANATION OF PLATES.

PLATE	I.—Mean surface temperature and salinity . . .	February.
,,	II.—Mean bottom temperature and salinity . . .	February.
,,	III.—Mean surface temperature and salinity . . .	May.
,,	IV.—Mean bottom temperature and salinity . . .	May.
,,	V.—Mean surface temperature and salinity . . .	August.
,,	VI.—Mean bottom temperature and salinity . . .	August.
,,	VII.—Mean surface temperature and salinity . . .	November.
,,	VIII.—Mean bottom temperature and salinity . . .	November.
,,	IX.—Mean surface temperature and salinity . . .	Whole Year.
,,	X.—Mean bottom temperature and salinity . . .	Whole Year.
,,	XI.—Sections showing mean salinity and temperature . .	February.
,,	XII.—Sections showing mean salinity and temperature . .	May.
,,	XIII.—Sections showing mean salinity and temperature . .	August.
,,	XIV.—Sections showing mean salinity and temperature . .	November.
,,	XV.—Sections showing mean salinity and temperature . .	Whole Year.

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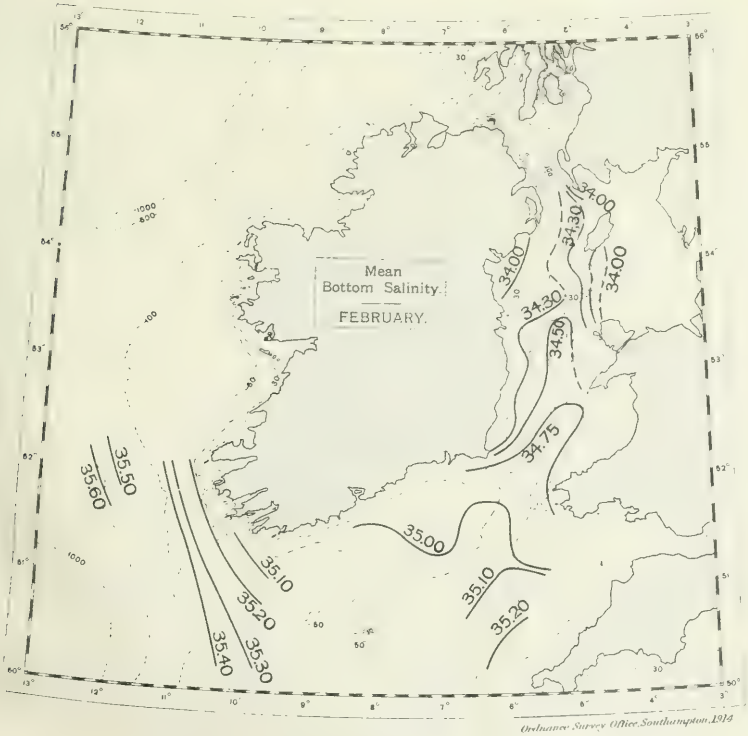
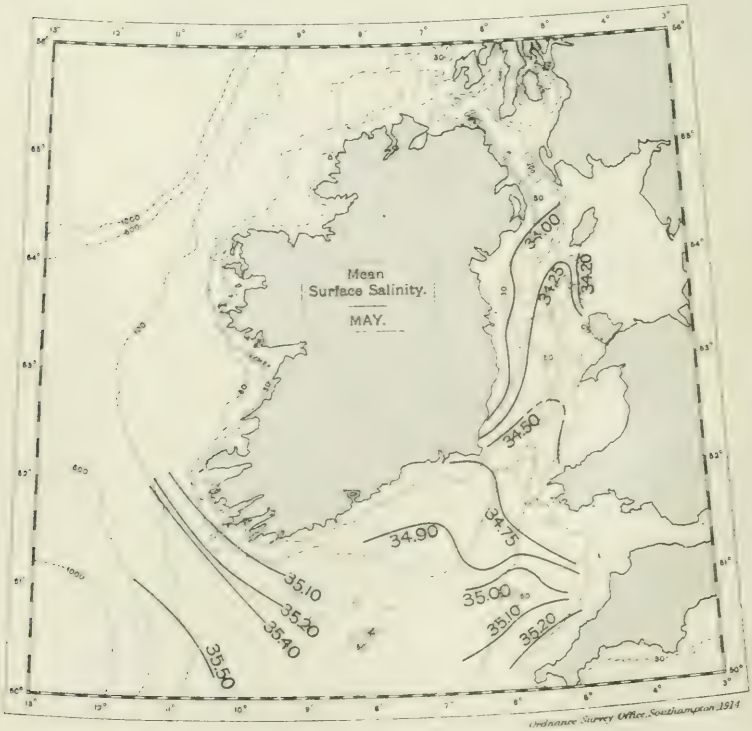
Ordnance Survey Office Southampton 1911.



Ordnance Survey Office Southampton 1914



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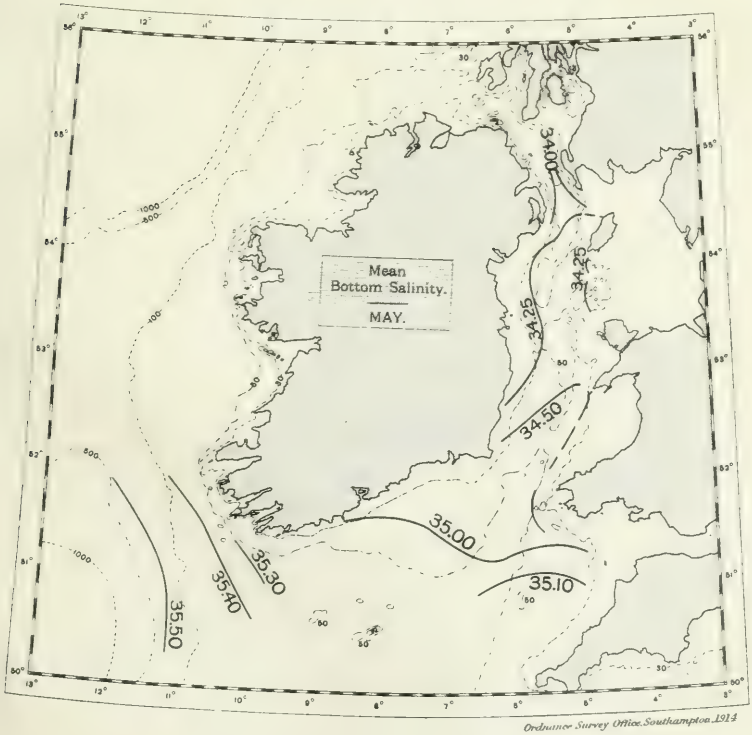

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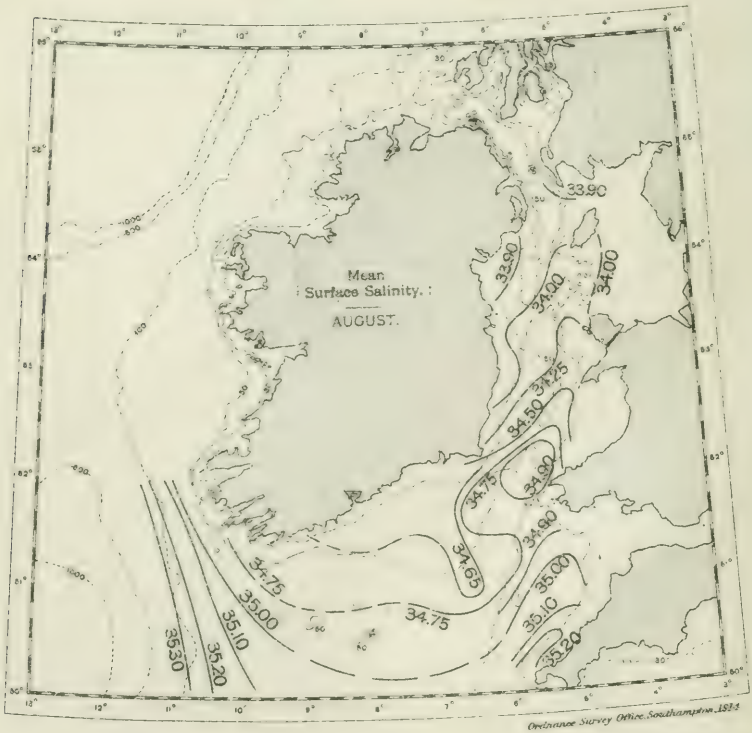

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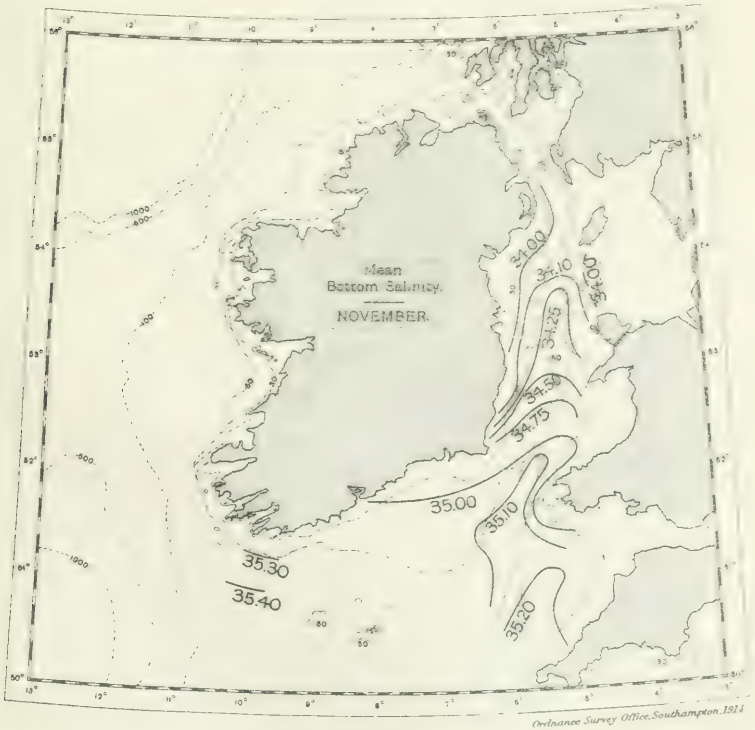
Ordnance Survey Office, Southampton 1911.



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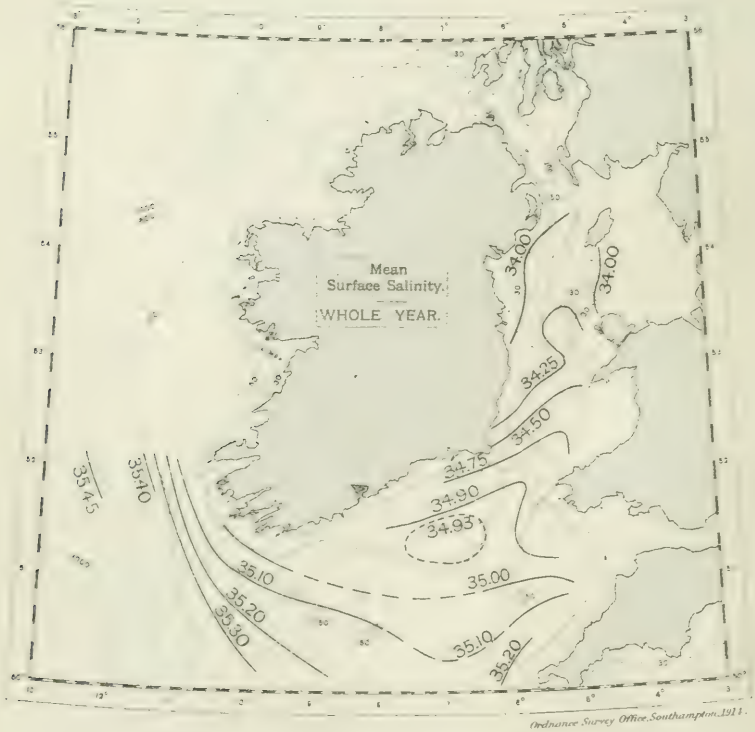

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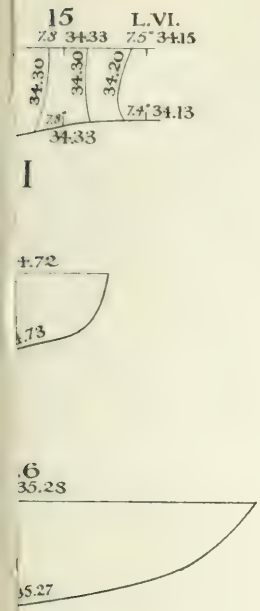
Ordnance Survey Office, Southampton, Eng.



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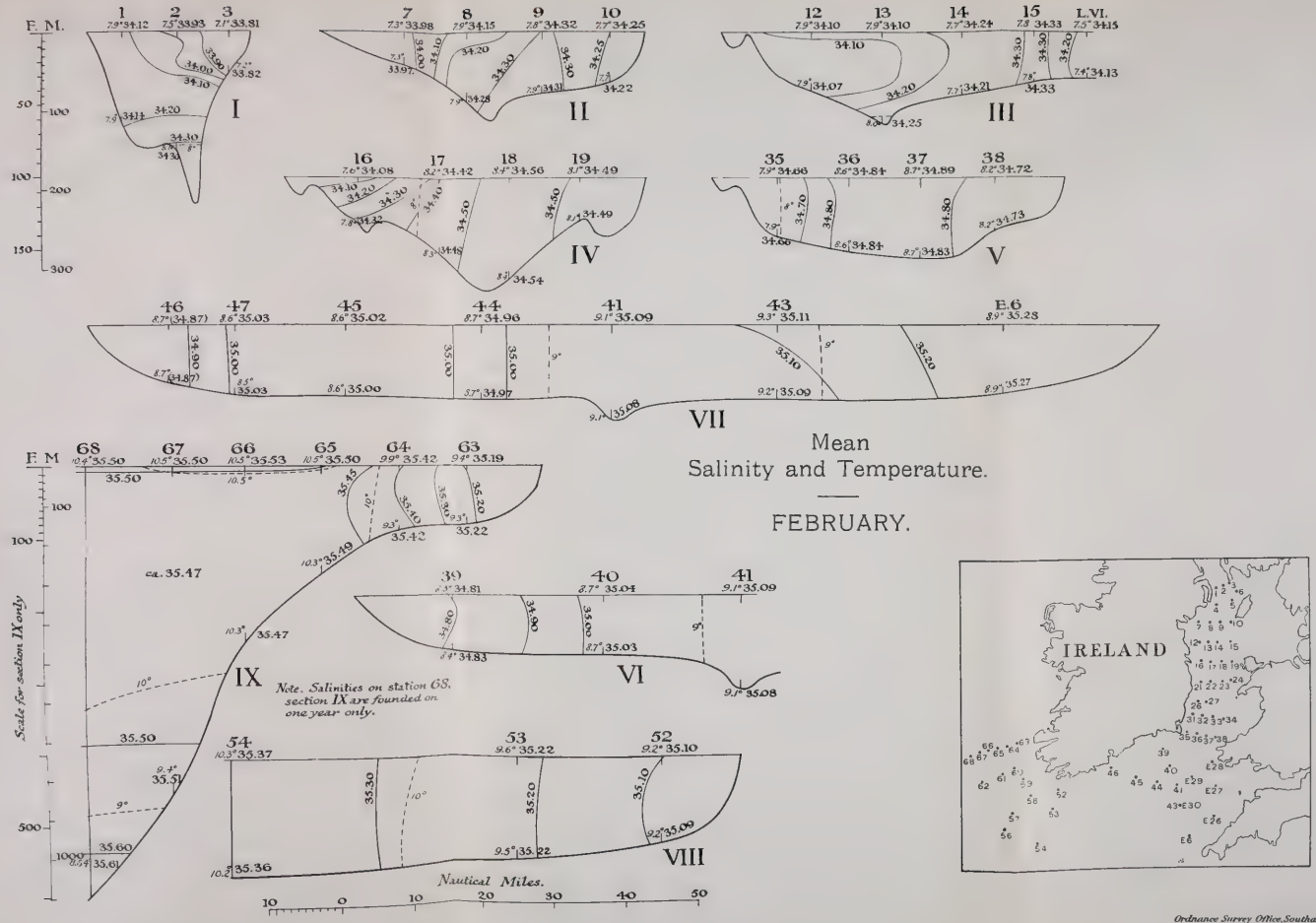
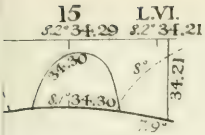
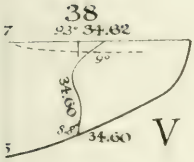
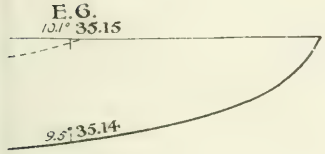

Mean
Salinity and Temperature.
FEBRUARY.
I
II
III
IV
V
VI
VII
VIII
IX
IRELAND
Note. Salinities on station 68, section IX are founded on one year only.
Scale for section IX only
Nautical Miles.
Ordnance Survey Office, Southampton, 1914.







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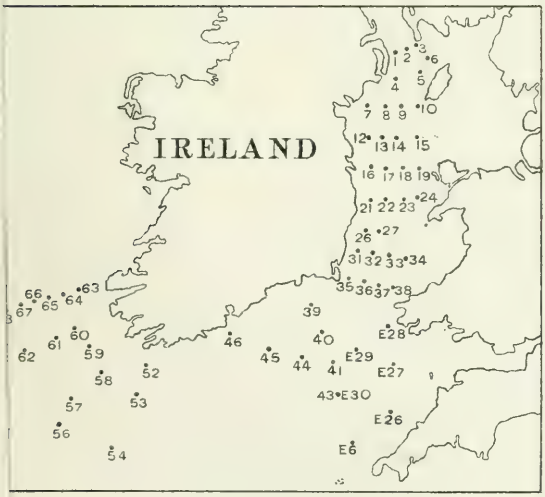

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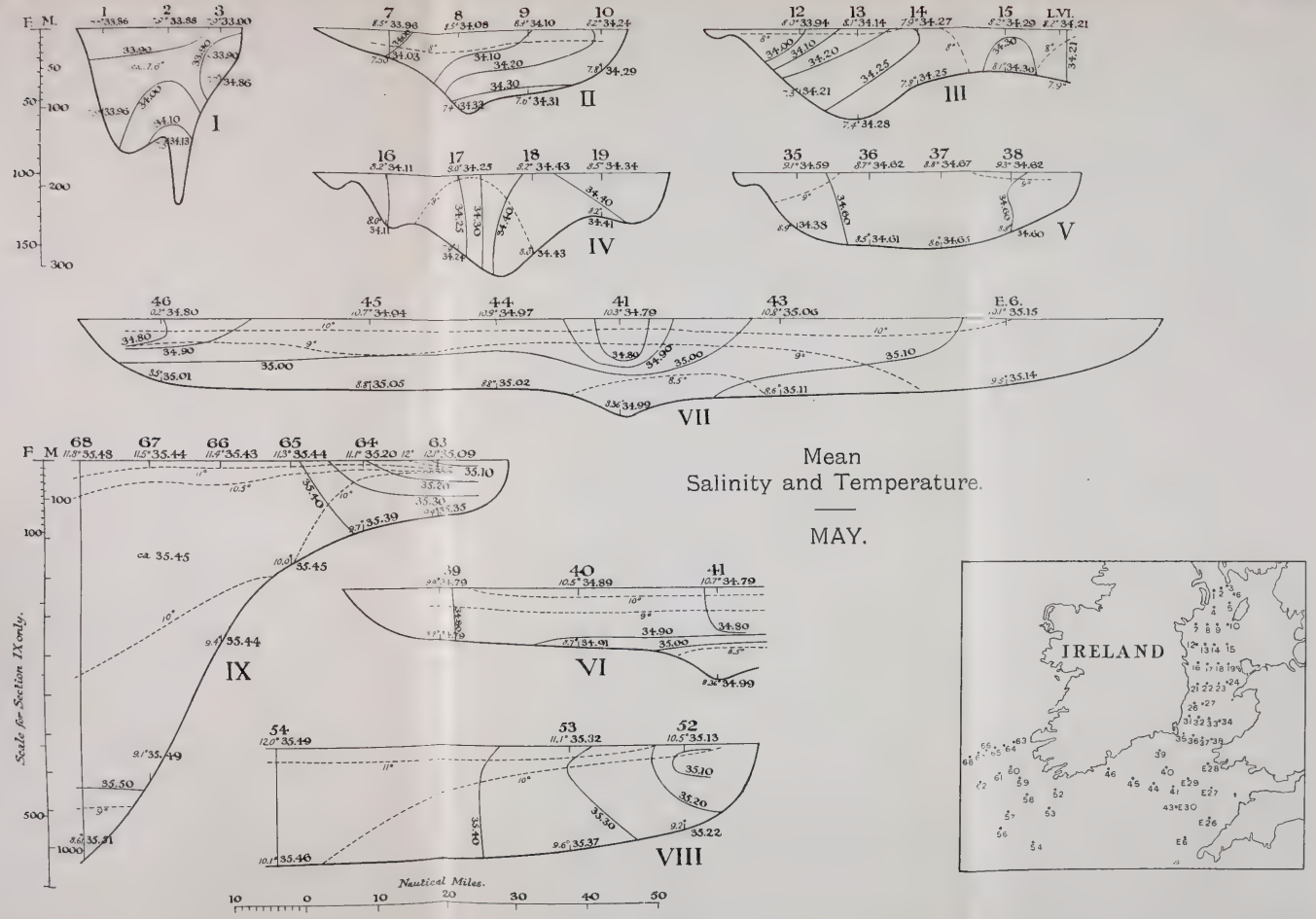

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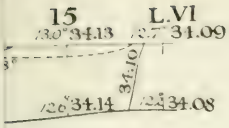

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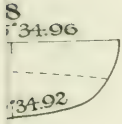

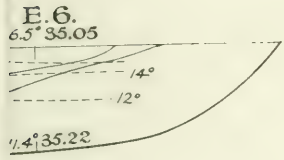

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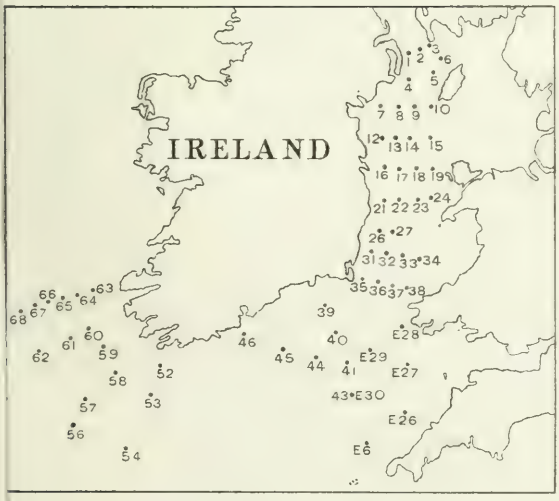

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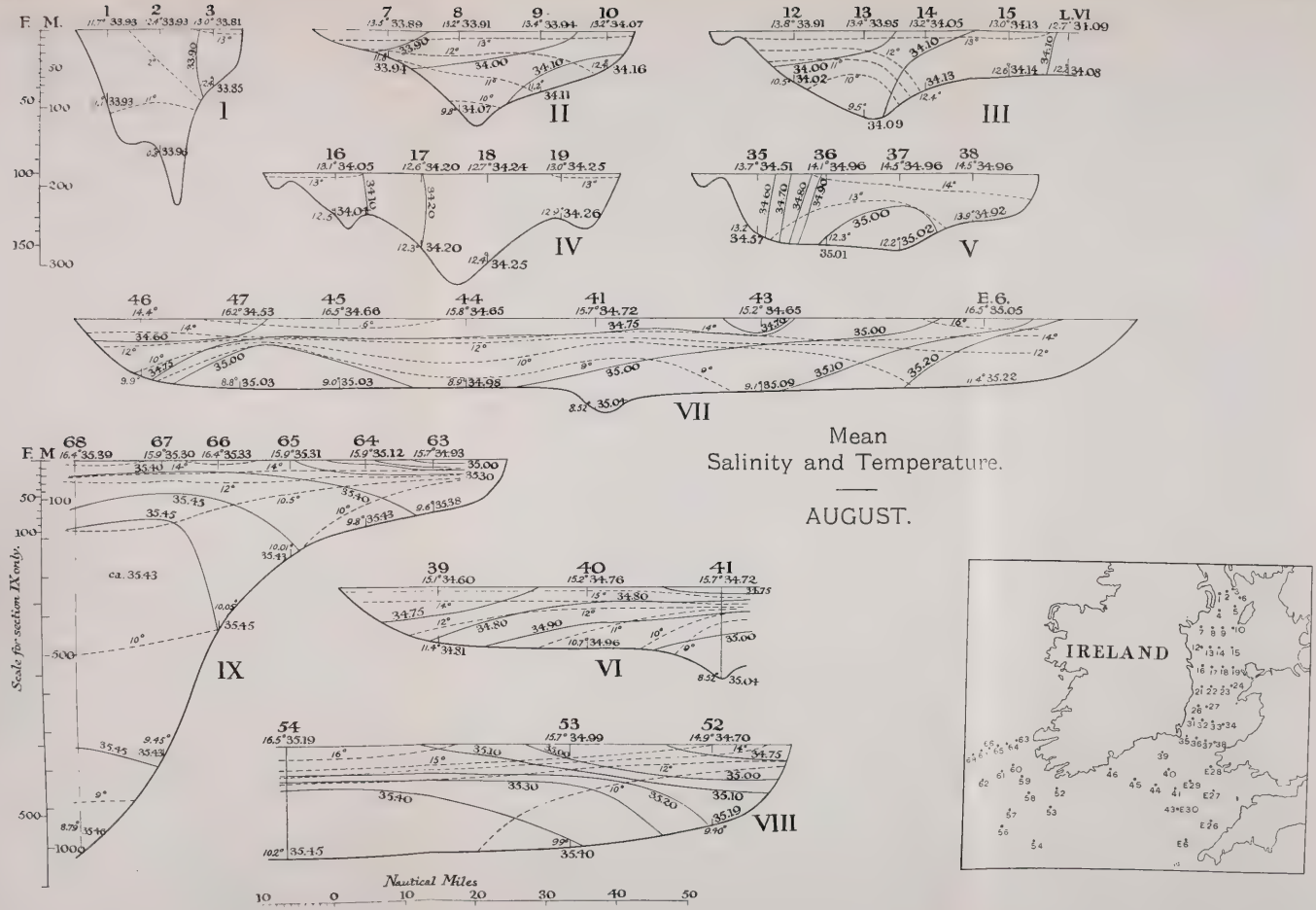
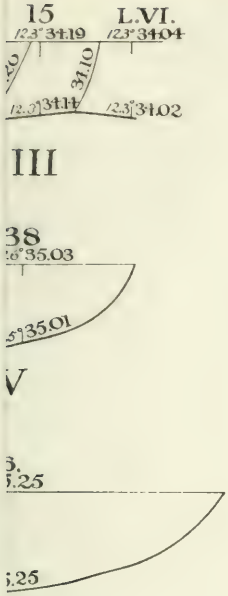


Mean
Salinity and Temperature.

AUGUST.

Ordnance Survey Office, Southampton 1914



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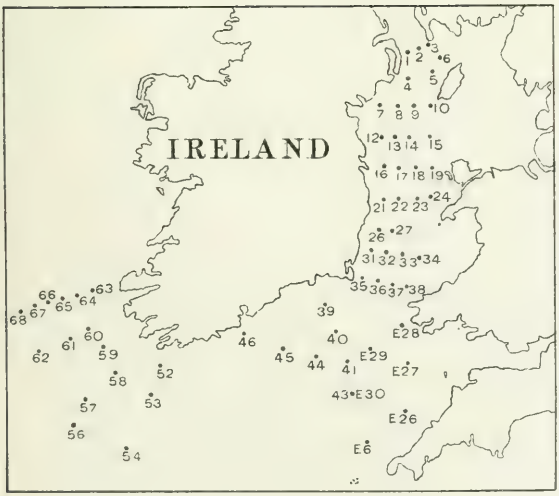

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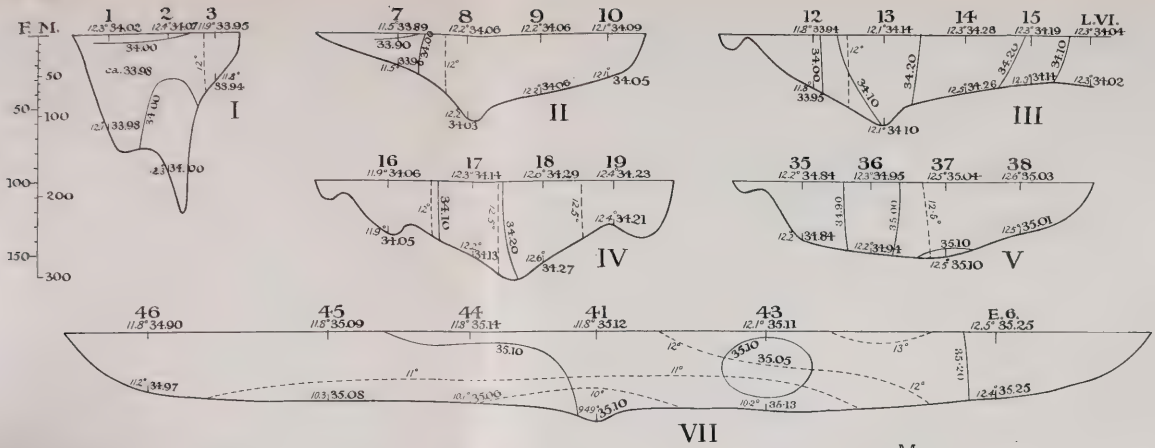
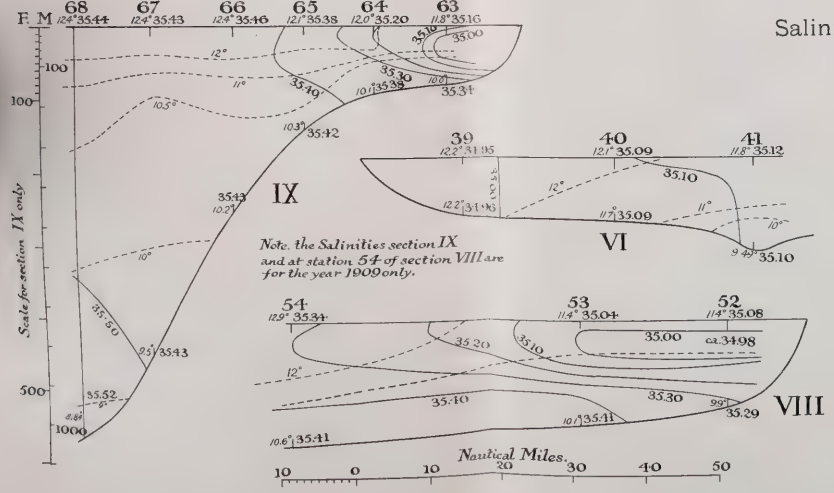


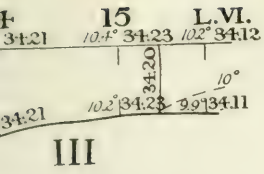
Mean
Salinity and Temperature.

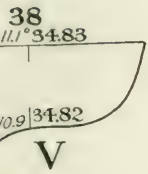
NOVEMBER.

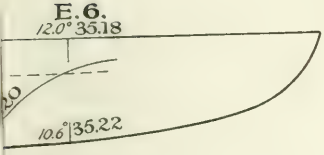


Note. the Salinities section IX and at station 54 of section VIII are for the year 1909 only.

Ordnance Survey Office, Southampton, 1914.







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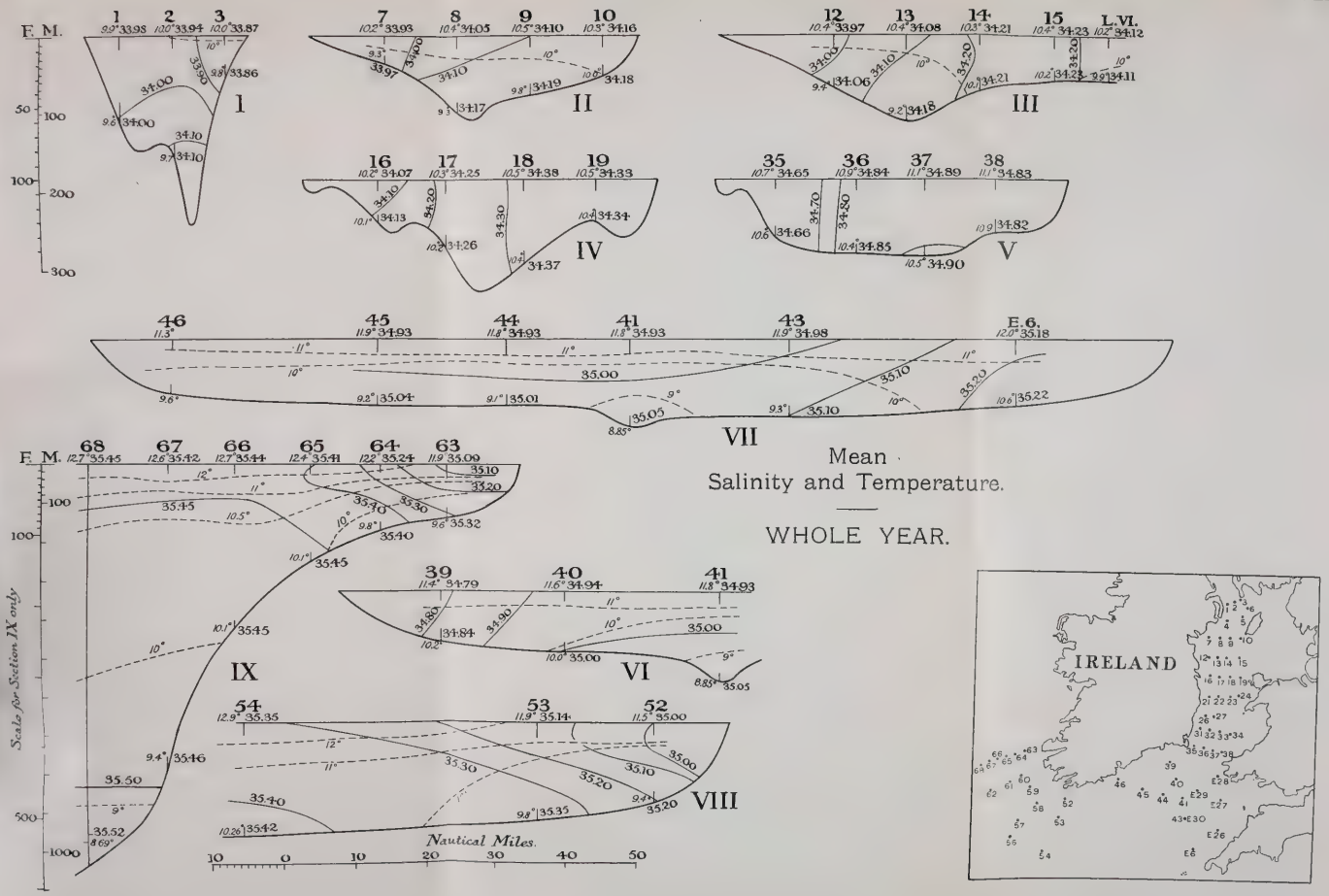

Mean
Salinity and Temperature.

WHOLE YEAR.

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To the series of "Scientific Investigations" for the Year 1913, published by the Department of Agriculture and Technical Instruction for Ireland.

The Roman numerals refer to the separate parts or numbers, the Arabic numerals to the pages.

DEPARTMENT OF AGRICULTURE AND TECHNICAL INSTRUCTION FOR IRELAND.

FISHERIES BRANCH.

SCIENTIFIC INVESTIGATIONS, 1914.

DUBLIN:
PRINTED FOR HIS MAJESTY'S STATIONERY OFFICE.

INDEX

To the series of "Scientific Investigations" for the Year 1914, published by the Department of Agriculture and Technical Instruction for Ireland.

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PART I.

PALINURA, ASTACURA, AND ANOMURA (EXCEPT PAGURIDEA).

BY

CORRIGENDA.

Page 3, line 13, for "done" read "down."
,, 3, ,, 34, for "*voncolor*" read "*concolor*."
,, 10, ,, 26, for "mention" read "mentioned."
,, 21, ,, 1, for "POLYCHELUS" read "POLYCHELES."
,, 43, ,, 33, for "trawels" read "trawlers."
,, 69, bottom line, for "0-60" read "50-60."
,, 104, line 10, after "shore collecting" insert "in Ballynakill Harbour."

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Fisheries, Ireland, Sci. Invest., 1914, I. [1914].

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Crustacea,"
in Lankester's "Treatise on Zoology."

The material on which the following account is based was nearly all taken by the Irish Fishery cruiser *Helga* since the year 1900. A few specimens taken within the Irish marine area by the Danish Fishery steamer *Thor* are also included. In the collection there are representatives of thirty-one species, four of which are new to science, eleven new to the British, and sixteen to the Irish marine fauna. The following is a list of those new to the Irish area in which those which are also new to British waters are marked with an asterisk :—

**Polycheles typhlops.*
**Polycheles sculptus.*
**Polycheles nanus.*
**Polycheles granulatus.*
**Eryonicus Faxoni.*
Nephropsis atlantica.
**Uroptychus rubrovittatus.*
**Uroptychus nitidus*, var. *concolor.*
**Gastroptychus formosus.*
Munida tenuimana.
**Munidopsis tridentata.*
**Munidopsis curvirostra.*
Axius stirhynchus.
**Jaxea nocturna.*
Callianassa Stebbingi.
Upogebia deltaura.

THE DECAPODA REPTANTIA OF THE COASTS OF IRELAND.

PART I.

Palinura, Astacura, and Anomura (except Paguridea).

BY

C. M. Selbie, B.Sc.,

National Museum, Dublin.

Plates I–XV.

Introduction.

The present paper is a continuation of the account of the Irish Decapoda, begun by Mr. Stanley Kemp in "The Decapoda Natantia of the Coasts of Ireland" (*Fisheries, Ireland, Sci. Invest.*, 1908, *I.* [1910]), and I have tried to keep the scope of the work as nearly as possible the same, that is to say, every species discovered since the appearance of Bell's "British Stalk-eyed Crustacea" in 1853 has been described and figured. This paper includes the whole of the Palinura, Astacura, and Anomura, with the exception of the Paguridea. The latter will be dealt with in the next part, and a third paper will complete the account of the Reptantia with the Brachyura.

The classification adopted is that drawn up by Borradaile (1907), as slightly altered by Calman in the volume "Crustacea," in Lankester's "Treatise on Zoology."

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**Gastroptychus formosus.*
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**Munidopsis tridentata.*
**Munidopsis curvirostra.*
Axius stirhynchus.
**Jaxea nocturna.*
Callianassa Stebbingi.
Upogebia deltaura.

The majority of these were taken in the deep water off the south-west coast. *Jaxea nocturna*, however, was found in the Irish Sea between the Isle of Man and the coast of Co. Louth. It is a species found commonly in the northern part of the Adriatic, and only very rarely in other parts of the Mediterranean. The single specimen which was taken by the *Helga* in 1905 was the first adult individual to be found outside the Mediterranean. Since then another full-grown *Jaxea* has been found in British waters; it was taken by the Scottish Fishery Board steamer *Goldseeker* in Loch Fyne in 1908. The discovery of *Jaxea* within the British marine area has long been expected, as the peculiar *Trachelifer* larval form has been taken on many occasions in the Irish Sea, and on the west coast of Ireland and Scotland.

Three of the other species new to the Irish fauna, *Axius stirhynchus*, *Callianassa Stebbingi*, and *Upogebia deltaura*, are littoral and shallow water forms with a burrowing habit. It is probably this latter fact which has prevented their being included in earlier lists of Irish Decapoda. With the exception of these few forms the remainder of the species in the foregoing list were found in deep water off the west and south-west coasts.

The feature of the collection is the large number of specimens included in it belonging to the family Eryonidae, of which no examples had hitherto been taken within the British marine area. Four species of *Polycheles* and four of *Eryonicus* have been captured, three of the latter, *E. hibernicus*, *E. Scharffi*, and *E. Kempi*, being new to science. Perhaps the most interesting specimen in the whole collection is a very young *Eryonicus*, only 7 mm. long, in which only the first two pairs of pereiopods are developed, the rostrum has the form of a long median spine, and the abdomen is very small. The most striking fact, however, is the presence of exopodites on the pereiopods and on the second and third maxillipedes. The specimen is, in fact, an *Eryonicus* in the *Mysis* stage of development.

Eryonicus differs from all the other species described in this paper in being a free-swimming form; all the others are true bottom-living forms.

There is also a new species of *Palinurus* in the collection. It is closely allied to the common species, *P. vulgaris*, and also to a South African species, *P. Gilchristi*. In many respects it is intermediate between these two forms, but I consider that its characters are sufficiently distinctive to give it specific rank. Eventually it may have to be reduced to a variety of *P. vulgaris*, on evidence based on the examination of a large number of specimens.

By far the greater part of the material was taken in the beam trawl, or in mosquito and sprat nets attached to the trawl as described in the introduction to Mr. Kemp's paper. The specimens of *Eryonicus* were nearly all taken in the midwater otter trawl, but in one or two instances they were found in

the beam trawl, in which case they must have been captured by the latter while it was being hauled to the surface.

Except in the case of very common species the actual records are given. The depths represent the soundings taken at the beginning and end of each haul, and the mean between these is to be regarded as the approximate depth at which the specimen was taken. Except in a few cases references are given only to the principal papers dealing with each species. Measurements of all specimens were taken from the tip of the rostrum to the end of the telson, when the abdomen is straightened out in macrurous fashion.

The following species are practically confined to the littoral and laminarian zones, that is, done to about twenty fathoms :—

Porcellana longicornis.
Porcellana platycheles.
Axius stirhynchus.
Callianassa Stebbingi.
Upogebia deltaura.

The following are also found in these zones, but they extend into deeper water as well :—

Palinurus vulgaris.
Homarus vulgaris.
Galathea intermedia.
Galathea squamifera.
Galathea nexa.
Galathea strigosa.

The species in the following list are all genuine deep-sea forms :—

Polycheles typhlops.
Polycheles sculptus.
Polycheles nanus.
Polycheles granulatus.
Nephropsis atlantica.
Uroptychus rubrovittatus.
Uroptychus nitidus, var. *concolor.*
Gastroptychus formosus.
Munida tenuimana.
Munidopsis tridentata.
Munidopsis curvirostra.

The various species of *Polycheles* are nearly always found on a bottom of ooze. *Uroptychus nitidus* var. *concolor* and *Munidopsis tridentata* are usually found clinging to pieces of *Lophelia prolifera.*

The Reptantia treated of here include three species of great economic importance, *Homarus vulgaris*, *Palinurus vulgaris*, and *Nephrops norvegicus.* The Irish Lobster fishery is of increasing importance, as may be seen by the figures given on page 54. The number caught annually has increased steadily since 1903, with the exception of the years 1906 and 1910, and in 1912 the total reached more than half a million for the first time. By far the greatest numbers come from the west

and south coasts. Thus the total catch for 1912 was made up as follows :—

West coast	42·3%
South coast	25·9%
North coast	17·1%
East coast	14·6%

There is practically no fishery of *Palinurus vulgaris* in Ireland. It does not occur in anything like the same numbers as the Lobster, and it is not held in great estimation as an article of food in this country, whereas on the Continent it is greatly prized and preferred by many to the Lobster itself.*

Nephrops norvegicus, usually known in Ireland as the "prawn," occurs in immense numbers in the northern part of the Irish Sea, especially between the Isle of Man and the coast of Louth and Down. It is from this district that the greatest numbers are brought in by the trawlers.

Many of the Reptantia described in this paper are of importance as a source of food supply for fish of commercial value. Off the south of Iceland *Nephrops norvegicus* occurs in such large numbers that it forms the chief food of the cod. Some of the burrowing species such as *Callianassa Stebbingi*, *Axius stirhynchus*, and *Upogebia deltaura* are much more frequently found in the stomach of bottom-living fishes than taken in the trawl.

MONTHS in which ovigerous females were taken.

	Jan.	Feb.	Mar.	Apl.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Polycheles typhlops								x				
Polycheles nanus					x							
Nephrops norvegicus	x	x				x		x		x	x	
Nephropsis atlantica		x						x				
Uroptychus nitidus, *var.* concolor.									x			
Galathea intermedia			x		x			x	x			
Galathea nexa	x	x	x	x	x		x					
Galathea strigosa				x								
Munida bamffica		x										
Munida tenuimana								x				
Munidopsis curvivostra					x							
Porcellana longicornis				x								
Axius stirhynchus		x										
Calocaris Macandreae								x		x		
Jaxea nocturna		x										

* See pp. 42, 43.

The Table printed above shows the months in which ovigerous females of the various species were taken. The Lobster, which may be found in the ovigerous condition at any time of the year, is not included.

The next table shows the distribution of those species which are found outside the Atlantic.

The third table shows the Atlantic distribution of each species. It will be seen that nine extend northwards beyond the Arctic Circle, and eighteen are found as far south as the Mediterranean.

A list of the papers to which references are given will be found at page 105, and an index to the genera and species at page 111.

I am glad to have this opportunity of expressing my indebtedness to Dr. Calman for his courtesy and patience in replying to my numerous inquiries, and also to the Rev. T. R. R. Stebbing, Dr. Allen of the Marine Biological Association, Dr. H. J. Hansen and Dr. Lundbeck of Copenhagen, and Prof. Steuer of Innsbruck, for the loan of specimens.

EXTRA-ATLANTIC DISTRIBUTION.

	Red Sea	Arabian Sea	Ceylon	Bay of Bengal and Andaman Sea	New Zealand	West Coast of America: San Diego to Ecuador
Polycheles typhlops	....	x	....	x		
Polycheles sculptus	....	x	....	....	....	x
Polycheles nanus	....	....	....	....	....	x
Polycheles granulatus	....	....	x	....	....	x
Nephropsis atlantica	....	x				
Uroptychus nitidus *var.* concolor	....	x	....	x		
Galathea strigosa	?					
Munidopsis tridentata	....	x	x	x		
Calocaris Macandreae	....	?	?	....	?	

ATLANTIC

	West Coast of Ireland	South Coast of Ireland	Irish Sea	South Coast of England	East Coast of England	East Coast of Scotland	W. and N. Coast of Scotland and Shetlands	East Coast of North America
1. Polycheles typhlops	x							
2. Polycheles sculptus	x	....	....	....	....	....	....	x
3. Polycheles nanus	x	x	x	x	x	x	x	x
4. Polycheles granulatus	x							
5. Eryonicus Faxoni	x							
6. Eryonicus hibernicus	x							
7. Eryonicus Kempi	x							
8. Eryonicus Scharffi	x							
9. Palinurus vulgaris	x	x	x	x	x	....	x	
10. Palinurus Thomsoni	x							
11. Nephrops norvegicus	x	x	x	x	x	x	x	
12. Nephropsis atlantica	x	....	....	....	....	....	x	
13. Homarus vulgaris	x	x	x	x	x	x	x	
14. Uroptychus rubrovittatus	x							
15. Uroptychus nitidus, *var.* concolor	x							
16. Gastroptychus formosus	x							
17. Galathea intermedia	x	x	x	x	x	x	x	
18. Galathea squamifera	x	x	x	x	x	x	x	
19. Galathea strigosa	x	x	x	x	x	x	x	
20. Galathea nexa	x	x	x	x	x	x	x	
21. Munida bamffica	x	x	x	x	x	x	x	
22. Munida tenuimana	x							
23. Munidopsis tridentata	x							
24. Munidopsis curvirostra	x	....	....	....	....	....	....	x
25. Porcellana platycheles	x	x	x	x	x	x	x	
26. Porcellana longicornis	x	x	x	x	x	x	x	
27. Axius stirhynchus	x	....	x	x				
28. Calocaris Macandreae	x	....	x	x	x	x	x	x
29. Jaxea nocturna	....	....	x	....	....	....	x	
30. Callianassa Stebbingi	x	....	x	x	....	x		
31. Upogebia deltäura	x	x	....	x	....	x		
32. Upogebia stellata	....	....	....	x	x	x		

DISTRIBUTION.

	West Greenland	Iceland	Coasts of Norway North of Arctic Circle	Coasts of Norway South of Arctic Circle	Sweden	Denmark	Bay of Biscay	Coasts of Spain and Portugal	Mediterranean	Black Sea	West Coast of Morocco and Sudan	Azores	Canaries	Cape Verde Islands and Senegambia	South and South West Africa	West Indies
1.	....	....	....	....	....	....	x	x	x	....	....	x	x	x	....	x
2.	....	....	....	....	....	....	x	....	x	....	....	....	....	....	x	x
3.	x	x	....	....	....	....	x	....	....	....	....	....	....	....	x	
4.	....	....	....	....	....	....	....	x	....	....	....	x	x	x	?	
5.	....	....	....	....	....	....	....	....	x	....	x					
6.																
7.																
8.																
9.	....	....	....	?	....	x	x	x	x	....	x	....	x			
10.																
11.	....	x	x	x	x	x	x	x	x							
12.	....	....	....	....	....	....	x	....	....	....	....	....	....	....	x	
13.	....	....	x	x	x	x	x	x	x							
14.	....	x	....	....	....	....	x	x	....	....	x	x	x	x		
15.	....	x	....	....	....	....	x	x	....	....	x	x	x	x	x	
16.	....	....	....	....	....	....	x	x	....	....	....	....	x			
17.	....	....	x	x	x	x	x	x	x	....	....	x	x			
18.	....	....	x	x	x	x	x	x	x	....	....	x	x	x		
19.	....	....	x	x	x	x	x	x	x	....	....	x				
20.	....	....	x	x	x	x	x	x	x	....	....	x	x			
21.	....	x	x	x	x	x	x	....	x	....	x	....	x	x		
22.	x	x	x	x	....	x										
23.	....	....	x	x	....	....	x	x	....	....	x	x	x	x		
24.	x	x	....	....	....	....	....	....	....	....	x					
25.	....	....	....	....	....	....	x	x	x	....	....	....	x			
26.	....	....	....	x	x	x	x	x	x	x	....	....	x			
27.	....	....	....	....	....	....	x	....	x							
28.	....	x	....	x	x	x	....	....	x							
29.	....	....	....	....	....	....	....	....	x							
30.	....	....	....	....	....	....	x	....	x	x						
31.	....	....	....	....	....	x	....	....	x							
32.	....	....	....	x	x	x										

DECAPODA REPTANTIA.

PALINURA.

The two tribes forming the Palinura may be separated as follows :—

Antennal scale present ; first four pairs or all five pairs of pereiopods chelate ; pleopods present on first abdominal somite, .. ERYONIDEA.

Antennal scale absent ; none of the pereiopods chelate, except occasionally the fifth pair in the female ; pleopods absent from the first abdominal somite, ... SCYLLARIDEA.

TRIBE ERYONIDEA.

FAMILY *ERYONIDAE*.

No specimens belonging to this family have previously been recorded from British waters. Attention was first drawn to these very peculiar Decapods by the *Challenger* expedition. The honour, however, of being the first to describe one of the group must be given to Heller, who in 1862 described and figured a small specimen of *Polycheles typhlops* from the Mediterranean. No one seems to have attached much importance to this description until after the discovery of several allied species by the *Challenger*. The capture of these specimens was amongst the most remarkable results achieved by the expedition, as the discovery of *Polycheles* and its allies was at least a partial fulfilment of the hopes of those who maintained that, owing to the uniformity of conditions existing at great depths, there might be found there organisms which had been regarded as extinct, for the nearest relatives of *Polycheles* and *Willemoesia* are the species of *Eryon* found in the Trias and Lower Cretaceous.

Two genera have been taken in Irish waters, *Polycheles* (including *Pentacheles*), and *Eryonicus*. *Willemoesia*, which is closely allied to *Polycheles*, is not yet known to occur within the boundaries of the Irish marine area.

The two genera are separable as follows :—

Carapace depressed, the lateral borders very sharply defined ; abdomen longer than carapace, ... *Polycheles*.

Carapace globular and inflated ; abdomen shorter than carapace, ... *Eryonicus*.

Polycheles, Heller.

Polycheles, Heller, 1862. *Polycheles*, Heller, 1863. *Polycheles*, Bate, 1888. *Pentacheles*, Bate, 1888. *Stereomastis*, Bate, 1888. *Polycheles*, Faxon, 1893. *Polycheles*, Faxon, 1895. *Polycheles*, Alcock, 1901. *Pentacheles*, Alcock, 1901. *Polycheles*, Stebbing, 1903. *Polycheles*, Bouvier, 1905. *Polycheles*, Kemp, 1912.

In his report on the Macrura of the *Challenger* Expedition Spence Bate distributes the species of this group among three genera, *Polycheles*, *Pentacheles*, and *Stereomastis*. In *Pentacheles* all five pairs of pereiopods were chelate, and in *Polycheles* only the first four pairs. Faxon, however (1895), showed that this character was useless as some of the species included in *Pentacheles* had the fifth pereiopods chelate in the female and simple in the male. *Stereomastis* was founded for the reception of these species in which "the mastigobranchial lash does not exist." After the examination of a large amount of material, Faxon was able to state that the epipodites of the thoracic legs were to be found in all grades of development, from large structures extending far up into the branchial chamber, to the merest rudiments. He therefore united the three genera in one, and has been followed by the majority of recent writers. Alcock, however, revived (1901) the genus *Pentacheles*, separating it from *Polycheles* by the following characters.

> "Epipodite . . . of the external maxillipedes is represented at most by a papilla. Epipodites are present on the first four pairs of thoracic legs, but they are only membranous expansions of the base of the podobranch, and ascend little or not at all into the branchial chamber.—*Polycheles*.
>
> External maxillipedes carry a functional epipodite, and the epipodites of the first four pairs of thoracic legs are independent plates, attached to the podobranchiae at the base only, and ascending into the branchial chamber in normal fashion.—*Pentacheles*."

But this was merely employing again the character which Faxon had shown to be useless for the distinction of *Stereomastis*. Moreover, Kemp has shown (1912) that Alcock's species *Pentacheles hextii* is a synonym of *Polycheles typhlops*. The characters given by Alcock, therefore, though doubtless holding good for Indian species, cannot be applied to the group as a whole. *Polycheles* is used in the present paper as including the three genera described by Spence Bate.

The carapace is nearly as long as the abdomen, and is very much flattened dorsally. The lateral edges are very well defined, and are lined with strong broad spines or teeth, the number of which varies with the species; the edges are slightly

convex or almost parallel. A distinct carina runs along the middle of the dorsal surface from the rostrum, marked by a single or double spine, to the posterior margin, which is concave. On the part of the carapace below the lateral margin there are two less distinct carinae, one running to the base of the antennae, and the other to the base of the chelipeds; both start from near the postero-lateral angle of the carapace. These three carinae all bear more or less well developed spines which are of great importance as specific characters. There is also usually a row of spines on the outer cardiac area running parallel to the posterior part of the lateral margin. The front edge of the carapace is excavated on either side into a deep sinus in which lies the fixed eyestalk.

The abdomen tapers rapidly to the telson, which always ends in a long narrow point. The abdominal terga bear median crests, which are sometimes developed into huge forward-curving spines. The pleura of the second segment are much larger than those of the other segments.

The eyestalks fill the sinuses in which they lie, and are opaque and dull except for a small circular area which is present at the posterior dorsal end in some species; this part is translucent and soft. The anterior end of the eyestalk, which may or may not bear a small spine, gives off a branch which passes outwards and downwards beneath the antero-lateral angle of the carapace; its tip is translucent like the dorsal area already mention.

The basal joint of the antennular peduncle is produced into an elongated and pointed scale on the inner side, and bears one or two spines at its outer angle. There is a narrow antennal scale. The outer antennulary flagellum is always very short and slender, the inner one nearly equal in length to the antenna, which is usually slightly longer than the carapace. The renal tubercle is very well developed and presses against the base of the antennulary peduncle, in which there is a rounded hollow for its reception.

The oral appendages are very uniform in the different species and are described in detail later.

All five pairs of thoracic legs are chelate in the female; in the male the last pair is more or less imperfectly chelate. The first pair is very long, often longer than carapace and abdomen, and the joints are all more or less flattened. The fingers are long and slender with strongly curved tips which cross when closed. The other pairs of legs become successively shorter and feebler backwards.

The pleopods are long and slender with a rod-like *appendix interna*. There is no transverse suture on the uropods.

There is no epipodite on the second maxillipedes; that on the third maxillipedes may be a mere papilla or of fair size. Epipodites and podobranchs are present on the first four pairs of thoracic legs and vary in size, sometimes reaching far up into the branchial chamber, sometimes hardly ascending into the

chamber at all. The arthrobranch on the third maxillipedes is never greatly developed, and it may be absent altogether.

Branchial formula :—

—	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.
Podobranchs. .	ep.	—	ep.	1+ep.	1+ep.	1+ep.	1+ep.	—
Arthrobranchs.	—	—	±1	2	2	2	2	—
Pleurobranchs..	—	—	—	—	1	1	1	1

Four species of *Polycheles* have been taken by the *Helga*, all of them new to the British fauna. *P. typhlops* has been taken frequently, and also several specimens of *P. sculptus*. Three specimens of *P. nanus*, belonging to the variety described as *P. Grimaldii* by Bouvier, were taken in the same haul as several specimens of *P. sculptus*. Finally, a single specimen of *P. granulatus* was taken. The species of this genus are good examples of the very wide range so often possessed by organisms living at great depths. Of the four species described here *P. typhlops*, *P. sculptus*, and *P. granulatus* have each been found in the Atlantic, Indian, and Pacific Oceans. They are nearly always captured on a bottom of Globigerina ooze and their long and slender chelipeds would appear to be well adapted for raking and sifting the ooze in the search for food.

A key for the separation of the four British species is given below.

A. No spines on hind border of carapace ; teeth on lateral margins hardly decreasing at all in size posteriorly ; no ridge on the sixth abdominal tergum ; one spine on the outer angle of the basal joint of the antennular peduncle, ... *P. granulatus.*

B. Spines on hind border of carapace ; teeth on lateral margins decreasing in size posteriorly ; a double ridge on the sixth tergum ; two spines on the outer angle of the basal joint of the antennular peduncle.

a. Rostral spine single ; rows of tubercles on edges of terga, ... *P. typhlops.*

b. Rostral spine double ; no rows of tubercles on edges of terga,

I. Chelipeds slightly shorter than body ; ridge on sixth tergum very prominent, with jagged edges, ... *P. nanus.*

II. Chelipeds much longer than body ; ridge on sixth tergum low, with smooth edges, *P. sculptus.*

Polycheles typhlops, Heller.

Pl. I, figs. 1–13.

Polycheles typhlops, Heller, 1862.
Polycheles typhlops, Heller, 1863.
Polycheles typhlops, Carus, 1885.
Polycheles Doderleini, Riggio, 1885.
Pentacheles Hextii, Alcock, 1894.
Polycheles typhlops, Adensamer, 1898.
Pentacheles Hextii, Alcock, 1901.
Polycheles typhlops, Senna, 1903.
Polycheles typhlops, Bouvier, 1905 (a).
Polycheles typhlops, Bouvier, 1905 (b).
Polycheles typhlops, Kemp, 1912.

The carapace is slightly shorter than the abdomen. Its dorsal surface is almost flat, and its lateral margins are very slightly convex. The frontal margin considered as a whole is slightly concave, and is divided into three lobes by the deep sinus at each side, in which the fixed and immovable eyestalk lies. The median lobe is bounded at either side by a strong spine. In the centre is the rostrum, formed by a single sharp spine pointing forwards and upwards. Below this there is a broader and blunter process in the median line. The outer border of each orbital sinus is furnished with three or four small teeth, which are more distinct in the female than in the male. At each antero-lateral angle of the carapace there is a strong curved spine, and from this there runs backwards a line of teeth along the lateral margin. These lateral spines decrease in size towards the posterior end, and the series is divided into three parts by the two branches of the cervical groove. The front part has usually seven spines, the middle four or five, and the hind part about twenty. The numbers however vary considerably. Senna gives them as 6 or 7, 4, 14 to 18, and Carus 7, 5, 20 to 23. The two sides of the same specimen even may show differences in the number of spines; in one of the specimens taken by the *Helga* the left side has 7, 5, 18, and the right, 8, 5, 20. The hind carapace margin is strongly concave, and is composed of a strong bar, the two halves of which meet at an obtuse angle in the centre. At this point there are two large forward-pointing spines, and two smaller ones further down on either side. The posterior extremities of this bar are firmly buckled to the first abdominal segment. From the middle of the hind margin to the rostrum there runs a raised carina along the whole length of the carapace. It is broken only at one point, where it is crossed by the cervical groove. It bears several distinct spines, some of which are double, and between these it is

covered with rough tubercles. In front of the cervical groove the spines, according to Senna, are arranged as follows

Rostrum + 1, 1, 1, 1, 2, 2,

in the male, and in the female either the same or,

Rostrum + 1, 1, 1, 2, 2.

In the specimens taken by the *Helga* these spines are not always well developed. It is especially difficult sometimes to say whether a spine is double or not. The one which lies just in front of the cervical groove is very often single, or has one half much larger than the other, or is altogether rudimentary. Behind the groove there are three double spines, but often some of these are very slightly developed. The arrangement of the carinal spines on some of the Irish specimens is as follows. (The semicolon marks the position of the cervical groove, and *r* signifies that the spine is rudimentary.)

Rostrum + 1, 1, 1, 2, $1\frac{1}{2}$; 2, *r*, 2.
Rostrum + 1, 1, 1, 2, *r* ; *r*, *r*, 2.
Rostrum + 1, 1, 1, 1, 2, $1\frac{1}{2}$; *r*, *r*, 2.
Rostrum + 1, 1, 1, 2, $1\frac{1}{2}$; 2, 2, 2.
Rostrum + 1, 1, 1, 2, *r* ; *r*, *r*, 2.

The cervical groove is situated almost exactly half-way between the rostrum and the hind margin of the carapace. It is well marked, and at a point rather nearer the median line than the margin it divides into two. The posterior branch cuts the margin almost at right angles, whereas the anterior, which is the fainter of the two, slants forwards, and meets the margin at an acute angle. From the hind branch of the cervical groove a low ridge furnished with about twelve to fourteen small teeth runs backwards parallel with the margin to the posterior end of the carapace. It is almost twice as far from the median carina as from the lateral margin. From the middle of the anterior branch of the cervical groove to the orbital sinus there is a curved row of four or five spines, which are not situated on a ridge. On the cervical groove itself, besides the two central spines forming part of the median carina, there is a single smaller spine on each side above the bifurcation, and three or four very small ones on the hind branch below it. Besides the larger spines, the position of which has been indicated, there are numerous very small ones scattered over the surface of the carapace; they are particularly plentiful about the borders of the cardiac region, and all of them are directed forwards.

On the lower surface of the carapace there are at each side two oblique carinae armed with small teeth. The external or upper of these submarginal ridges begins just opposite the base of the antenna and runs backwards towards the postero-lateral angle of the carapace. Its anterior end is marked by a large spine. The teeth are fairly large in the front portion, but they

die away about the middle, and the hind part is only faintly traceable. The internal submarginal carina runs from the posterior angle of the carapace forwards to a point opposite the base of the first pereiopods. It is more definitely spiny than the other.

The tergum of the first abdominal somite is almost quite smooth, but on the second there is a well developed median spine, and on the third, fourth, and fifth there are large spines curving forwards. The sixth segment bears a low double keel which is broken up into six or seven tubercles.

The pleura of the first segment are the smallest, and those of the second the largest of the series. The others diminish in size and increase in sharpness from the third to the sixth.

The basal part of the telson has a median row of three or four tubercles. It tapers to a narrow but not very sharp point.

The pigmentless and immovable eyestalks fill the deep orbits in the front of the carapace. Each one gives off a tapering branch on the outer side, which extends beneath the antero-lateral angle of the carapace. There is a short spine on the front of each eyestalk.

The inner flagella of the antennules are longer than the carapace; the outer are very short and much thinner than the others. The antennular scale extends far past the end of the peduncle, and ends in a sharp point; its inner margin is armed with teeth. The outer angle of the basal joint of the peduncle bears two prominent spines.

The narrow antennal scale does not reach the end of the peduncle. The flagellum is slightly shorter than the inner branch of the antennule. From the basal joint of the peduncle there projects on the inner side a short rounded process, the phymacerite or renal tubercle, the end of which lies in a hollow on the under side of the base of the antennule.

The cutting edge of the mandible bears about a dozen teeth, of which one at each end and one in the middle are larger than the others. There is a three-jointed palp.

The two lobes of the first maxillae are strongly incurved; they are very slender, and end in sharp bristles, which are stouter in the anterior one.

In the second maxillae the two lobes are not subdivided, but are long and slender, the inner larger than the outer; the scaphognathite is very large.

The first maxillipedes are very long and of unusual form. Fig. 7 shows the appearance of the anterior part without the epipodal lamella, which forms a prolongation backwards, so that the total length of the appendage is greater than that of the scaphognathite. The two lobes of the protopodite are represented by the parts *a* and *b*. From *b* there springs the long, slender endopodite, heavily fringed with setae, and having an imperfect joint slightly nearer the tip than the base. The exopodite, on the other hand, is very broad; in its distal part it divides into two curved plates which are curiously curled round

one another. That which is seen in profile in Fig. 7, *d*, partially encloses the other, *c*, which spreads out into a broad lamella from a very narrow base at *e*. On the anterior edge of the proximal protopodial lobe there are two rows of setae, one directed outwards, the other inwards; the former are plumose, the latter simple. The lobe *a* appears to be narrower in the figure than it really is, owing to foreshortening.

Neither the second nor the third maxillipedes have an exopodite. Both appendages are slender and pediform. In the second maxillipedes the carpus is long and much expanded; the dactyl ends in a spine. The third maxillipedes are very long and slender, and are unarmed except for the spines on the dactyl. The whole appendage is covered with long setae. There is a small epipodite.

In the female all five pairs of pereiopods are chelate, but the last pair are not perfectly so, the dactyl being slightly longer than the projecting part of the propodite. In the male the first four pairs are chelate, but the fifth ends simply. In both sexes the tips of the fingers in the first and second pereiopods cross one another and are strongly curved.

The first pereiopods or chelipeds are slightly longer than the whole body from rostrum to tip of telson. They are remarkably slender and feeble. The ischium is very narrow at the proximal end, but expands distally, and this is also true of the carpus.

The merus is broad at the proximal end, narrows in the middle, and then widens again. The palm of the propodite is the stoutest part of the whole appendage, and is not so compressed as the ischium and merus. The fingers are very long and thin, and are sharply bent near the tip. The inner edge of each finger is furnished with a row of small plates set obliquely, and overlapping one another. The merus bears one or two spines at its upper distal end, and the carpus also has one in the same position. Sometimes the propodite bears a spine opposite the base of the dactyl. The upper margin of the merus is very minutely spinulose.

The other pereiopods are very much shorter than the first, and diminish in size from the second to the fifth.

The first pair of pleopods are very different in the two sexes. Those of the female are fairly large and robust, passing the base of the fourth pereiopods, and are heavily fringed with setae, which are of two kinds. There is a continuous fringe of slender pinnate setae along each margin, and in addition to these there is a much smaller number of simple hairs, which are much longer and thicker than the pinnate ones. The largest of all are to be found in a little group of four or five situated at the base of the distal joint.

The first pleopods in the male are quite devoid of hairs, with the exception of five or six on the proximal joint, and one at the extreme tip. Near the extremity there is a slight swelling on the inner side, which bears a group of little hooks. The appen-

dage is very slender, and is considerably shorter than in the female.

The succeeding pairs of pleopods are all well developed, and possess an *appendix interna*, and in the male the second pair have also an *appendix masculina*.

The uropods are large and broad, the exopodite more so than the endopodite. The margins are entire and fringed with long setae. In the endopodite there is a midrib extending to the tip, and in the exopodite two similar ribs, neither of which reach the margin.

Occasionally in the female there may be seen two spermatophores cemented firmly to the sternal surface between the coxae of the fourth and fifth pereiopods. These are not unlike the spermatheca which is found in certain Decapods in the same position, and in *P. sculptus* they have erroneously been described as such (see Andrews, 1911).

Size :—Senna (1993) mentions three large females, taken in the Mediterranean, which measured 65, 70, and 99 mm. The largest specimens taken by the *Helga* are two females, each 80 mm. long. Another female measures 74 mm.

The following measurements are taken from a female from station S. R. 490.

Total length	80 mm.
Length of carapace	35 mm.
Length of abdomen	45 mm.
Breadth of carapace	23 mm.
Length of chelipeds	81 mm.
Length of ischium of chelipeds ..	13 mm.
Length of merus of chelipeds ..	26·5 mm.
Length of carpus of chelipeds ..	13·5 mm.
Length of propodite of chelipeds ..	27·5 mm.
Length of palm of chelipeds ..	12 mm.
Length of fingers of chelipeds ..	15·5 mm.
Length of second pereiopods ..	32 mm.
Length of third pereiopods	28 mm.
Length of fourth pereiopods	26 mm.
Length of fifth pereiopods	22 mm.
Length of antennules	43 mm.
Length of antennae	Broken.

General Distribution :—The species was taken originally in the Mediterranean, and was described by Heller (1862 and 1863). It has since been recorded from Sicily (Heller, Riggio), Sardinia (Senna), the Adriatic, north coast of Africa, south coast of Asia Minor, and Crete (Adensamer). Under the name of *P. Agassizi* it has been recorded from several localities in West Indian waters (Milne Edwards), and Bouvier has shown that it is widely distributed in the eastern Atlantic. Kemp (1912)

has shown that Alcock's species *Pentacheles Hextii* is a synonym of *P. typhlops*, so that the range of the species is extended to the Indian Ocean.

Norman (1879) gives a description of two specimens of *Polycheles* taken by the *Porcupine*, one, a male, off the Portuguese coast, and the other, a female, on the Atlantic slope west of the English Channel (48° 13′ N., 9° 11′ W.). The male appears from the description to belong to *P. typhlops*, but the female certainly does not.*

Vertical Distribution :—Riggio records a Mediterranean specimen from about 55 fms., but usually the depths are very much greater. Senna's specimens were taken in 358–848 fms., and Adensamer's in 339–1122 fms. The depths at which the *Helga* has taken this species range from 208 to 728 fms.

Irish Distribution :—The species has not previously been recorded from British waters. All the specimens were found off the south-west coast.

Helga :—

S. R. 171—5 XI '04.—52° 7′ N., 11° 58′ W., 337 fms. Trawl.—Two, 63–34 mm.

S. R. 188—3 II '05.—51° 53′ N., 11° 59′ W., 320–372 fms., mud. Trawl. Temperature at 300 fms., 10·125° C., Salinity 35·5 °/₀₀.—One, 70 mm.

S. R. 321—1 V '06.—50° 56′–51° 0′ 30″ N., 11° 17′ W., 480–208 fms., fine sand. Trawl.—One, 74 mm.

S. R. 353—6 VIII '06.—50° 37′–50° 40′ N., 11° 32′ W., 250–542 fms., mud and sand. Trawl.—Temperature at 500 fms., 8·58° C., Salinity 35·46 °/₀₀.—Seven, 80–30 mm.

S. R. 482—29 VIII '07.—51° 6′ N., 11° 26′ W., 368 fms., fine sand. Trawl.—Three, 55–32 mm.

S. R. 490—7 IX '07.—51° 57′ 30″ N., 12° 7′ W., 470–491 fms., ooze. Trawl. Temperature at depth 6·68° C.—One, 80 mm.

S. R. 502—11 IX '07.—50° 46′ N., 11° 21′ W., 447–515 fms. Trawl. Temperature at depth 8·8° C., Salinity 35·37 °/₀₀.—Three, 50–30 mm.

S. R. 504—12 IX '07.—50° 42′ N., 11° 18′ W., 627–728 fms., coral. Trawl.—One, 32 mm.

S. R. 1242—14 VIII '11.—51° 27′ N., 11° 55′ W., 550–590 fms. Trawl.—One, 52 mm.

S. R. 1693—20 VIII '13.—51° 30′ N., 11° 51′ W., 500–479 fms. Trawl.—One, 76 mm.

* Dr. Calman informs me that the female specimen has been seen by Mr. Kemp, and was referred by him to *P. sculptus*.

Polycheles sculptus, Smith.

Pl. II, figs. 1–9.

Polycheles sculptus, Smith, 1880 (*a*).
Polycheles sculptus, Smith, 1880 (*b*).
Pentacheles spinosus, Milne-Edwards, 1880.
Pentacheles sculptus, Smith, 1882.
Polycheles sculptus, Caullery, 1896.
Pentacheles sculptus, Alcock and Anderson, 1899.
Polycheles sculptus, Alcock, 1901.
Polycheles sculptus, Senna, 1903.
Polycheles sculptus, Stebbing, 1903.
Polycheles sculptus, Hansen, 1908.

The carapace is longer than the abdomen; its sides are almost parallel, but converge slightly in front and behind; the greatest breadth is just in front of the cervical groove. The latter is deeper than in *P. typhlops*. The rostrum is formed of two spines; there is a spine at the inner angle of the orbital sinuses, but not at the outer. The orbits are not of the same shape as in *P. typhlops*; their posterior part is not narrowed to a point, but is rounded. The margins of the sinus are not denticulate. The hind margin of the carapace is concave, and bears no spines except the two in the centre, which are the last of the median carina. The surface of the carapace is fairly smooth between the spines. The oblique line running forwards and outwards from the posterior cardiac region is without spines. The spiny armature of the carapace is more robust than in *typhlops* and is more constant in its arrangement. The spines of the median carina are arranged thus:—R + 1, 2, 1, ; 2, 2, 2. On the lateral margins there are six spines in the anterior part, three in the central, and seven behind. They diminish in size backwards, but are all larger than the corresponding spines in *P. typhlops*. There is a curved row of five small spines extending from the posterior end of the orbit to the cervical groove. There is also a ridge furnished with five or six spines between the median and lateral carinae; it is not quite parallel to the lateral margin, but curves slightly inwards. Of the two submarginal carinae the upper and outer one is very faint in its posterior part but becomes more distinct in front, and ends in a prominent tooth at the base of the antenna; the inner and lower one bears a row of well-developed teeth which decrease in size anteriorly.

The abdomen is broadest in its anterior part and tapers uniformly to the telson. The first five terga are all keeled in the median line. In the first segment the keel is not greatly developed, in the second it is larger, in the third and fourth it reaches a maximum, and in the fifth segment is slightly smaller. The dorsal median line of the sixth segment has a low unbroken double ridge. The basal part of the telson has sometimes a very small, blunt tubercle, but never anything like a well-developed spine. The first tergum has two spines at its lateral

extremities, one above and one below the point of attachment to the hind margin of the carapace. Each of the large median keels on the first five terga is in the form of a broad spine which curves forwards. The pleura of the first segment are very small. In the second segment they reach their greatest development; they overlap the pleura of the segment in front and also those behind. The pleura become successively narrower and shorter in the posterior segments. Each pleuron has a curved midrib which springs from the thickened pleurotergal suture. All the pairs of pleura are fringed with setae. On the terga of the second to fifth segments there is on each side an oblique furrow running from the postero-lateral angle towards the median keel.

The telson has a slight median ridge and tapers to a fine point. The eyestalks bear a small, blunt tubercle on the anterior margin. Occasionally it is almost absent, and apparently is not present in Indian specimens (Alcock, 1901). At the posterior end of the orbital sinus there is a small part which appears almost translucent, whereas the rest of the impacted eyestalk is hard and opaque. Smith (1882) suggests that this may represent an old corneal area, and that there was another one at the tip of the lateral process of the eyestalk.

The antennules are very like those of *P. typhlops*, but the scale is narrower and much longer than the peduncle, and has no teeth on its inner margin. The inner flagellum is very slightly longer than the antennae, and is also longer than the carapace. The outer flagellum is very short and slender, only slightly longer than the scale. There are two spines at the outer distal angle of the basal peduncular joint. The outer flagellum has a dense fringe of setae on its distal three-fourths.

The antennal scale is longer and more sharply pointed than in *P. typhlops*. It reaches almost to the tip of the peduncle and is furnished with setae on both edges, as are also the peduncular joints.

The mouth parts are practically identical in structure with those of *P. typhlops*.

The chelipeds vary from about two and a-half to three times the length of the carapace. All the joints are flattened, especially the merus and ischium. There are one or two spines on the proximal half of the upper border of the merus, and one at the distal end of the same joint; the lower margin is very minutely spinulose, sometimes almost smooth. The carpus has an upper and a lower distal spine. The lower border of the propodite is spinulose.

The other pairs of pereiopods are similar to those of *P. typhlops*. The fifth are chelate in the female, while in the male the fixed finger is much shorter than the dactyl.

Neither the pleopods nor the uropods present any important differences from those of *P. typhlops*.

Size.—The largest specimen taken by the *Helga* is 75 mm. long. Alcock gives the length of one of his largest specimens

as 120 mm., and Smith's two largest measured 126 mm. and 124 mm.

The following measurements are taken from a male from station S. R. 944 :—

Total length	68 mm.
Length of carapace	30 mm.
Length of abdomen	38 mm.
Breadth of carapace	32 mm.
Length of chelipeds	81 mm.
Length of ischium of chelipeds ..	11·5 mm.
Length of merus of chelipeds ..	26·5 mm.
Length of carpus of chelipeds ..	15·5 mm.
Length of propodite of chelipeds ..	25 mm.
Length of palm of chelipeds ..	10·5 mm.
Length of dactyl of chelipeds ..	14·5 mm.
Length of second pereiopods ..	25 mm.
Length of third pereiopods	22 mm.
Length of fourth pereiopods	21 mm.
Length of fifth pereiopods	15 mm.
Length of antennules	46 mm.
Length of antennae	45 mm.

General Distribution.—The species has been frequently taken in both the western and eastern Atlantic. It was first described by Smith from the east coast of the United States, and very soon after by Milne Edwards from the West Indies, under the name of *Pentacheles spinosus.* In the eastern Atlantic it has been taken as far north as Iceland (Hansen), and also in the Bay of Biscay (Caullery), and in the Mediterranean (Senna). Stebbing has recorded it from off Cape Natal and Alcock from the Arabian Sea. In the eastern Pacific Ocean it is represented by a var. *pacificus*, Faxon.

Vertical Distribution :—The *Helga* specimens were taken in depths of 610–982 fms. The species seems to occur most frequently between 500 fms. and 900 fms., but it has been taken in much greater depths than this, e.g., 1140–1508 fms. (Senna), and also in much shallower water, e.g., 250 fms. (Smith) and 440 fms. (Stebbing).

Irish Distribution :—This species has been taken at four stations, all on the west coast.

Helga :—

S. R. 331—9 v '06.—51° 12′ N., 11° 55′ W., 610–680 fms., ooze. Trawl.—One, 40 mm.

S. R. 335—12 v '06.—51° 12′ 30″–51° 17′ 30″ N., 12° 18′–12° 16′ W., 893–673 fms. Trawl.—One, 43 mm.

S. R. 506—12 IX '07.—50° 34′ N. 11° 19′ W., 661–672 fms. Trawl. Temperature at 600 fms, 8·22° C., Salinity 35·53 ‰.—Two, 75–44 mm.

S. R. 944.—17 v '10.—51° 22′ N., 12° 41′ W., 982 fms., ooze. Shrimp trawl.—Three, 68–56 mm.

Polychelus nanus (Smith).

Pentacheles nanus, Smith, 1884.
Pentacheles nanus, Smith, 1886.
Polycheles nanus, Faxon, 1895.
Polycheles nanus, Caullery, 1896.
Polycheles nanus, Stebbing, 1908.
Polycheles nanus, Hansen, 1908.

P. nanus, var. **Grimaldii,** Bouvier.

Pl. I, figs. 14–15.

Polycheles Grimaldii, Bouvier, 1905 (b).

This species is closely allied to *P. sculptus* and both Faxon and Smith suggest that it may be merely a dwarf deep water variety of that species. It seems, however, to be distinguished by well-marked characters, which Smith, who has examined a large number of specimens, says are very constant. Hansen has also seen a large amount of material and is convinced that it forms a species quite distinct from *P. sculptus*.

The various spines and grooves are more robustly developed than in the last species. The sides of the carapace are slightly convex; the spines on the lateral margin are very slender and project almost at right angles; there are five or six in front, three in the central part, and seven behind. The frontal margin is concave considered as a whole, and is divided into three parts by the deep orbital sinuses. These are rounded posteriorly and do not narrow to a fine point as in *P. typhlops*. At the inner angle of each orbital sinus there is a small spine on the median lobe of the carapace in *P. Grimaldii* as described by Bouvier. As this, however, is the only difference between it and *P. nanus*, I have thought it best to give it merely the rank of a variety. Sometimes there is a blunt spine or process below the rostrum, but it is not so large as in *P. typhlops*, and is not a constant character. The rostrum is formed of two small spines. The median carina has its spines arranged as follows:—R + 1, 1, 2, 1; 2, 2, 2. The hind margin of the carapace has two small spines on each side beside the median ones. The carina which lies between the median line and the lateral margin has five prominent spines interspersed with smaller ones, and curves slightly inwards. The oblique line running outwards and forwards from the posterior cardiac region is well-marked and spiny. The submarginal carinae are well developed and furnished with distinct teeth.

The median carinal spines on the abdominal segments are longer and more strongly curved than in *P. sculptus*. The first segment, which is much narrower than the others, has two teeth on the lateral part of the tergum, one above and one below the point of attachment to the hind margin of the carapace; the carinal spine is not greatly developed. On the second segment the carinal spine is still quite low. In the next three segments, however, the median spines reach an enormous size and project

far over the preceding segments. The tergum of the sixth segment is marked by a double ridge, the edges of which are broken up into jagged teeth. On the basal part of the telson there is a sharp tooth with a very small tubercle on its posterior edge. The terga of the second to fifth segments have a deeply chiselled groove on each side, sloping upwards and forwards from the postero-lateral angle. The relative proportions of the pleura of the different segments are as in *P. sculptus*. In the present species, however, the lower edges of the pleura are minutely serrate. All the pleura are fringed with setae, as are also the telson and uropods.

The eyestalks have a small tubercle on the anterior edge, but sometimes it is very indistinct. At the posterior end of the orbital sinus there is a small translucent area on the eyestalk as there is in *P. sculptus*.

The basal joint of the antennular peduncle has two spines at its outer anterior angle. The outer flagellum is shorter than the peduncle and very slender. The inner flagellum is as long as the antennae, and longer than the carapace.

The chelipeds are extremely slender and compressed. They are much shorter than in *P. sculptus*. The merus bears a small spine on the proximal part of the upper margin, and also one at the distal extremity ; the carpus also has a dorsal distal spine.

All five pairs of pereiopods are chelate in both male and female.

The pleopods are similar to those of the species already described.

The three specimens taken by the *Helga* are all females, one of them ovigerous, and belong to the var. *Grimaldii*, Bouvier.

Size :—The largest specimen taken by the *Helga* measures 74 mm., exactly the same as Hansen's largest specimen. Faxon took an ovigerous female only 58 mm. long, so the size of the adult forms is considerably less than in *P. sculptus*.

The following measurements are taken from the large ovigerous specimen.

Length	74 mm.
Length of carapace	31 mm.
Length of abdomen	43 mm.
Breadth of carapace	23 mm.
Length of chelipeds	73 mm.
Length of ischium of chelipeds ..	14 mm.
Length of merus of chelipeds ..	22·5 mm.
Length of carpus of chelipeds ..	12 mm.
Length of propodite of chelipeds ..	23·5 mm.
Length of palm of chelipeds ..	10 mm.
Length of dactyl of chelipeds ..	13·5 mm.
Length of second pereiopods ..	29 mm.
Length of third pereiopods	26 mm.
Length of fourth pereiopods	23 mm.
Length of fifth pereiopods	20 mm.
Length of antennules	41 mm.
Length of antennae	33 mm.

General Distribution :—The species has a very wide range, being known from the east coast of North America between 35° N. and 41° N. (Smith), from Davis Straits, the west, south-west, and south of Iceland* (Hansen), from the Bay of Biscay (Caullery), Senegal (Bouvier), north-east of the Cape of Good Hope (Stebbing), and from the west coast of America between 0° 31′ S., and 7° 30′ N. (Faxon).

Irish Distribution :—The *Helga* has taken this species at one station only, and in the same haul there were several specimens of *P. sculptus*.

Helga :—

S. R. 944—17 v '10.—51° 22′ N., 12° 41′ W., 982 fms., ooze. Shrimp Trawl.—Three, 74–52 mm.

Vertical Distribution :—This species inhabits, as a rule, deeper water than *P. sculptus*. The greatest depth at which it has been taken is 1917 fms. (Smith), and the least, 355 fms. (Caullery). It appears to occur most commonly in about 800–1200 fms.

Polycheles granulatus, Faxon.

Pl. III, figs. 1–11.

Polycheles granulatus, Faxon, 1893.
Pentacheles Beaumontii, Alcock, 1894.
Pentacheles Beaumontii, "Investigator," 1894.
Polycheles granulatus, Faxon, 1895.
Pentacheles Beaumontii, Alcock, 1901.
Polycheles dubius, Bouvier, 1905 (*b*).
Polycheles eryoniformis, Bouvier, 1905 (*c*).
? *Polycheles Beaumontii*, Stebbing, 1908.

This species differs from all the others taken by the *Helga* in the very great breadth of the carapace, in the granular surface of the latter, and in the poverty of the armature of spines.

The orbital sinuses are fairly narrow, and there is a spine at both the outer and the inner angle of each. The spine at the antero-lateral angle of the carapace is very long and sharp. There are two rostral spines. The edges of the carapace are convex; the spines with which they are furnished do not, as in the other species, diminish in size posteriorly; on the contrary, the last spines are as large as those in front. There are from seven to ten in front, three in the centre, and from twelve to fifteen behind the cervical groove. In the posterior half the edges of the carapace are tilted upwards. The cervical groove is not well marked, its anterior branch in particular being very indistinct, and there are no spines placed along it. There is no curved row of spines behind the orbit. The carina on the border

*I am indebted to Dr. Stephensen of the Copenhagen University Museum for the information that all Hansen's specimens of *P. nanus* possess the spine at the inner angle of the orbital sinus, which is the distinguishing character of the variety *Grimaldii*, Bouvier.

between the cardiac and branchial regions can be traced as a very faint curved ridge which fades away altogether in front. The hind margin is not so markedly concave as in the species already described, and is quite devoid of spines. The whole surface of the carapace is covered with very minute tubercles or granules. The median carina of the carapace is formed of a double row of large granules, and is furnished with very few spines. These are rather variable in number. In the *Helga* specimen there are three single spines between the rostrum and the cervical groove ; in Alcock's specimen there is a single spine, a double, and another single ; in Faxon's specimen two double spines and a single. In Bouvier's *P. eryoniformis*, which is probably a synonym of *P. granulatus*, there are two single spines in front of the cervical groove and two double ones behind it ; none of the others have spines behind the groove. The submarginal carinae are very indistinct, the upper and outer one particularly so.

The abdominal segments are also granular. There are median carinae on the first five segments. The first three come to more or less sharp points which are directed forwards ; the fourth is not produced to a point at all, and the fifth is reduced to a mere blunt ridge. The sixth segment is quite smooth. On the basal part of the telson there is a blunt tubercle, but no spine. On the second to fifth segments there is a groove sloping upwards and forwards from the postero-lateral angle of the tergum towards the median line. The pleura have smooth edges and are of the usual relative sizes.

There is a spine on the anterior end of the eyestalk.

The antennular scale is very broad ; its inner edge is furnished with four or five teeth. The tip of the scale is bent inwards and upwards and ends in a long sharp point. There is a single spine at the outer angle of the basal peduncular joint.

The antennal scale is leaf-like, with a blunt tip, which does not quite reach the end of the peduncle. In Faxon's specimen the antennal scale is longer than the peduncle, in Alcock's "almost as long as the peduncle."

The oral appendages are very similar to those of *P. typhlops* and *P. sculptus*.

The chelipeds are considerably longer than the body and are compressed. The merus has a row of fairly prominent spinules on its lower edge ; they decrease in size towards the distal end. At the latter there is a single curved spine on the dorsal side, which also bears a row of very minute spinules. The carpus has an upper and a lower distal spine. The propodite, which is slightly longer than the merus, has a spine at the base of the dactyl and both its edges are spinulose.

The other pairs of pereiopods and the abdominal appendages present no points of difference from those of the three species already described.

Size.—The single specimen taken by the *Helga* measures

76 mm. Alcock's specimen was 80·5 mm. long, and Faxon's 99·5 mm. A specimen of *P. dubius* (= *granulatus*) taken at the Azores reached the length of 112 mm. (Bouvier).

The following are the dimensions of the single Irish specimen :

Length	76 mm.
Length of carapace	36 mm.
Length of abdomen	40 mm.
Breadth of carapace	29·5 mm.
Length of chelipeds	92 mm.
Length of ischium of chelipeds ..	15 mm.
Length of merus of chelipeds ..	25·5 mm.
Length of carpus of chelipeds ..	18 mm.
Length of propodite of chelipeds ..	29 mm.
Length of palm of chelipeds ..	13·5 mm.
Length of dactyl of chelipeds ..	15·5 mm.
Length of second pereiopods ..	31 mm.
Length of third pereiopods ..	29 mm.
Length of fourth pereiopods ..	25 mm.
Length of fifth pereiopods ..	19 mm.
Length of antennules	58 mm.
Length of antennae	54 mm.

There seems to me to be no doubt that *P. Beaumontii*, Alcock, is merely a synonym of *P. granulatus*, Faxon. Alcock (1894) gives the following four distinctive characters for his species :—(1) Great breadth of carapace ; (2) the diminutive size of antennulary scale ; (3) the deficient spinature of the median carina of the carapace ; (4) the great length of the chelipeds. Of these, the first, third, and fourth are equally characteristic of Faxon's species, and as the latter writer points out (1895) the form of the antennules of Alcock's specimen must have been due to "malformation or mutilation." The figure of *P. Beaumontii* (*Investigator*, 1894) appears to support this view, and in his later description (1901) Alcock says :—"The antennular scale appears to have been of the broad type of *P. gibbus* and *P. Carpenteri*."

The Irish specimen is in many respects intermediate between *P. granulatus* and *P. Beaumontii*. *P. dubius* (Bouvier) is also clearly a synonym of *P. granulatus* ; it appears to agree very closely with the *Helga* specimen. More doubtful is the case of *P. eryoniformis*, Bouvier, in which there are faint ridges behind the orbits, and "carènes branchiales armées de fortes spinules" which are quite wanting in the other specimens.

Stebbing (1908) mentions specimens from about 40 miles N.E. of the Cape of Good Hope, which he doubtfully refers to *P. Beaumontii* ; from his description, however, I do not think they can belong to that species. His specimens have two spines at the outer angle of the basal peduncular joint of the antennules, and also differ in other points.

General Distribution.—The species has been recorded from the

Gulf of Panama* (Faxon), from off Colombo (Alcock), from the Azores, Cape Verdes, south of Madeira and coast of Spain (Bouvier).

Irish Distribution.—Only a single specimen has been taken in Irish waters.

Helga.

S. R. 593—6 VIII '08. 50° 31′ N., 11° 31′ W., 670–770 fms., ooze. Trawl. Temperature at 650 fms., 7·75° C.; Salinity 35·53°/₀₀—One, 76 mm.

Vertical Distribution.—The greatest depth for the species is 1,076 fms. (S. of Madeira); the others range from 675 fms. (off Colombo) to 899 fms. (Gulf of Panama).

Eryonicus, Spence Bate.

Eryoneicus, Spence Bate, 1888. *Eryonicus*, Faxon, 1895. *Eryonicus*, Alcock, 1901.

This genus was founded by Spence Bate on a very small specimen 13 mm. long, which was taken by the *Challenger* near the Canary Islands. He gave to this specimen the name of *E. coecus*, but, owing to the immaturity of the original of his description, it is difficult to refer adult specimens to the same species with certainty. Faxon, however, identified several specimens taken by the *Albatross* off the west coast of Central America as belonging to Bate's species. He gives a very complete and detailed account of these specimens, but it is very doubtful whether they really belong to *E. coecus*. Since then *Eryonicus* has been taken in several parts of the Atlantic, in the Mediterranean, and in the Indian and Pacific Oceans.

Though *Eryonicus* and *Polycheles* are distinguishable at a glance, yet examination shows that in very many points there is close approximation between the two genera. The chief characteristics which distinguish *Eryonicus* are (1) the extreme inflation of the carapace, which is sometimes almost spherical, and is larger than the abdomen; (2) the very peculiar form of the renal tubercle of the antennae which is produced to an extraordinary length, nearly equalling the peduncle itself, in the form of a slender cylindrical rod projecting inwards and forwards; (3) the shortness of the antennules and antennae which are less than half the length of the carapace; (4) the shortness of the chelipeds, (5) the almost membranous character of the integument.

The spiny armature of the carapace and abdomen is on the same plan as in *Polycheles*, the spines being usually confined to certain definite carinae. Sometimes, however, there are also spines scattered over the intercarinal surface of the carapace.

The eyestalks are of the same form as in *Polycheles*, but they do not so completely fill the orbital sinuses, nor is the outer lateral process so well developed, indeed in small specimens the latter

**P. granulatus* has also been taken at a number of stations near the Hawaiian Islands (Rathbun, 1906.)

is sometimes hardly distinguishable. Usually there is a blunt conical tubercle on the front of the eyestalk and this may possibly represent the remains of the eye itself.

The oral appendages are similar to those of *Polycheles*.

The pereiopods are also on the same plan as in the last genus, but the chelipeds are shorter and there are differences in the arrangement of the spines.

Except on the first abdominal segment, where they are modified in the usual manner in adults, and are small and slender in immature individuals, the pleopods are long and well developed. There is an *appendix interna* with distal hooklets on the endopodites.

The telson and uropods are very similar to those of *Polycheles*.

The branchiae are as described by Faxon, formed of a stem which gives off long delicate filaments which decrease in size towards the tip. In the specimens which I have examined the epipodite of the third maxillipedes is large and well developed, but those of the first four pairs of pereiopods are very small and feeble. The branchial formula is as follows :—

—	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.
Podobranchs.	ep.	—	ep.	1+ep.	1+ep.	1+ep.	1+ep.	—
Arthrobranchs.	—	—	1 ?	2	2	2	2	—
Pleurobranchs.	—	—	—	—	1	1	1	1

I have been unable to find any trace of an arthrobranch on the third maxillipedes. In speaking of *Polycheles* Alcock says that this is sometimes very small and may be altogether absent, and it would seem as if the same were true of *Eryonicus* for Faxon mentions the arthrobranch in his description.

It has been suggested by more than one author that these interesting crustaceans are not adult forms, but are merely a stage in the development of *Polycheles*. This view was put forward by Spence Bate in his original description, and has been supported by some on the ground that no specimen has been found bearing ova, that the first pleopods are of an immature type, and that the whole aspect of the animal is that of a larval form. On the other hand, Faxon had in his collection a specimen measuring 62·5 mm., and another of 40 mm., and it is difficult to believe that animals of such large size should be merely larval forms, especially when we know that perfectly formed specimens of *Polycheles* have been found measuring no more than 30 mm. Moreover in Faxon's largest specimen he showed that the first pair of pleopods were developed with a broad expanded distal part just as in adult males of *Polycheles*. This individual had also an *appendix masculina* in addition to an *appendix interna* on the second pair of pleopods. Bouvier (1905 (b.)) has also described an adult male measuring 35 mm., the type specimen of *E. spinoculatus*. In one of the *Helga* specimens also the first pleopods are well developed and of the normal male type

This specimen is 34 mm. long. That no ovigerous female has yet been captured is not a serious difficulty when it is remembered that only about thirty-five specimens have been taken in all.

The *Helga* has captured ten specimens, including the types of three new species. Of these one, *E. hibernicus*, belongs to the division of the genus in which the carapace spines are confined to a few definite rows as in *E. coecus*, *E. Faxoni*, etc. The other two, *E. Scharffi* and *E. Kempi*, belong to the group containing *E. spinulosus* and *E. Puritanii*, in which the spines are scattered over the whole of the carapace. Perhaps the most interesting of all the specimens taken by the *Helga* is a very small individual measuring only 7 mm., in which the rostrum has the form of a very long median spine, and only two pairs of thoracic legs are developed. On these, however, and on the second and third maxillipedes there are slender exopodites, so that it is really a young *Eryonicus* in the *Mysis* stage of development.

Eryonicus leads a free-swimming life at a considerable distance from the bottom. Most of the *Helga* specimens were taken by the midwater otter trawl. Others were taken by the beam trawl, but these must have been caught as the latter was being hauled to the surface. The great soundings at some of the stations where specimens have been taken may be very deceptive. Faxon mentions a case where the depth was 1168 fathoms, and where four specimens were caught less than 400 fathoms below the surface. Another of the *Albatross* specimens was taken by the trawl where the depth was only 384 fathoms. These facts would seem to show that *Eryonicus* sometimes comes to within a comparatively short distance of the surface.

Ten species are known so far and a key for the determination of these is given below.

Key to species of *Eryonicus*.

1. *a*. Carapace spines almost entirely confined to definite rows, ... 2
   b. Carapace spines not confined to definite rows but also scattered generally over surface, .. 7

2. *a*. Two median spines on basal part of telson, *E. coecus*, Sp. Bate.
   b. One median spine on basal part of telson, ... 3

3. *a*. Spines on anterior part of median row of carapace : *rostrum*+1, 1, 2, 1, 1, ... 4
   b. Spines on anterior part of median rows of carapace : *rostrum*+1, 2, 1, 1, ... 6

4. *a*. One spine on outside of basal joint of antennular peduncle, ... *E. indicus*, Alcock.
   b. Two spines on outside of basal joint of antennular peduncle, ... 5

5. *a.* Abdominal median spines : 1, 1, 3, 3, 3, 2, 1, *E. spinoculatus*, Bouvier.
   b. Abdominal median spines : 1, 1, 2, 2, 2, 1, 1, *E. hibernicus*, n. sp.

6. *a.* Spines on posterior part of median carapace carina : 2, 2, 1, 2, .. *E. Faxoni*, Bouvier.
   b. Spines on posterior part of median carapace carina : *tubercle*, 2. Carapace broader than long, ... *E. Alberti*, Bouvier.

7. *a.* Tip of telson bears four very long and slender pinnate processes, .. *E. Puritanii*, Lo Bianco.
   b. No such processes present, ... 8

8. *a.* Basal part of telson bears two median spines, *E. spinulosus*, Faxon.
   b. Basal part of telson bears one median spine, .. 9

9. *a.* Basal joint of antennular peduncle bears one external spine, ... *E. Scharffi*, n. sp.
   b. Basal joint of antennular peduncle bears two external spines, ... *E. Kempi*, n. sp.

Eryonicus Faxoni, Bouvier.

Pl. IV, figs. 1–5.

Eryoneicus Faxoni, Bouvier, 1905 (*a*).
Eryoneicus Faxoni, Bouvier, 1905 (*b*).

This species is in many ways very similar to that described by Faxon (1895) as *E. coecus*, Spence Bate, but it possesses several characters which at once serve to distinguish it.

It has the large and globular carapace characteristic of the genus. It is broadest in the branchial region and narrows considerably anteriorly ; the posterior end is somewhat truncate but has rounded angles. When seen in profile the top of the carapace appears almost flat, ascending slightly from back to front, till it reaches a point three-fourths of the length from the hind margin, when it turns abruptly downwards, sloping very steeply, almost vertically, to the rostrum. *E. Faxoni* belongs to the division of the genus in which the spines on the carapace are almost entirely confined to definite rows running lengthwise along the surface. Between these rows the carapace is devoid of spines, and has merely a few setae scattered over it. The rostrum is marked by a pair of small spines in the centre of the frontal margin between the orbital sinuses. The internal angle of each sinus is also marked by a spine sharper but not so thick as the rostral ones. The sinuses themselves are fairly deep and very broad, and do not become narrower backwards. Externally each is bounded by a sharp spine, which is the most anterior of a row extending along the whole lateral margin

of the carapace. These marginal spines are arranged as follows: in the front part there are six which are sharp and slightly curved forwards; in the centre there are three very small, and in the hind part seven large spines, these latter thicker and blunter than the others; they increase in size posteriorly. Along the median dorsal line there runs a series of prominent spines arranged thus:—

Rostrum + 1, 2, 1, 1, ; 2, 2, 1, 2,

(The semicolon denotes the position of the cervical groove.)

Between this median carina and the lateral margin on the posterior half of the carapace there is a row of six spines, the *branchial carina*, decreasing slightly in size anteriorly. These run parallel to the margin and are nearer it than to the median carina; they extend from the hind margin to the cervical groove. There is a large single spine at the point of bifurcation of the cervical groove, one immediately in front of this, and also one external to it. Of the submarginal carinae the upper is minutely denticulate in its anterior third, and fades away behind this; while the lower and shorter one is formed of eight or nine spines, the last three of which are small, but the others large and prominent. Between the orbital sinus and the lower part of the cervical groove there is a curved row of three or four very small spines.

The abdomen is shorter than the carapace and very much narrower; it tapers slightly posteriorly. Each segment bears one or more large median dorsal spines arranged thus: 1, 3, 3, 3, 3, 1, 1, the last on the basal part of the telson. In the triple spines of the central segments the middle point is the largest and the front one is usually less erect than the others, sometimes almost horizontal. Besides these the abdominal segments bear other spines. On the sixth segment there is one at each edge of the tergum, and one projecting backwards horizontally from each postero-lateral angle. On the second, third, fourth, and fifth segments there is a spine at each edge of the tergum and also one on the middle of each pleuron. The pleura of the first segment are narrow and tapering. At each side of this segment there is a lateral extension which is buckled firmly to the hind part of the carapace. The second pleura are broad and expanded, with six or seven small spines on the lower margin. The pleura of the next three segments are all narrower than those of the second, and have each four or five marginal spines. The sixth pleura end in a single sharp point. They all bear setae at least on their posterior margin.

The telson is long and tapering, and has small spines on either margin and on two ridges running along the dorsal surface, besides the single large spine already mentioned. Its tip is prolonged into a sharp needle-like point.

The eyestalks are fixed and immovable in the orbital sinuses. Each bears in front a blunt conical process.

The basal joint of the antennular peduncle has two spines at the outer angle ; the third joint is much shorter than the second. The scale extends beyond the peduncle and tapers to a sharp point ; its inner edge bears two or three small teeth. The outer flagellum is very thin and less than half as long as the stout inner one.

The antennae are about equal in length to the larger flagella of the antennules. The scale is narrow and oval and fringed with plumose setae ; it reaches just beyond the peduncle. The renal tubercle is about equal in length to the whole peduncle.

The oral appendages are similar to those of *Polycheles*.

The chelipeds are nearly as long as the body without the telson, and are compressed in all their joints. The shape and relative lengths of the different joints are the same as in *Polycheles*. Both margins of the merus are spinulose, but the outer edge has only two or three spinules near the proximal end and a single curved distal spine, the inner having a row of very small spinules. The carpus has the usual upper and lower distal spines, and the propodite has one above the base of the dactyl.

The second pereiopods are much shorter than the chelipeds, and are also compressed. The merus is long and stout and thickly covered with setae on both margins. It bears two large distal spines and also two near the middle. The carpus has a long proximal and two distal spines, and setae on the outer margin. The palm of the propodite is very slightly larger than the fingers.

The third and fourth pereiopods are shorter than the second, and have no spines except a single one at the distal end of the merus and carpus.

The fifth are the shortest of all. They have no spines and are imperfectly chelate, the fixed finger of the propodite being represented by a very short blunt process.

The first pleopods are very small and extremely slender two-jointed appendages.

The succeeding pairs are long and well developed, and are fringed with long pinnate setae. An *appendix interna* is present furnished with a group of hooklets at the distal end.

The uropods are slightly shorter than the telson. Both the exopodite and endopodite have spinules and long setae on their margins.

Size.—The largest specimen taken by the *Helga* measures 35 mm. Bouvier gives the length of his as 30 mm.

The chief measurements of the largest specimen are as follows :—

Length	35 mm.
Length of carapace	18 mm.
Breadth of carapace	16 mm.
Length of abdomen	17 mm.
Length of antennules	10 mm.
Length of chelipeds	26 mm.

General Distribution.—The type specimen was taken by the *Talisman* off Cape Cantin, on the west coast of Morocco, and and another individual of the species was captured by the *Princesse Alice* in the Mediterranean, south of Majorca.

Irish Distribution.—

Helga.—

S. R. 335—12 v '06.—51° 12′ 30″–51° 17′ 30″ N., 12° 8′–12° 16′ W. 893–673 fms. Trawl.—One, ca. 18 mm.

S. R. 397—2 II '07.—51° 46′ N., 12° 5′ W., 549–646 fms. Trawl.—One 13·5 mm.

S. R. 443—16–17 v '07.—51° 28′ N., 12° 5′ W. Soundings 683 fms. Midwater otter tra 10–500 fms. Temp. at surface 11·65° C. Salinity 34·96 ‰.—One, 35 mm.

S. R. 449—19 v '07.—50° 28′ 30″ N., 11° 39′ W. Soundings 950 fms. Midwater otter trawl 0–700 fms.—One, 15 mm.

S. R. 806—15 VIII '09.—68 mls. W. ¼ N. of Tearaght Light. Soundings 634–651 fms., ooze. Midwater otter trawl 0–550 fms.—One, 24 mm.

I have referred these five specimens to Bouvier's species but the identification is open to doubt except in the case of the individual from station S. R. 443 which agrees exactly with the original description. The others are absolutely similar with the exception of the arrangement of the median abdominal spines. In the five specimens these are arranged as follows :—

S. R. 443	1, 3, 3, 3, 3, 1, 1.
S. R. 335	1, 2, 3, 3, 2, 1, 1.
S. R. 806	1, 1, 3, 3, 2, 1, 1.
S. R. 397	1, 1, 2, 2, 2, 1, 1.
S. R. 449	1, 1, 2, 2, 2, 1, 1.

It will be seen that with the exception of the last two, the arrangement of the spines is different in every case. I have placed them in such order as will best show that there is a distinct gradation from the first to the last. Moreover the specimens from stations S. R. 397 and S. R. 449, in which the spines are fewest are the smallest, so that the differences may be due, partly at least, to age.

Vertical Distribution.—As these organisms lead a free-swimming life at a considerable distance from the bottom it is very difficult to say exactly at what depth they were captured by the net. We may safely conclude that those specimens which were found in the trawl were caught as the latter was being hauled to the surface, and not on the bottom, but there is no means of knowing at what depth they entered the net.

Eryonicus hibernicus, n. sp.

Pl. V, figs. 1–2.

In general appearance this species closely resembles *E. Faxoni*, but is distinguished by certain well-marked characteristics. It has the spines of the carapace confined to definite rows, and not scattered thickly over the whole surface. The rostrum is double, and immediately below it there is a small median spine ; the latter is not present in *E. Faxoni*. The whole surface of the carapace is more or less setiferous, being especially so about the rows of spines. The spines of the median carina are arranged as follows :—

Rostrum+1, 1, 2, 1, 1 ; 2, 2, 1, 2.

The carina between the cardiac and branchial regions is marked by five or six large spines. The lateral margin has six spines on the anterior part, three in the middle, and seven on the posterior part. The upper submarginal carina is faintly seen in its front part but dies out towards the hind margin. The lower submarginal carina is furnished with ten or twelve medium-sized spines. Behind the orbital sinus there are four small spines in a row, which curves towards the median line and ends in a large spine on the anterior branch of the cervical groove. There is a single spine at the point of bifurcation of the cervical groove, and also one on the space between the anterior and posterior branches. There is also a spine on the cardiac region between the median and branchial carinae, and finally, a spine on each side of the median line on the hind margin of the carapace.

The abdominal median spines are arranged as follows :— 1, 1, 2, 2, 2, 1, 1, the last being on the basal part of the telson. The double spines on the third, fourth, and fifth segments are different in shape from those of other species. They are very broad and the lower portions of the two spines are united ; they become separate only comparatively near the tip. On the second to fifth segments there is a spine at the lateral edge of the tergum, and also one on the pleuron. This latter spine in the sixth segment is situated at the upper posterior angle of the pleuron and projects over the base of the uropods. The pleura of the second segment are much broader than the others ; they bear a row of teeth on their lower edge. The pleura of the other segments become successively narrower until in the sixth they end in a single sharp point. The pleura of the first segment are merely rudimentary as usual. The telson tapers to a sharp point, and bears small spines on either edge, and a double converging row of spinelets on its dorsal surface.

The eyestalks nearly fill the orbital sinuses ; each bears a blunt tubercle in front, and has a fairly large lateral process developed which passes outwards and downwards beneath the antero-lateral angle of the carapace.

There are two spines at the outer angle of the basal peduncular joint of the antennules. The sharp narrow scale passes the end of the peduncle of which the ultimate joint is the smallest.

The antennae are similar to those of *E. Faxoni*.

The outer margin of the merus of the chelipeds has one large proximal spine, and one curved distal one. Except for these both margins are smooth. The carpus has an upper and a lower distal spine. The propodite is not spinulose ; it bears a single spine at the base of the dactyl.

On the merus of the second pereiopods there are two spines at the middle of the outer side, and two at the distal extremity. The carpus has one proximal, and three large and one or two small distal spines.

The third and fourth chelipeds have each a distal spine on the merus and the carpus.

All the pereiopods are chelate except the fifth, in which the fixed finger of the propodite is represented by a short process not half as long as the dactyl.

The first pleopods are of the adult male type as seen in *Polycheles*. They have the same expanded distal part, with a group of hooklets on a small tubercle near the distal end of the inner margin.

The other pairs of pleopods are similar to those of *E. Faxoni*. There is no *appendix masculina* on the second pair.

The uropods bears small spines on the external margin. They are considerably shorter than the telson. At the outer angle of the basal part of the uropods there is a minute spine which is not present in *E. Faxoni* (see fig 2).

Fringes of setae are present on the edges of the pleura, and uropods, on the telson, the median carina of the abdominal segments, and on the pereiopods, except the first pair.

In the single specimen taken by the *Helga* the length of the carapace is 18 mm., of the abdomen, 16 mm. The greatest breadth of the carapace is 14 mm.

Size.—The measurements of the single specimen are as follows :—

Length	34 mm.
Length of carapace	18 mm.
Breadth of carapace	14 mm.
Length of abdomen	16 mm.
Length of antennules	10 mm.
Length of chelipeds	20 mm.

Helga.—

S. R. 231—20 v '05. *ca.* 50 mls., N. by W. of Eagle Island, Co. Mayo, 55° 1′ N., 10° 45′ W. Soundings 1,200 fms. Midwater otter trawl, O—1,150 fms., One, 34 mm.

Eryonicus Scharffi, n. sp.

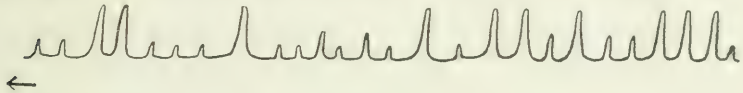
Pl. V, figs. 9–12.

The spines on the carapace are not confined to definite rows, but are also present on the surface between these. Two species of this sort have already been described, *E. spinulosus*, Faxon, from the Gulf of Panama, and *E. Puritanii*, Lo Bianco, from the Mediterranean, from both of which the present species is distinguished by several well-marked characteristics.

The ventral part of the carapace is more distinctly flattened than in the other species. The rostrum is marked by two long spines, and on either side of it the front of the carapace is produced into a horn-like process; these horns end in sharp spines and have also smaller spines on both edges. The arrangement of the spines on the median dorsal line is quite unlike that in any previously described species of *Eryonicus* :—

Rostrum + 2, 1, ; 2, 2, 1, 1, 2, 1, 2, 2.

It will be seen that there are only two spines between the rostrum and the cervical groove, one double and one single, while behind it there are no less than eight, five of which are double. The row of spines separating the cardiac from the branchial areas is very obscure, and is hardly distinguishable among the crowd of long, slender spines scattered over the carapace surface. The lateral margin has seven anterior spines on one side and eight on the other; in the central part there are four, of which the most posterior is smaller than the others; on the hind part there are ten large blunt spines interspersed with about fifteen or sixteen much smaller ones as in diagram :—



The orbital sinuses are shallow and wide.

The upper submarginal carina bears seven or eight large spines interspersed with a few smaller ones in its posterior third, but in front it becomes very faint, being marked by a few denticules, and ending in the usual spine at the base of the antenna. The lower submarginal carina is denticulate in front and bears five or six prominent spines posteriorly.

As already mentioned, the whole of the carapace surface, both above and below the lateral margin, is covered with spines which are not arranged in definite rows; they are largest towards the posterior end of the carapace, and are interspersed with setae, which are especially numerous on the lateral margin and on the median carina.

The median spines on the abdominal segments are arranged as follows :—2, 2, 2, 2, 2, 1, 1, the last being on the basal part of the telson. There are also other smaller spines present on each segment :—

First Segment.—Central double spine; and on each side two small spines on posterior margin.

Second Segment.—Central double spine; one large spine at each side of tergum, and one large and one small on each side of posterior margin.

Third Segment.—Central double spine; one at each side of tergum, one on each pleuron, and one small spine on each side of middle of posterior margin of tergum.

Fourth Segment.—Central double spine; one at each side of tergum, two on each pleuron, and two small ones on each side on posterior margin of tergum.

Fifth Segment.—Central double spine; one at each side of tergum, and two on each pleuron, near the posterior edge.

Sixth Segment.—Central single spine; one at each side of tergum, and one at upper posterior angle of pleuron extending over base of uropods.

In the double spines the anterior point is the larger, and it is more or less erect, though often curving backwards near the tip; the posterior halves are inclined at an angle of about forty-five degrees to the horizontal.

The pleura of the first segment are very small and narrow. Those of the second segment are broader than any of the others; their lower margin is rounded and bears a row of small teeth. In the third and fourth segments the pleura taper slightly downwards, and are also furnished with teeth near their extremities. The fifth pleura are very narrow and end in a long spine in front of which are one or two teeth. In the sixth segment they are narrower still and taper to a needle-like point.

The telson bears a single large median spine near its base, and tapers to a sharp point. Its edges bear small spines, and are also fringed with setae. There are no spinules on the dorsal surface.

The median line of the abdominal segments bears a number of stiff setae scattered about the bases of the large spines.

The eyestalks bear a small tubercle on the anterior margin; they do not completely fill the orbital sinuses.

The basal joint of the antennular peduncle has only a single spine at its outer anterior angle. The scale ends in a sharp inturned point and has six or seven spines on the inner edge.

The antennal scale is narrow and has a rounded tip; it is fringed with setae, and reaches to the end of the peduncle.

The chelipeds are shorter than the body. The merus is spinulose on both margins, and has the usual distal spine. The carpus has an upper and a lower distal spine. The margin of the propodite is spinulose from the proximal end to the base of the dactyl, where there is a single spine. The basus bears a spine just below the beginning of the ischium.

The second pereiopods are much stouter than the succeeding pairs, but shorter and slenderer than the chelipeds. The merus is slightly thicker in its distal portion than near the base; slightly more than half-way to the distal end it bears three large and three or four small spines on its outer margin; at

the distal end there are three larger spines. The carpus has on its outer margin one proximal, two central, and three distal spines, all of which are large ; there are also two or three small distal spines. As usual the palm of the propodite is longer than the fingers, which have minutely serrate cutting edges and the tips of which cross one another. The propodite, carpus, and distal part of the merus bear setae on the outer edge.

In the third pereiopods the dactyl is slightly larger than the fixed finger. The carpus has a single distal spine.

The fourth pereiopods are shorter and feebler than the third, and the carpus has no distal spine.

In the very short and slender fifth pereiopods the fixed finger is represented by a very small process of the propodite.

The pleopods are well-developed, biramous appendages, except the first pair, which are small and rudimentary.

The basal joint of the uropods bears a small spine at its outer angle. Both exopodite and endopodite are considerably shorter than the telson and are fringed with setae. The uropods have no spines on their margins.

Size.—The principal dimensions of the single specimen taken by the Helga are as follows :—

Length	26·5 mm.
Length of carapace	15·5 mm.
Length of abdomen	11 mm.
Breadth of carapace	14 mm.
Length of chelipeds	22 mm.

Irish Distribution :

Helga.—

S. R. 193—10 II '05.—40 mls., N. by W. of Eagle Island, Co. Mayo, 54° 50′ N., 10° 30′ W. Soundings $\overline{650}$ fms. Triangle net, O—630 fms. Surface temperature, 9·6° C. Salinity 35·41°/$_{oo}$; at 480 fms., temperature 9·2° C., One, 26·5 mm.

Eryonicus Kempi, n. sp.

Pl. V, figs. 3–8.

This species belongs to the division of the genus in which the carapace is more or less densely covered with spines, between, as well as on, the definite ridges. The spines, however, are not so thickly scattered as in *E. Scharffi*, and they are rather shorter than in that species. The inter-carinal spines are almost entirely absent on the submarginal part of the carapace, being represented merely by a small group near the posterior end. On the upper branchial, cardiac and gastric areas, however, they are present in large numbers, interspersed with setae. The carapace is very broad in its posterior half ; in the branchial region its breadth is greater than the length from rostrum to hind margin. It narrows rapidly in front, and the anterior end is somewhat rounded as seen from above. In the cardiac region the surface

is almost flat. The frontal margin is produced into a horn on each side of the rostrum; each horn ends sharply in a short spine and also bears a few small spines on its sides. Immediately beneath the rostrum, which is formed of two spines, there is a single median spine directed downwards. The gastric surface slopes downwards very steeply, almost vertically, to the rostrum. The hind margin of the carapace is concave. The spines of the median carina are arranged thus:—

Rostrum + 1, 1, 1, 2, 1; 2, 2, 1, 2.

On the front part of the lateral margin there are seven or eight spines, in the middle five or six, and posteriorly, from seventeen to twenty. These latter increase in size towards the hind margin. The branchial carina consists of ten or eleven spines. The upper submarginal carina has six spines at the posterior end, practically disappears in the middle, but is continued anteriorly as a low ridge bearing a large number of spinules, and ending in a strong spine opposite the base of the antenna. The lower submarginal carina has twelve or thirteen spines, extending almost to the base of the chelipeds; they are not quite so large as those of the upper row. Along the edge of the upper part of the cervical groove there are three or four sharp spines. As already mentioned, the intercarinal spines are most plentiful above the branchial ridge, less common between the latter and the lateral margin, and practically disappear below this. The setae are most plentiful on the carinae.

The median spines on the abdominal segments are arranged as follows:—1, 3, 3, 3, 3, 1, 1, the last on the base of the telson. In addition to these the segments bear other spines. On the sixth there is one at each postero-lateral angle, and one at each edge of the tergum, and a very small one just in front of this. The fifth has one at each side of the tergum, with a smaller one in front of it, and one on the middle of each pleuron. On the second, third, and fourth segments there is likewise a spine at each lateral end of the tergum, and one on each pleuron, and on the second and third only, a single spine on the tergum, between the median line and the edge of the tergum.

The pleura of the first segment are very small and narrow; in the second segment they are broad and expanded, and on their lower margin they have a row of spinules. The third, fourth, and fifth pleura are narrowed, and have each five or six small spines at their extremities. In the sixth segment the pleura end in a single narrow tapering point.

The telson has a row of seven or eight spines along each margin, but none on its dorsal surface.

There is a short, blunt tubercle on the front of the eyestalk. The eyestalks do not quite fill the wide orbital sinuses.

The antennular scale ends in a narrow spine, not quite reaching the end of the peduncle. Its inner margin bears five or six spines, and also pinnate setae. At the outer angle of the basal peduncular joint there are two spines. The third joint is shorter

than the second. The inner flagellum is about two-thirds the length of the carapace.

The last three joints of the antennal peduncle have each a thick spine on the inner side. The renal tubercle is not as long as the peduncle. The scale is narrow and leaf-like, fringed with pinnate setae, and does not quite reach the tip of the peduncle. The flagella are slightly shorter than the inner branch of the antennules.

The chelipeds are shorter than the body. Both margins of the merus are spinulose. The outer margin has only five or six spinules, the inner many more, but these much smaller. At its distal end it bears two curved spines. The carpus has the usual upper and lower distal spines, and has also a row of minute spinules on its outer edge, as has also the palm of the propodite. At the base of the dactyl there is a single spine.

The merus of the second pereiopods has a row of five or six long spines on the posterior margin, and four similar spines on the outer side. The carpus has also five spines on its posterior margin, and two at the distal end ; it bears a heavy fringe of setae on the outer side.

The third and fourth pereiopods are shorter than the last and very slender. They are devoid of setae except for a tuft at the end of the merus, and a similar one on the carpus.

The fifth pereiopods are very slender and feeble, and are almost simple, the fixed finger being represented by a very short process of the propodite. They are fringed with setae throughout.

The first pair of pleopods are very small and feeble two-jointed structures.

The second to fifth pairs of pleopods are very long and slender, the distal portions being fringed with long pinnate setae. An *appendix interna*, with an inner distal group of hooklets, is present.

At the external angle of the basal part of the uropods there are two small spines on one side, but only one on the other. The outer margins of the uropods bear a few small spines. The exopodite is much broader than the endopodite. Both are very nearly as long as the telson.

Size.—The principal dimensions of the type specimen are as follows :—

Total length	25 mm.
Length of carapace	13 mm.
Length of abdomen	12 mm.
Breadth of carapace	15 mm.
Length of antennules	8·5 mm.
Length of chelipeds	18·5 mm.

Two specimens of this species have been taken by the *Helga*, both off the west coast.

Helga.

S. R. 332—10 v '06. 51° 12′ N., 12° 2′ 30″ W., 680–735 fms., ooze. Trawl—One, 25 mm.

S. R. 752—16–17 v '09. 51° 48′ N., 12° 11′ 30″ W. Soundings 523–595 fms., ooze. Midwater otter trawl, O–595 fms, Surface temperature 11·9° C. Salinity 35·32 ‰; at 10 fms., temperature 11·51° C. Salinity 35·34‰; at 50 fms., temperature 10·54° C. Salinity 35·32‰; at 100 fms., temperature 10·45° C. Salinity 35·34 ‰; at 200 fms., temperature 10·18° C. Salinity 35·32 ‰; at 500 fms., temperature 8·9° C. Salinity 35·43‰.—One, 22 mm.

Eryonicus sp. juv.

Pl. IV, figs. 6–9.

This very interesting specimen was taken by the midwater otter trawl off the south-west coast; at the same station a small *E. Faxoni* was taken, and it is possible that the present specimen belongs to the same species. It is a very immature individual, in which only the first two pairs of pereiopods are developed, and these, as well as the second and third maxillipedes are furnished with exopodites. It is, in fact, a young *Eryonicus* in the *Mysis* stage of development, and the first that has been found, so far as I am aware.

The carapace is very much inflated, and is almost spherical. The rostrum is very long and slender; on each side of the base there is a small spine, probably representing the spine at the internal angle of the orbit of the adult. The median row of spines is well developed, and has the following arrangement:—

Rostrum + 1, 2, 1, 1, ; 2, 2, 1, 2.

The lateral margin is not at all clearly defined, and there is hardly a trace of branchial or submarginal carinae. There are four spines in a curved row behind the orbit, which is very wide and shallow. A few spines are present on the carapace besides those of the median carina. All the large spines on the carapace have setae springing from them. On the lower antero-lateral edge of the carapace there is a loop through which the tip of the second maxilla is visible. The edge of the loop is finely serrate.

The abdomen is very small and poorly developed. Each tergum bears a single feeble median spine, and there is a similar one on the basal part of the telson. The pleura are rounded, except in the sixth segment, where they end in a sharp point. A spine projects over the base of the uropods from the postero-lateral angle of the sixth segment. The telson is not fringed with setae.

The eyes do not nearly fill the very wide orbital sinuses. Besides the small part of the eye, which projects into the sinus, the larger posterior part can be seen as a dark yellow body, through the transparent carapace, and on the external side of this there is seen a bud or tubercle which represents the lateral process of the eyestalk of the adult.

The antennules are merely rudimentary and very short. No spine is developed at the outer angle of the basal peduncular joint, and the scale is represented by a short, blunt process.

The antennae are also very small. The scale is very feeble, but the renal tubercle is comparatively well-developed.

The first four pairs of oral appendages are similar to those of the adult.

The second and third maxillipedes have each a large exopodite, which is quite absent in full-grown specimens. In the second maxillipedes it is about two and a-half times as long as the endopodite, and in the third maxillipedes the two are about equal in length. The exopodite in both cases ends in a tuft of long setae.

There are only two pairs of pereiopods developed, but these are large and well formed. Each bears an exopodite ending in a group of long setae. These exopodites are formed of two joints, which are of equal length.

The first pereiopods are not relatively so long as in the adult, and the sutures between the various joints are not easily seen, especially in the proximal part of the limb. Near the distal end, and on the outer side of the merus, there are two strong spines. The carpus also bears two large spines, one proximal and one distal. The propodite is large and massive, the palm slightly shorter than the fingers. The exopodite is shorter than the propodite.

The second pereiopods have four very long spines on the merus, two near the middle, and two at the distal end. These spines are longer than the joint which bears them. The carpus has two spines of which the distal is the longer. The palm of the propodite is longer than the fingers. The exopodite is longer than the propodite.

The pleopods are formed, but are not functional as yet ; they are very small and have no setae. There is a mere tubercle indicating the position of the *appendix interna*.

The uropods are shorter than the telson and are very feeble.

Size.—The specimen measured from tip of rostrum to end of telson, when the abdomen is straightened out, is only 7 m.m long.

The single specimen was taken at the following station :—

Helga.

S. R. 449—19 v '07. 50° 28′ 30″ N., 11° 39 W. soundings 950 fms. Midwater otter trawl, 0–700 fms. One, 7 mm.

Tribe SCYLLARIDEA.

Family *PALINURIDAE.*

Genus **Palinurus,** Fabricius.

The two Irish species may be separated thus :—

On the middle of the carapace there are two rows of large spines, parallel in front of the cervical groove, slightly converging behind it. Merus of first pereiopods has four small teeth on proximal part of inner keel, and a large distal spine ; on under side of propodite there is a small, sharp tooth near the distal end, ... *P. Thomsoni.*

Middle of carapace has no such rows of spines. Except for a distal spine the inner keel of the merus of the first pereiopods is smooth. There is a very large and broad triangular tooth on under side of propodite, near the distal end, ... *P. vulgaris.*

Palinurus vulgaris, Latreille,

Pl. VI, fig. 3.

Palinurus vulgaris, Bell, 1853.

Palinurus vulgaris, Gruvel, 1912.

This species has been very fully described by Gruvel in his recent monograph on the *Palinuridae,* so that there is no need to repeat its characteristics here.

General Distribution.—The species reaches its maximum development as regards numbers in the Mediterranean and on the west coasts of Spain, Portugal, and Morocco. In the Mediterranean it is extremely abundant around Corsica and Sardinia, the Balearic Islands, and off the coast of Tunis and Tripoli. It also occurs in large numbers in the Adriatic and the Aegean. It is found at Madeira, and extends southwards as far as Cape Bojador (Gruvel). It extends northwards through the Bay of Biscay to the coasts of Britain, which form the northern limit to its range.

On the east coast of England* it is present only in small numbers, and becomes scarcer towards the north, ceasing altogether about Flamborough Head. It extends, however, along the whole west coast, being plentiful in the Bristol Channel and the Irish Sea. On the west of Scotland it is not common, but has been recorded from the Firth of Clyde, Loch

* For British distribution, see Ritchie, *Proc. Royal Phys. Soc., Edin.,* vol. XVIII, 1909-1910.

Fyne, Mull, Skye, North Uist and Sutherlandshire, the last four localities being represented by only one or two records each. It has been taken twice at the Orkneys.

Finally a single specimen has been found on the coast of Norway, near Bergen, but Appellöf (1906) regards this as a doubtful record.

Irish Distribution.—It is found all round the Irish coasts, but most plentifully in the south and west; in the north it is rare. It has been recorded from the following localities: South coast: Youghal (Bell), Cove (Humphreys), Derrynane, Valentia (Kinahan); west coast: Galway (Melville), Oranmore, Ballynakill, Aran; north coast: Magilligan (Kinahan); east coast: Larne Lough (Rankin), Dalkey Sound (Kinahan).

It is common at Inishbofin, Co. Galway.

On the Continent, and especially in France, Spain, and Portugal, *P. vulgaris*, the "Langouste," is of great commercial importance. It is fished on all the Atlantic and Mediterranean coasts of the countries named. The fishermen use boats fitted with large tanks in communication with the sea, and in these the animals may be kept alive for any length of time desirable. Some of the larger boats can carry eight or nine thousand living Langoustes. There is also a thriving industry connected with the species in Corsica, and on the Italian coasts. In Greek waters, on the other hand, it is not fished to any great extent, though occurring in large numbers. It is not held in great estimation in this country as an article of diet, and most of the specimens caught on the coasts of Devon and Cornwall are sent to Boulogne.

There is at present no regular fishery of *P. vulgaris* in Ireland, the pots used for the capture of lobsters being too small to admit full-grown "crayfish." The latter, when caught, are generally found clinging to the outside of the pot. They are also taken, not unfrequently, by trawels, and may often be seen exposed for sale in Dublin. I understand that it is proposed to use trammels for "crayfish" on the South coast. Trammels have been found very effective, especially if left in the water until the first fish caught in them become somewhat decomposed.

Palinurus Thomsoni, n. sp.

Pl. VI, figs. 1–2.

This species is at present represented by a single male specimen taken off the south-west coast of Ireland in 212-229 fms. It is closely related to *P. vulgaris*, Latrielle, and also to a South African species, *P. Gilchristi*, Stebbing.

On the median dorsal part of the carapace there are two rows of strong, well-developed spines. The rows begin at a point half-way between the rostrum and the cervical groove, and extend very nearly to the hind margin of the carapace. The part of each row which lies in front of the cervical groove consists of

three very large uniform spines, the tips of which point forwards, and almost overhang the base of the spine in front. Here the two rows are parallel, but behind the cervical groove they begin gradually to converge, and the spines to diminish in size. There are seven of these in each row behind the groove.

A somewhat similar arrangement of spines occurs in *P. Gilchristi*. Mr. Stebbing has very kindly lent me a specimen of this South African species for comparison with the Irish specimen.* I find that the dorsal rows are composed of much larger and stronger spines in the latter than in Mr. Stebbing's specimen; they are also more uniform in size and regular in arrangement.

The large supraorbital spines are more horizontal than in either *P. vulgaris* or *P. Gilchristi*, and the distance between the tips of these spines is greater than in the other two species. The distance from tip to tip is exactly half the length of the carapace, whereas in the other two species mentioned it is always markedly less than half. On the anterior margin of each of these spines there are four small teeth of uniform size. The posterior margin is smooth. Behind this large spine and also behind the suborbital spine there are diminishing rows of smaller spines, as in *P. vulgaris*.

The rest of the spiny armature of the carapace is more robust than in the specimen of P. *Gilchristi* which I have examined.

On the front edge of the epistome there are several small tubercles, in addition to the sharp central tooth and those at the external angles; they are not so large or so sharp as in *P. vulgaris*.

The pear-shaped body at the anterior end of the sternum bears two small tubercles.

The most important difference between this species and *P. Gilchristi* lies in the sculpture of the abdominal terga. On each of these from the second to the fifth there is a transverse furrow which is interrupted in the median line by a low flat ridge or carina; but in *P. Gilchristi* in addition to this, there is also on each of these segments an anterior furrow which is unbroken by the carina and which is heavily fringed with setae. In neither *P. Thomsoni* nor *P. vulgaris* is this second furrow present; there is at most a very faint depression on the second segment alone, and this bears only a few setae. The presence of this important furrow is not mentioned in the original description of *P. Gilchristi* (Stebbing 1900 (*b*)).

The spines of the abdominal pleura are quite as long and as sharp as in *P. vulgaris*. There is a sharp tooth on the anterior edge of the pleura of the second segment.

The first pair of legs are stouter and shorter than the succeeding pairs, but not very markedly so. On the inner side of the ischium there are two blunt tubercles. The inner crest of the merus

* Since writing the above, I have seen another specimen of *P. Gilchristi*, kindly sent to me by Dr. Calman. It agrees exactly with Mr. Stebbing's specimen.

bears four small sharp teeth on the proximal part of the joint, while at the distal end there is a much larger single tooth. The outer keel is quite smooth, and on the distal part of the upper keel there is a very faint granulation, but nothing comparable to the strong row of teeth present in *P. vulgaris*. Both the upper and outer keels end in sharp points. Near the distal end of the propodite there is on the under side a very minute, sharp tooth directed forwards.

The combined lengths of carpus and propodite in the fifth pair of legs are exactly equal to the combined lengths of these joints in the fourth pair.

The colour of the specimen (in alcohol) is as follows :—The abdomen is pale violet brown, mottled with pale yellow. The same violet brown colour is present on the carapace and extends half-way up the supra-orbital spines, the distal half of which is yellow ; the extreme tip is a translucent golden brown. All the carapace spines are of this pale yellow tint and have translucent points. The sternum, legs, antennules, telson, and uropods are yellow ; the antennae are marked with alternate bands of brown and whitish yellow.

The single specimen is a male, and measures 154 mm., from rostrum to end of telson.

I have great pleasure in naming the species in honour of my first instructor in Zoology, Prof. J. Arthur Thomson, of Aberdeen.

The record of the single specimen is as follows :—

Helga.

S. R. 1178—22 v '11. 58 mls. W. ½ N. of Blackball Head. 51° 20′ N., 11° 30′ W., 212–229 fms., sand. Trawl—One 154 mm.

As the three species, *P. Thomsoni*, *P. Gilchristi*, and *P. vulgaris*, are closely related it may be of use to give a summary of their characters in tabular form.

[TABLE

A. *Palinurus Thomsoni.*	*B.* *Palinurus Gilchristi.*	*C.* *Palinurus vulgaris.*
On the middle of the carapace there are two rows of large spines, parallel in front of cervical groove, slightly converging behind it. The spines are largest in front and diminish posteriorly.	As in *A*, except that the spines are not so large or so uniformly arranged.	No such rows of spines.
A transverse furrow fringed with hairs on the second to fifth abdominal terga. Each furrow is broken by a low broad median carina.	A transverse furrow as in *A*, broken by a narrow carina. In addition to this there is another unbroken transverse furrow on the anterior part of the tergum.	As in *A*.
On front margin of supra-orbital spines there are four uniform teeth.	Three or four teeth, of which that nearest the tip is the largest.	Four teeth; that nearest the tip much longer and sharper than others.
Distance between tips of supra-orbital spines is ·5 of length of carapace.	·47—·42 of length of carapace.	·41 in specimen 4 inches long. ·36 in specimen 7 inches long. ·33 in large adult.
Merus of first pereiopods has four small teeth on proximal part of inner keel, and a large distal spine.	4–6 small teeth, otherwise as in *A*.	Except for a distal tooth, inner keel is quite smooth.
Upper and outer keels of merus, smooth, except for very faint granulation on upper keel at distal end. Spine at end of each keel.	Upper and outer keels quite smooth, but with spine at extreme tip of each as in *A*.	Distal end of upper keel bears a row of prominent spines.
On under side of propodite there is a small, sharp tooth near the distal end.	As in *A*.	A very large and broad triangular tooth near distal end.
Pear-shaped body at apex of sternum bears two small tubercles.	Pear-shaped body smooth.	Pear-shaped body bears several rough tubercles.
Pleura long and sharp; those of the second segment have a spine on the anterior edge.	Blunter and shorter than in *A*. No spine on second segment.	As in *A*.

ASTACURA.

Tribe NEPHROPSIDEA.

Family *NEPHROPSIDAE.*

There are three genera occurring in Irish waters :—

A. Eyes small, without pigment ; no antennal scale, ... *Nephropsis.*

B. Eyes large, well pigmented ; antennal scale present.—

1. Eyes very large, reniform, broader than stalks ; antennal scale foliaceous, .. *Nephrops.*
2. Eyes large, but not broader than stalks ; antennal scale spine-like, ... *Homarus.*

Genus **Nephrops,** Leach.

Nephrops norvegicus, Linne.

Nephrops norvegicus, Bell, 1853.
Nephrops norvegicus, Heller, 1863.
Nephrops norvegicus, Ortmann, 1892.
Nephrops norvegicus, Hansen, 1908.

This species, the Norway Lobster, or "Dublin Prawn," is so well known that it is quite unnecessary to give a description of its characters here.

Size.—The largest specimen taken by the *Helga* is a male from the west coast ; it measures 240 mm. from the tip of the rostrum to the end of the telson ; carapace, 108 mm. ; abdomen, 132 mm. ; rostrum, 34 mm. ; breadth of carapace, 44 mm. This individual was taken along with six others in the great depth of 337 fathoms.

The average length of adults is about 165–180 mm. for males, and 120–140 for females.

General Distribution.—The most northerly locality for the species is off the south coast of Iceland (Hansen), where it is so plentiful that it forms the chief food of the cod. It occurs on all the Scandinavian coasst (Sars, Meinert, etc.), on the coasts of Belgium and France (Van Beneden, Bonnier, Caullery), in the Mediterranean and Adriatic (Heller, Senna), and on the coast of Morocco (Milne Edwards). It is also present in great numbers on the coasts of England and Scotland, but it is not known to occur in the Hebrides, Shetlands or Faeroes (Hansen).

Irish Distribution.—It is found all round the Irish coasts, but it is specially plentiful in the Irish Sea between the Isle of Man and the coasts of Louth and Down. In this region several hundred specimens are frequently taken in one haul.

Vertical Distribution.—The species occurs in greatest numbers in depths of 10–40 fathoms in the Irish Sea; on the west coast it also extends into deep water down to more than 300 fathoms. The *Helga* took seven specimens, two of them very large, in 337 fathoms, the greatest recorded depth for the species, with the exception of one given by Senna (1903), from the west of Sicily, 416–450 fathoms.

Genus **Nephropsis,** Wood Mason.

Nephropsis, Wood Mason, 1873. *Nephropsis*, Norman, 1882. *Nephropsis*, Alcock, 1901. *Nephropsis*, Stebbing, 1903.

The rostrum is fairly long, robust, usually furnished with lateral spines. Carapace more than half as long as the abdomen; cervical groove very distinct; telson quadrate.

The eyes are hidden beneath the rostrum; they lie close together, are very small, and devoid of pigment. The first joint of the antennular peduncle has no stylocerite; there is no antennal scale. First three pairs of legs chelate; first pair large and massive, very slightly unequal in both sexes; second pair slightly stouter than the succeeding pairs.

Nephropsis atlantica, Norman.

Pl. VII, figs. 1–13.

Nephropsis atlantica, Norman, 1882.
Nephropsis atlantica, Caullery, 1896.
Nephropsis atlantica, Alcock, 1901.
Nephropsis atlantica, Hansen, 1908.

The surface of the carapace is granular and bears a fairly dense coating of hair. The large rostrum, slightly upturned near the tip, is about half as long as the carapace; it bears a fringe of setae low down on either side. Normally it has two pairs of large lateral spines, but occasionally there are three pairs, and sometimes two on one, and only a single spine on the other side. At the base of the rostrum there are two large spines directed outwards and forwards, and behind these, two smaller ones. Between these two pairs there is a double divergent row of small teeth which decrease in size backwards. Enclosed by these, on the median line there is a blunt oval tubercle. At each side there is a large spine over the base of the antenna. There is a slight furrow running along the median line from the rostrum to the very prominent cervical groove; behind the latter it becomes much fainter, but can be traced to the posterior margin of the carapace, which is slightly concave. A distinct ridge divides the cardiac from the branchial area. From the posterior angle of the carapace there runs a very prominent ridge downwards and forwards parallel to the latero-ventral

margin till it meets the cervical groove. Starting from the same point and keeping parallel to this ridge, but between it and the margin, there is a shallow groove.

The abdomen is of almost uniform breadth throughout, narrowing very slightly about the fifth and sixth segments. From the second to the sixth segment there is a low median carina. The terga are all coated with a dense covering of setae. They are separated from the pleura by prominent curved ridges. On the first segment the pleura are very slightly developed, but in the other segments they are large. On the second to the fifth segments they taper rapidly downwards and are produced into very long sharp points. Both anterior and posterior edges are minutely serrate. Half way down the anterior border of the pleura of the second segment there is a single spine.* The pleura of the sixth segment are much blunter than the others. They have a sharp spine projecting backwards over the base of the uropods.

The telson is almost quadrate in outline, the posterior margin being very slightly convex. On its surface there are two ridges which diverge backwards and terminate at the external angles in sharp spines. It is covered with short scattered hairs and fringed with long setae on the posterior and lateral margins.

The eyes are devoid of pigment and are very small. They lie close together beneath the rostrum.

The first and third joints of the peduncle of the antennules are almost equal, the third being very slightly larger. The second is about half the length of the third. The outer flagellum is thicker and slightly shorter than the inner which is considerably less than twice the length of the peduncle.

The flagella of the antennae are extremely long, sometimes nearly two and a-half times the total length of the body. The peduncle is equal to that of the antennules. The opening of the renal tubercle is conspicuous on the lower side. The antennal peduncle is practically hairless, but that of the antennules bears heavy fringes of pinnate setae.

The mandibles are massive, and have no toothed edge. There is a three-jointed palp, the basal joint very small.

The first maxillae have a two-jointed palp, the distal joint very much more slender than the proximal, at the base of which there is a dense brush of setae. The inner edge of the upper endite bears rows of strong teeth, and the lower one spines and long pinnate setae.

In the second maxillae the palp is very long, extending beyond the tip of the scaphognathite.

The endopodite of the first maxillipedes is two-jointed, the first joint more than twice as long as the second. The exopodite is very long and slender, and its distal part is multiarticulate. The epipodite is large and foliaceous.

* In a male specimen taken in 610-680 fms., at station S. R. 331, each of the pleura from the second to the fifth segment has two large spines on the anterior border. In all other respects the specimen is quite normal.

In the second maxillipedes the merus is the longest joint. The propodite is short and inflated; the dactyl bears a few terminal spines. The exopodite is very long and slender; its peduncle reaches beyond the distal extremity of the merus, and its flagellum well beyond the tip of the dactyl, when the appendage is straightened out. The epipodite is rather slender.

The teeth on the crest of the ischium of the third maxillipedes are rather blunt. The merus is slightly shorter than the ischium. None of the joints are armed with large spines. The carpus, propodite, and dactyl are nearly equal in length. The exopodite is short, not reaching the distal end of the merus.

The chelipeds are massive, are densely setose, and have more or less rounded angles. They are slightly unequal. They are longer in the male than in the female. In the specimens taken by the *Helga* the chelipeds are ·71 of the length of the body in the males, and only ·59 in the females. The merus is very slightly shorter than the propodite, though Norman, in his original description of the species (1882), says the merus is the longest joint. At its distal end the merus bears two spines, one above and one below. It is thicker distally than at the proximal end. The carpus is short and stout and bears several spines, three on the inner side, one on the outer, and one below. Sometimes, however, only four spines are present. The propodite is the largest joint; it is quite unarmed and is very thickly covered with hair; the palm is slightly longer than the fingers, the tips of which cross when closed. The whole surface of the appendage is more or less granular. The setae are thickest on the carpus and propodite.

The second pair of legs are rather stouter than the next three, which are long and slender. The second and third pairs are chelate, and their coxae bear on the inner side large flattened lobes, which in the third pair end in a conspicuous hook at the outer side. These lobes are almost entirely absent in the female. The fourth legs are the longest; the fifth are a little shorter, and the third and second slightly shorter still.

In the male the first pleopods lie close together, and are pressed against the ventral surface. In adult specimens they reach as far as the base of the second legs. They consist of two joints, the first of which is very short. The second is expanded into a flattened blade, which is concave on the inner side, so that when pressed together the two pleopods form a tube. On the inner surface of each there are two rows of stiff setae, one on the margin, and the other springing from a low ridge that runs from the proximal into the concave distal part; the setae all point forwards.

In the female the first pleopods are very slender and short; the distal part is multiarticulate and is fringed with long pinnate hairs.

In the male the second pair of pleopods has a large *appendix masculina* attached to the endopodite. It usually lies closely pressed against the first pair. It is nearly as long as the pleopods

themselves, is much stouter, and ends in a group of long, sharp teeth.

The following pairs of pleopods are long and slender and bear fringes of long pinnate setae. A small and feeble *appendix interna* is present on the second to fifth segments, in the female, and third to fifth in the male. In the latter it is wanting on the second segment. It is never more than about half the length of the endopodite, and becomes smaller on the posterior segments.

The exopodites of the uropods have a transverse suture. Both exopodite and endopodite are strengthened by two ridges, one median and the other along the outer border. The latter ends in a sharp tooth. The base of the uropods also bears a spine pointing backwards. The hind margins of the uropods are fringed with long setae.

The branchial formula is as follows :—

—	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.
Podobranchs.	ep.	ep.	1+ep.	1+ep.	1+ep.	1+ep.	1+ep.	—
Arthrobranchs.	—	—	2	2	2	2	2	—
Pleurobranchs.	—	—	—	—	1	1	1	1

In the females there is situated between the bases of the fourth pair of thoracic legs a structure corresponding to the thelycum of the Peneidae. So far as I know such an organ has not hitherto been described in this species.* It consists of two plates lying in contact on the sternal surface between the coxae of the last two pairs of legs. At the anterior end they coalesce and are rounded ; at the posterior end, on the other hand, they diverge and end in narrow points beside the fifth coxae. The two plates are arched and rise steeply from the sternum on either side. Between them there is a deep groove which is widest posteriorly and gradually narrows towards the front. It leads to the minute opening into the interior of the spermatheca.

If one of the plates is removed it is found that the interior is filled with a whitish friable substance, in which I have succeeded in finding spermatozoa. The interior of the one plate is in communication with that of the other by the anterior portion where they are united.

There seems to be no doubt that the structure is a genuine spermatheca. It is not merely a body produced by the close adherence of two spermatophores, such as has been erroneously described as a spermatheca in some of the Eryonidae (Andrews, 1911), for in this case it is invariably present in females, and possesses perfect bilateral symmetry, two features which are wanting, for instance, in *Polycheles sculptus*, in which species spermatophores found adhering to females have been taken for a spermatheca.

* Since writing the above I have found this structure mentioned by Caullery (1896).

The coxae of the third pair of legs, which bear the large oval genital openings, are much swollen, and project inwards, so that they lie immediately in front of the spermatheca.

In a male specimen from station S.R. 477 there was found a spermatophore projecting from the genital orifice to a distance of 9 mm. It consists of a slightly convoluted cylindrical tube within which the spermatozoa are densely packed. The tube is embedded in a flattened translucent mass of a brownish-yellow colour. This is narrowed to a point at the anterior end.

The spermatozoa themselves are flask-shaped bodies which are surrounded, except at the tip, by a thick transparent envelope.

A specimen which was taken by the *Thor* at 49° 23′ N.L., 12° 13′ W.L., is peculiar in having some of the male characters united with those of the female. There is a spermatheca present exactly as in a normal female, and the first pair of pleopods are of the female type. On the coxae of the third pair of thoracic legs, however, there are flattened plates ending posteriorly in hooks as in male specimens. There are no genital openings on the third coxae, but there are on the fifth. Thus in the one individual we have the male genital openings and the male hooks on the third coxae, and also a spermatheca and first pleopods of the female type. The internal sexual organs are those of a normal male; no trace of ovaries is to be seen.

The hermaphroditism here is not so complete as in *Calocaris Macandreae*, where the first pleopods are of the male type, and both male and female genital openings are present (see p. 93.)

General Distribution.—The species was first described from a single specimen taken by the *Knight Errant* off the north of Scotland (Norman, 1882), and it was again taken in the same region, in the Faeroe Channel, by the *Michael Sars* in 1902. It has also been recorded from the Bay of Biscay (Caullery), from South Africa (Stebbing), and from the Arabian Sea (Alcock).

Two specimens have also been taken by the *Thor* off the south-west coast of Ireland, just outside the Irish marine area.

Irish Distribution.—The *Helga* has taken the species on several occasions, always off the south-west coast.

S. R. 327—8 v '06. 51° 43′ 30″—51° 38′ N., 12° 15′—12° 18′ W., 550–800 fms. Trawl—One female, about 85 mm. (rostrum broken).

S. R. 331—9 v '06. 51° 12′ N., 11° 55′ W., 610–680 fms. Trawl—Five, three males, two females, 103–52 mm.

S. R. 333—10 v '06. 51° 37′ N., 12° 9′ W., 557–579 fms. Trawl—Temp. at 500 fms. 9·2° C., Salinity 35·1°/₀₀—One female, 101 mm.

S. R. 334—10 v '06. 51° 35′ 30″ N., 12° 26′ W., 500–520 fms. Trawl—One male, 84 mm.

S. R. 363—10 VIII '06. 51° 22′ N., 12° W., 695–720 fms. Trawl—One female, 70 mm.

S. R. 400—5 II '07. 51° 21′ N., 11° 49′ W., 525–600 fms. Trawl—Two.

S. R. 401—5 II '07. 51° 14′ N., 11° 51′ W., 600–660 fms. Trawl. Temp. at 580 fms. 8·35° C., Salinity 35·5 °/₀₀ —Two females, 75–73 mm.

S. R. 477—28 VIII '07. 51° 15′ N., 11° 47′ W., 707–710 fms. Trawl. Temp. 7·19° C.—Two males and two females, one ovigerous, 94–84 mm.

S. R. 484—30 VIII '07. 51° 35′ N., 11° 57′ W., 602–610 fms. Trawl—One male, 84 mm.

S. R. 506—12 IX '07. 50° 34′ N., 11° 19′ W., 661–672 fms. Trawl. Temp. at 600 fms. 8·22° C., Salinity 35·53 °/₀₀—Two males and two females, 79–70 mm.

S. R. 593—6 VIII '08. 50° 31′ N., 11° 31′ W., 670–770 fms. Trawl. Temp. at 650 fms. 7·75° C., Salinity 35·53 °/₀₀—Four females, one ovigerous, 97 mm.

Vertical Distribution.—The depths at which this species has been found range from 350 fms. (Caullery) to 740 fms. (Alcock). It appears to reach its greatest frequency between 600 and 700 fms.

Genus **Homarus,** H. Milne-Edwards.

Homarus vulgaris, Milne-Edwards.

Homarus vulgaris, Bell, 1853.
Homarus vulgaris, Heller, 1863.
Homarus vulgaris, Carus, 1885.

Size.—Though as a rule it is considerably smaller than the closely-allied American Lobster, the European species sometimes attains a very large size. The largest specimen of which I have been able to find a record is one measuring 20 inches from the rostrum to the telson; it was taken in Guernesy in 1873. A very large individual was taken in the Irish Sea in 1911; it measures 19 inches from rostrum to tip of telson and has the following additional dimensions :—

Length of carapace (including rostrum)	219 mm. (8⅝ ins.)
Breadth of carapace	108 mm. (4¼ ins.)
Tip of longest cheliped to tip of telson	784 mm. (31 ins.)
Length of crushing chela ..	292 mm. (11½ins.)
Length of cutting chela	273 mm. (10¾in.)

General Distribution.—The northern limit of the range of the European Lobster is about Tromsö on the north-west coast of Norway; it is, however, much more plentiful on the south-west coast (Appellöf). It occurs commonly in Swedish and Danish waters (Goës, Meinert), and along all the coasts of the North Sea. It is found all round Britain, and extends southwards through theBay of Biscay to the coast of Spain and

Portugal, and into the Mediterranean. It does not occur there in such large numbers as in Northern Europe, and is of less importance from an economic point of view than *Palinurus vulgaris*, the "Langouste." Its range is not bounded eastwards by the Adriatic as stated by Herrick (1911), as it extends into the Aegean (see Calman and D'Arcy Thompson, *Nature*, 1911).

Irish Distribution.—The Lobster is found on all the coasts of Ireland, and is the basis of a fishery which is growing in value and importance, as may be seen from the tables given below. In 1912 the total catch was more than half a million for the first time. The figures for England and Wales, and for Scotland, are given below in parallel columns for comparison. The greatest numbers are landed on the west and south coasts.

In the last half-century an extensive literature on the lobster has grown up, and experiments have been carried out in many countries with a view to devising some practical method of lobster-culture, which would counteract the serious depletion of the supply which has been brought about by over-fishing. I have thought it useful to give here references to a few of the most important papers dealing with the lobster and its fisheries.

1888, Ewart and Fulton; 1894, Ehrenbaum; 1895, E. J. Allen; 1896, E. J. Allen; 1896, F. H. Herrick; 1909, Appellöf; 1911, F. H. Herrick.

The most complete account of the European lobster is to be found in the paper by Appellöf (1909). Herrick's splendid monograph (1911) gives a most exhaustive and detailed account of the structure, relationship, habits, development, and fisheries of the American lobster; it also includes a large amount of information on the European species, and contains an almost complete bibliography of the literature of both.

NUMBER AND VALUE OF LOBSTERS LANDED IN IRELAND, ENGLAND AND WALES, AND SCOTLAND FROM 1900 TO 1912.

	Ireland		England and Wales		Scotland	
	Number	Value	Number	Value	Number	Value
		£		£		£
1900	285,821	8,321	654,152	28,590	672,093	31,609
1901	244,854	7,351	650,491	28,735	790,310	36,621
1902	193,820	6,585	648,736	29,403	789,554	37,329
1903	176,656	6,120	549,351	25,431	1,195,788	34,568
1904	190,902	6,452	*546,001	*25,566	*747,121	*35,736
1905	234,592	7,362	585,789	26,712	1,239,317	36,320
1906	196,502	6,733	520,657	25,256	828,252	35,966
1907	323,030	10,088	495,781	23,802	725,421	35,505
1908	374,185	11,883	512,478	24,377	685,371	33,920
1909	420,830	11,361	546,823	26,288	688,526	33,688
1910	324,585	12,499	533,008	25,435	688,856	34,795
1911	493,465	16,722	570,272	27,436	640,797	32,091
1912	508,986	17,490	640,860	30,576	624,703	32,173

* Eleven months only.

ANOMURA.

Tribe GALATHEIDEA.

The three families having representatives in Irish waters may be separated as follows :—

A.—Posterior half of abdomen bent under the first, but telson not tucked under last segment ; telson broad, made up of separate plates suggestive of a tergum and pair of modified appendages ; antennal peduncle four-jointed ; no acicle ; arthrobranchs normally placed, ... Galatheidae, Dana.

B.—Abdomen bent as in Galatheidae, but in addition the telson and uropods are tucked under the last abdominal segment ; telson narrow, weak, and transversely fissured ; antennal peduncle five-jointed ; second joint usually with an acicle ; arthrobranchs placed on side of thorax, .. Uroptychidae, Henderson.

C.—Cephalothorax very broad, almost circular in outline ; abdomen bent and closely-pressed against sternum as in Brachyura ; third maxillipedes have ischium much flattened, and merus with broad internal lobe ; in the male a single pair of pleopods present, on the second segment ; antennal peduncle four-jointed ; no acicle ; arthrobranchs normally placed. Porcellanidae, Henderson.

Family *UROPTYCHIDAE*.

Chirostylidae, Ortmann, 1892. Diptycinae, Milne-Edwards and Bouvier, 1900. Uroptychidae, Alcock, 1901.

The two genera included in the family may be separated as follows :—

Rostrum spiniform ; lateral margins of carapace very obscure ; no acicle on antennae ; chelipeds often more than five times length of carapace and abdomen ; walking legs very long, ... *Gastroptychus.*

Rostrum flat and triangular ; lateral margins of carapace well defined ; well developed triangular acicle ; chelipeds long ; walking legs moderately long, ... *Uroptychus.*

Genus **Uroptychus**, Henderson.

Diptychus, Milne-Edwards, 1880. *Diptychus*, Bonnier, 1888. *Uroptychus*, Henderson, 1888. *Diptychus*, Milne-Edwards and Bouvier, 1894 (*a*). *Uroptychus*, Alcock, 1901. *Uroptychus*, Stebbing, 1903.

The two Irish species may be distinguished from one another by the following characters :—

Dorsal surface of carapace bearing numerous fine hairs, especially on branchial and hepatic areas ; no movable spines on lower edge of propodite of walking legs ; upper and lower surface of chelipeds covered with small scales, which bear each a row of long hairs, .. *U. rubrovittatus.*

Dorsal surface of carapace devoid of hairs, very smooth and shining, minutely punctate ; lower edge of propodite of walking legs bears a row of movable spines ; chelipeds quite smooth, without scales, and without hairs, except at the tips of the fingers, *U. nitidus*, var. *concolor.*

Uroptychus rubrovittatus (Milne-Edwards).

Pl. VIII, figs. 1–4.

Diptychus rubrovittatus, Milne-Edwards, 1881.
Diptychus rubrovittatus, Bonnier, 1888.
Uroptychus rubrovittatus, Caullery, 1896.
Diptychus rubrovittatus, Milne-Edwards and Bouvier, 1900.
Uroptychus rubrovittatus, Hansen, 1908.

The carapace is broadest in the branchial region ; it is slightly narrower behind, and considerably so in front. The rostrum is large and triangular, with very slightly crenulated margins ; it is slightly hollowed out on the upper surface. The carapace is arched from side to side, and is almost quite smooth ; the cervical groove is represented by a faint crescent-shaped depression. There is a sparse covering of tufts of fine hairs which are most plentiful on the branchial and hepatic areas, and also occur on the upper surface of the rostrum. The posterior margin is slightly concave. The lateral margins have a row of very small tubercles which do not come to sharp points. There is an inward curved spine at each antero-lateral angle, and there is a smaller spine on the anterior margin above the base of each antenna. The *linea anomurica* is distinctly marked. The submarginal parts of the carapace bear a number of small and rather obscure tubercles, which, however, are absent from the central part.

The first abdominal segment is very narrow and almost entirely hidden by the carapace. The pleura of the second segment are poorly developed and its lateral margins are concave. In the third to sixth segments the pleura are well developed, and are fringed with setae. The terga are smooth and have a very sparse covering of setae. The abdominal segments are much broader in the female than in the male, and in the former the pleura completely enclose the space in which the ova are carried before hatching.

The telson is folded against the lower surface of the sixth abdominal segment. It is divided into a proximal and a distal portion by a transverse suture. Both are thin and feeble, but the proximal part is slightly calcified, while the distal part is wholly membranous and transparent. The lateral borders have each a deep sinus opposite the suture ; the posterior margin is concave ; the posterior angles are rounded ; the lateral and posterior margins are fringed with fine setae. The telson as a whole is much narrower than the abdominal segments which precede it.

The eyes are small and reach only to the middle of the rostrum. The eyestalks are cylindrical, and the border between stalk and cornea is entire and straight. The eyes (in spirit) are of a bright reddish-brown colour.

The basal joint of the antennules is short, and bears a strong curved spine at its upper and outer extremity ; this spine bears two or three small teeth on its margin. The second joint is roughly cylindrical, and the third is very much thickened distally. The upper flagellum consists of about a dozen joints, and the lower, which is much shorter and very slender, of three to five joints. There are no hairs springing from the distal end of the third peduncular joint as in some of the Galatheidea.

The peduncle of the antennae is five-jointed. The basal joint is short and broad, with the opening of the renal gland on its lower surface. The second joint bears a well developed scale, which tapers to a fine point ; its inner border is entire, but the other is very slightly denticulate, and bordered with hairs. The third and fourth joints are short and thick, the fifth long and slightly thickened distally, bearing a thin flagellum which reaches beyond the merus of the chelipeds.

The third maxillipedes are long and pediform ; the propodite is the longest individual joint. When extended they reach beyond the merus of the chelipeds. None of the joints bear spines, with the exception of the ischium, which has the usual *linea cristata*. The carpus is very short and broad. The propodite is as long as the merus and the carpus together ; on its inner surface there is a broad obtuse process which reaches its greatest size in the proximal third of the joint. The inner surface of the dactyl, the distal two-thirds of the propodite, and the carpus bear dense fringes of setae. The peduncle of the exopodite reaches just beyond the middle of the merus ; its flagellum is nearly as long as the peduncle.

The chelipeds are longer than the whole body of the animal. The first two joints are not much larger than those of the walking legs; the ischium is narrow, flattened, and quite short; the merus is very much thicker, and is practically cylindrical; the carpus is about as long as the merus and the ischium together, and becomes thicker at the distal end; the propodite is the longest and stoutest joint of the appendage, and is almost as long as the merus and carpus together; the dactyl is about half as long as the palm of the propodite. On the cutting edge of the dactyl there is a large prominence near the base. The tips of the fingers are incurved, and cross one another. The whole surface of the appendage is covered with a large number of scale-like protuberances arranged in longitudinal rows, and each bearing three or four setae pointing forwards. The scales are not always easy to see; they are most prominent on the lower surface of the merus, and decrease gradually till they disappear about the base of the dactyl. Two teeth are present at the anterior end of the lower side of the merus and also of the carpus.

The three pairs of walking legs which follow also bear scales furnished with hairs, but they are often very difficult to detect. The three pairs are sub-equal. The posterior margin of the dactyl bears a row of teeth, of which that at the tip is the largest.

The fifth pair of pereiopods are very much reduced; they end in chelae covered with long setae. The sternum of the fifth pair is obsolete.

In the male the only pleopods present are those of the first and second pairs. In the female, on the other hand, only the appendages of the third and fourth segments are present; these are slender and three-jointed. The first and second pleopods of the male are similar to those of *U. nitidus* var. *concolor*.

The uropods are tucked underneath the sixth abdominal segment along with the telson. They are rather narrow, and have rounded posterior margins fringed with fine setae. There is no transverse suture on either endopodite or exopodite.

Size.—Hansen (1908) mentions some very large specimens which were taken by the *Thor* off the south of Iceland, a male and a female, measuring 33mm. and 40 mm., respectively. The usual size seems to be about a quarter or a third less than this.

General Distribution.—The species is known from the west coast of Africa as far south as Cape Bojador (Milne-Edwards), from the Canaries and Azores (Milne-Edwards and Bouvier), from the Spanish coast (Bonnier), and the Bay of Biscay (Caullery, Kemp). More recently it has been recorded by Hansen from the south of Iceland.

Irish Distribution.—So far as I know this species has not hitherto been correctly recorded from British or Irish waters. Calman (1896) gives "*Uroptychus rubrovittatus*" in the list of species from the south-west of Ireland, but I have had the opportunity of examining these specimens in the Irish National

Museum, and I find that all of them must be referred to *U. nitidus* var. *concolor*.

The *Helga* has taken this species on two occasions.

Helga.

S. R. 223.—12 v '05. 53° 7′ N., 14° 50′ W., 410–500 fms., coral. Trawl.—One, 17 mm.

S. R. 327.—8 v '06. 51° 43′ 30″–51° 38′ N., 12° 15′–12° 18′ W., 550–800 fms., ooze. Trawl.—Three.

Vertical Distribution.—The species appears to occur most frequently in depths of 300–700 fathoms, but it has been taken in 160 fathoms on the one hand and 766 fathoms on the other.

Uroptychus nitidus, var. **concolor** (Milne-Edwards).

Pl. VIII, figs. 5–10, Pl. IX, fig. 1.

Diptychus nitidus, var. *concolor*. Milne-Edwards and Bouvier, 1894 (*b*).

Uroptychus nitidus, var. *concolor*, Caullery, 1896.

Diptychus nitidus, var. *concolor*, Milne-Edwards and Bouvier, 1899.

Diptychus nitidus, var. *concolor*, Milne-Edwards and Bouvier, 1900.

In general appearance this species resembles *U. rubrovittatus*, but is distinguishable by well-marked characteristics.

The surface of the carapace and abdomen is quite smooth and glistening; it is sparsely punctate, but this can be seen only when the specimens are dry. The carapace is narrower than in the last species, and is devoid of hairs. The cervical groove is barely distinguishable. The lateral margins are slightly granular, with here and there a denticule. The antero-lateral spine curves slightly more inwards than in *U. rubrovittatus*. The tooth above the base of the antenna is blunt. The rostrum is narrower and rather longer than in *U. rubrovittatus*, and its margins are quite entire; it is quite free from setae. The basal part of the rostrum curves downwards, and the tip is elevated, so that when seen in profile it has quite a different appearance from that of the last species (Pl. VIII., figs. 2, 5.).

The abdomen resembles that of *U. rubrovittatus*, but is free from setae.

The eyes are large and oval; they reach beyond the middle of the rostrum, and almost to the end of the antennal peduncle. The stalks are slightly swollen just below the cornea, which is of an orange yellow colour (in spirit).

The antennules much resemble those of *U. rubrovittatus*. The curved process springing from the basal peduncular joint bears two large sharp teeth. The upper flagellum has fourteen joints, and the lower only four.

The scale of the antennae is narrower than in the last species, and on neither edge has it any setae or teeth. The slender flagellum does not reach the distal end of the merus of the chelipeds.

The third maxillipedes differ from those of *U. rubrovittatus* in having a groove on the outer surface of the merus. The teeth of the *linea cristata* are also longer and sharper.

The chelipeds differ greatly from those of the last described species in having no covering of setiferous scales. Setae are absent, except for the tufts at the end of the fingers. The ischium is short and slender; on its lower surface it bears two or three rows of fairly sharp tubercles which point forwards. The merus is a much longer and stouter joint, and its lower surface is furnished with three or four rows of similar but larger tubercles; the rows vary somewhat in distinctness. The merus is more or less cylindrical, but the two succeeding joints are slightly compressed. The carpus is considerably longer than the merus, and the propodite again is longer than the carpus. The carpus, the upper surface of the propodite, and merus are all quite smooth, and are sparsely and minutely punctate. On the lower surface of the propodite, however, there are five or six longitudinal rows of very minute tubercles; they are often very difficult to detect, and are most easily seen in dry specimens; they may be felt by passing the finger backwards along the joint. The dactyl is only about one-third as long as the propodite. Both fingers bear tufts of long setae which are most crowded near the tip. When closed the fingers are in contact for nearly the whole of their length. The inner edge of the dactyl bears near its base a formidable tooth or process which is almost rectangular, and is about a quarter of the whole length of the cutting surface. There is a slight depression in the inner edge of the other finger opposite this tooth; the edges of the latter are crenulated. The teeth on the cutting edges of the fingers are not sharp, but are rounded. The tips of the fingers curve towards one another, and cross when closed. The whole surface of the chelipeds is bright and glistening.

The next three pairs of pereiopods are nearly equal, but the middle pair, the third pereiopods, are the shortest. The merus in the second and fourth pereiopods is flattened laterally, but in the third it is cylindrical. In the second and fourth the carpus is slightly thickened distally, but not in the third. The propodite is more slender in the second pereiopods than in the next two pairs. In each case the dactyl is robust, strongly curved, and bears numerous teeth on its lower surface.

The lower side of the distal half of the propodite bears a row of long, mobile spines, and these, together with the teeth of the dactyl when bent back, form a very efficient subchela, which enables the animal to get a firm grip of the coral on which it lives. The teeth on the dactyl are broad, and not long and narrow as in *U. rubrovittatus*; there are usually ten or eleven.

The merus of these walking legs bears a very few long hairs; on the carpus they are more numerous, especially on the dorsal side, except in the third pereiopods where they are almost absent. The distal half of the propodite bears tufts of long hairs in all three pairs of appendages, and they are also present on both surfaces of the dactyl.

The fifth pereiopods are very slender and reduced. They end in a chela, and the propodite and dactyl are covered with long plumose hairs.

In the first pleopods of the male the distal joint is expanded into a broad membranous lamella with incurved edges. Its inner surface bears a few short bristles.

The second pleopods of the male have a long cylindrical proximal joint, and a much shorter distal joint, which is greatly expanded and flattened. This part is partially divided into two lobes, both of which are fringed with stiff hairs. In one lobe these are much shorter than in the other, and the same lobe has its surface covered with short bristles. The opposite edge of the distal joint is curled downwards, and bears short, slender bristles on its inner edge. The lobe bearing the bristles represents the *appendix masculina*, which has become fused with the internal ramus of the pleopod. The external part is represented by a small, blunt process at the extremity of the proximal joint.

In the female, pleopods are present on the third and fourth abdominal segments only. They are very slender and serve for the attachment of ova. The latter are large and never numerous. One of the *Helga* specimens bears seven eggs and the other twenty. In ovigerous females the telson is not folded against the sixth abdominal segment, but is extended so that it rests on the surface of the thoracic sternum.

The uropods are similar to those of *U. rubrovittatus*.

Size.—The largest specimen taken by the *Helga* is an ovigerous female, measuring 27 mm. The chelipeds of the same specimen are 45 mm. long.

General Distribution.—The typical *U. nitidus* is confined to West Indian waters. The var. *concolor* is, on the other hand, widely spread. It has been found in many parts of the eastern Atlantic (Mi ne-Edwards, Bouvier, Caullery), on the west coasts of France, Spain, and Morocco, at the Azores and Cape Verdes. Its most northerly record is from the south-west of Iceland (Hansen). It is also recorded from South African waters (Stebbing), and from the Laccadive Islands and Bay of Bengal (Alcock).

The species is represented in the Pacific Ocean by a var. *occidentalis*, Faxon, which was taken by the *Albatross* in the Gulf of Panama.

Irish Distribution.—The species has previously been taken in Irish waters, viz., by the *Lord Bandon* expedition in

1888 off the south-west coast, but the specimens were recorded under the name of *U. rubrovittatus* (see p. 58).

The *Helga* has taken this species at three stations.

Helga.

S. R. 493.—8 IX '07. 51° 58′ N., 12° 25′ W., 533–570 fms. Trawl.—One, 21 mm.

S. R. 494.—8 IX '07. 51° 59′ N., 12° 32′ W., 550–570 fms. Trawl.—One, 27 mm.

S. R. 500.—11 IX '07. 50° 52′ N., 11° 26′ W., 625–666 fms. Trawl.—One, 25 mm.

Vertical Distribution.—The species is most commonly found in depths ranging from 400 fathoms to 650 fathoms, but it has been found in 318 fathoms and in 808 fathoms.

Genus **Gastroptychus,** Caullery.

Ptychogaster, Milne-Edwards, 1880. *Ptychogaster*, Henderson, 1888. *Chirostylus*, Ortmann, 1891–94. *Gastroptychus*, Caullery, 1896. *Ptychogaster*, Milne-Edwards and Bouvier, 1900. *Ptychogaster*, Alcock, 1901.

Gastroptychus formosus (Milne-Edwards).

Pl. IX, figs. 2–8, Pl. X, fig. 1.

Ptychogaster formosus, Filhol, 1886.
Ptychogaster formosus, Perrier, 1886.
Ptychogaster formosus, Milne-Edwards and Bouvier, 1894 (*b*).
Gastroptychus formosus, Caullery, 1896.
Ptychogaster formosus, Milne-Edwards and Bouvier, 1900

The carapace is much narrower in front than behind; its broadest part is a short distance behind the cervical groove. In front there is a narrow spiniform upturned rostrum, about twice the length of the eyestalks; its margins are entire. The gastric region of the carapace is inflated and sharply marked off from the surrounding parts. The carapace is furnished with a large number of spines. At each side of the base of the rostrum, above the eyes, there is a large spine: behind these, and much wider apart, is another pair of large spines; near the posterior edge of the gastric area there are two spines opposite the supraorbital ones in front; on the centre of the gastric area there is a large unpaired spine, so that on this part of the carapace there is a ring of six large spines enclosing a single median one. Just behind the cervical groove there are two median spines, and farther back a similar pair, while a third pair is situated on the posterior margin of the carapace. On the hepatic region there are two large spines on each side, and between these and nearer the median line is another spine. There are rows of smaller spines on the branchial regions, running parallel to the lateral margin of the carapace. Between the spines the surface of the carapace is perfectly smooth. The cervical groove is

distinct in its central part, but becomes obscure at the sides.

The sternum becomes very narrow anteriorly, and is furnished with two or three large spines at the base of the chelipeds. It is divided by three deep, transverse furrows. The sternal plates of the last thoracic segment are atrophied, being represented merely by a patch at the base of each of the fifth pereiopods. The *linea anomurica* is distinct, and is deepest in its posterior part. Below it the flanks of the carapace bear a number of small, irregularly-arranged spines.

The first two abdominal terga bear a transverse row of spines, some of which are much larger than others. The first abdominal segment is very narrow and its pleura are rudimentary. All the other segments are much broader and have well-developed pleura ; the latter are largest and most sharply pointed in the second segment, and become successively smaller and blunter backwards. The third, fourth, and fifth terga are practically smooth ; the sixth tergum, however, bears about a dozen spines arranged in two roughly crescentic rows, in addition to three on the posterior margin, which are pressed against the under surface of the thorax.

The terga bear very short setae on the smooth parts of their surface. The anterior edges of the pleura are furnished with setae, and in the second segment bear a few small teeth.

The telson and uropods are completely folded under the last part of the abdomen, which in its turn is bent on itself, so that the end of the sixth segment is pressed against the thoracic sternum. The telson is quite thin and membraneous ; it is slightly concave laterally and posteriorly, and is divided by a transverse suture.

The eyes reach the middle of the rostrum. The corneal part is wider than the cylindrical stalk.

The antennular peduncle extends well past the tip of the rostrum. The basal joint is thicker than the second and third ; the opening of the otolith-chamber is elevated into a ridge fringed with bristles. The third joint is the longest ; it is very slightly thickened distally. The internal flagellum is thick at the base, but tapers rapidly to a fine point ; it is composed of about twenty joints and bears a heavy fringe of hairs. The outer flagellum is much shorter, is quite slender throughout, and is composed of very few joints.

The antennal peduncle is very slender and quite short ; it extends just beyond the cornea of the eye. The flagellum is also short, being very slightly longer than the antennules. The peduncle is five-jointed and has a rudimentary scale. There is a slender spine at the distal end of the terminal joint.

The mandibles have a well developed three-jointed palp. The anterior four or five teeth on the cutting edge are much larger than those behind.

The exopodite of the first maxillae is represented by a mere rudiment ; at the tip of the endopodite there are three or four sharp spines.

The second maxillae are normally developed.

The first maxillipedes have a rudimentary epipodite; the basal part of the exopodite is very much flattened.

The exopodite of the second maxillipedes is longer than the endopodite, and its peduncular portion is expanded.

The coxa of the third maxillipedes has a strong spine on the inner edge; the ischium has the usual *linea cristata*. There is a short spine near the distal end of the outer margin of the merus, and a longer and sharper one in the same position on the carpus. The propodite is long and massive, and bears a rounded protuberance near its extremity on the lower side. Neither the propodite nor the dactyl have any spines, but bear thick tufts of setae. The exopodite is very slender; its peduncle reaches the middle of the merus; the first joint of its flagellum is much longer than the succeeding ones.

The chelipeds are developed to an extraordinary extent, being between five and six times as long as the carapace and rostrum. They are slender and cylindrical and thickly covered with sharp spines which are arranged in longitudinal rows. There are six or seven rows on each joint. The longest joint is the merus, and the spines also reach their maximum development there; here and there among the spines there are long setae. The spines are similarly arranged on the carpus and the propodite. The carpus is slightly shorter than the latter. The dactyl is less than a third of the length of the propodite. The fingers bear only a few small spines; both margins are setiferous; on the inner edge, near the base of each finger, there is a blunt tubercle; the cutting edges bear isolated teeth which crowd more closely together towards the tip; the fingers end in sharp and curved claws which cross one another; the cutting edges do not come in contact with one another except in their distal half and where the two tubercles meet.

The next three pairs of pereiopods are more slender than the chelipeds and are subequal in length. They are very much shorter than the chelipeds, reaching only to about the middle of the carpus of the latter. In the merus, which is the longest and stoutest joint, the spines are arranged as in the chelipeds. In the carpus the lower and outer edges are almost free from spines. The propodite is longer and thinner than the carpus, and bears a dorsal tuft of setae at its distal extremity; on the distal half of its lower margin there is a row of about a dozen mobile spines, interspersed with setae. The dactyl ends in a strong curved claw and also bears a row of about eight or nine spines on its lower surface; these spines increase in size distally.

The fifth pereiopods are very small and feeble, and are carried bent on themselves in the manner usual in the group.

There are no pleopods on the first abdominal segment in the female, but they are present on the second to fifth segments. They are uniramous and two-jointed, bearing tufts of long setae at the extremity of each joint.

In the male the distal joint of the first pleopods is expanded

into a wide lamella, which has the edges slightly, and the tip very much, curled inwards.

In the second pair in the male the peduncular joint is long and robust. The distal joint is of peculiar structure, being slightly twisted into a spiral; near the tip there is a wide ear-shaped plate standing out almost at right angles to the axis of the joint. The rounded margin of this plate, which half encircles the joint, is densely covered with short bristles. It is much thicker at one side than the other, and the bristles all point towards the thick part. A few setae are present on the tip of the joint, and below the plate-like expansion there is a fringe of longer setae on the margin. The other pairs of pleopods are represented by mere rudiments in the male.

The uropods are thin membranous structures, and are folded under the abdomen with the telson. They have no transverse suture on either branch; their lateral and posterior edges are setiferous.

When alive the animal is bright scarlet, and the eyes have a bronze lustre.

Size.—The largest specimen taken by the *Helga* measures 44 mm., when the abdomen and telson are fully extended. Milne-Edwards and Bouvier mention specimens 52 mm. long.

General Distribution.—The species is known hitherto only from those regions with which the names of the *Travailleur*, *Talisman*, and *Caudan* are associated. It has been recorded from stations ranging from Rochefort, in the Bay of Biscay, to the Canaries. More recently it has been taken further north, two specimens having been captured by the *Huxley*, in the latitude of Brest, long. 8° 13′ W., (Kemp). The specimens taken by the *Helga* extend the range of the species still further in a northerly direction.

Irish Distribution.—

Helga.

CXX.—24 VIII '01. 77 mls. W.N.W. of Achill Head, Co. Mayo, 382 fms. Trawl.—One.

S. R. 223.—12 V '05. 53° 7′ N., 14° 50′ W., 410–500 fms., coral. Trawl.—Two, 44–34 mm.

Vertical Distribution.—The depths in which the species has been taken range from 382 fms. (*Helga*) to 929 fms. (*Caudan*). The other specimens were captured in over 444 fms. (*Huxley*), 517 fms., and 482 fms. (*Travailleur* and *Talisman*).

FAMILY *GALATHEIDAE.*

There are two sub-families :—

A.—Integument crisp; exopodite of the first maxillipedes terminates in a flagellum; eyes facetted and well pigmented, .. GALATHEINAE.

B.—Integument very strongly calcified and very thick; exopodite of first maxillipedes does not end in a flagellum; eyes opaque, not facetted, and devoid of pigment, .. MUNIDOPSINAE.

SUB-FAMILY *GALATHEINAE*.

A.—Rostrum broad and flattened, armed with teeth, ... *Galathea*.

B.—Rostrum spiniform; supra-orbital spines very long, ... *Munida*.

GENUS **Galathea**, Fabricius.

Galathea intermedia, Lilljeborg.

Pl. XI, figs. 1–12.

Galathea Andrewsi, Kinahan, 1857 (*d*).
Galathea Andrewsi, Kinahan, 1861.
Galathea intermedia, Bonnier, 1888.

The carapace is roughly pear-shaped. It ends in front in a large triangular rostrum, and is slightly concave on the hind margin. Its surface is traversed by grooves running from one side to the other; they are bordered by fringes of fine setae. The rostrum has four spines on each side but they are not all well developed; the last pair, especially, are very small. The central point is longer than any of the lateral spines. The rostrum is longer and narrower in the male than in the female. The lateral margins of the carapace bear each a row of spines, of which those at the antero-lateral angles are the largest. There is a short, transverse groove surmounted by two spines at the base of the rostrum, separating it from the gastric area. Below the lateral margin there is a distinct *linea anomurica*, and beneath the latter are a number of oblique grooves running forwards and downwards.

Each of the abdominal terga bears a single transverse furrow. The pleura point slightly forwards, and are of equal size from the second to the sixth segment; in the first segment they are much reduced and more or less hidden by the carapace.

The telson is bisected by a longitudinal groove, and further divided by lines running obliquely inward from the postero-lateral angles. Its dorsal surface bears minute scales from which spring groups of bristles and spines, all directed backwards.

The eyes are small, and the eyestalks cylindrical, and partly hidden by the rostrum.

The basal joint of the antennules bears two long pointed processes, from which spring a few bristles near the tip. On the upper surface of the joint there is a deep groove into which the distal portion of the appendage can be folded. When in

this position the antennules are protected by the massive basal joint below, and by the rostrum above. On the same joint there is the slit-like opening of the auditory sac. From the exterior margin of the latter there grow inwards a row of long hairs, which form a protective covering to the opening. The slit widens towards the proximal end, and is here partly covered by a rounded flap. The second and third peduncular joints are about equal in length.

The outer flagellum is very thick at the base, but tapers rapidly ; it is composed of fifteen joints, and has a dense fringe of setae on its inner margin. The inner flagellum is composed of only six joints and is uniformly slender throughout.

The first, and largest, joint of the antennal peduncle has a sharp spine at the antero-interior angle ; there is no trace of a scale. The flagellum is as long as the chelipeds in the female, but scarcely reaches to the middle of the propodite in the male.

The first two joints of the third maxillipedes are short and broad. A small epipodite is attached to the coxa. The exopodite has a long peduncle which extends beyond the merus ; it narrows suddenly in its distal third ; the flagellum has one long basal joint, the rest being made up of short joints, each of which bears two long setae. The ischium is shorter than the merus, its lower distal extremity ends in three teeth. The *linea cristata* bears about twenty-two teeth. On the inner side of the merus there are two large spines ; one is situated at the distal end, and the other near the middle, but rather nearer the distal than the proximal extremity. Both ischium and merus bear fringes of long setae. The carpus is slightly swollen in its second half, and is of about the same length as the propodite. The dactyl is shorter than both.

In the young male the chelipeds are similar to those of the female ; in the adult, however, they become developed to a relatively enormous size, being about twice the length of the body (with the abdomen in its natural folded position). The elongation is accompanied by great thickening, and the unwieldy appearance of the appendage is enhanced by the fact that the first three joints remain slender. The thickening begins at the proximal end of the merus. The largest joint is the propodite. The two chelipeds are unequal, sometimes the right, sometimes the left, being the larger. In the latter the distal part of the propodite is peculiarly modified ; the fixed finger curves strongly outwards from the point of articulation of the dactyl, and meets the latter only at its tip. Opposite the curve there is a strong tubercle on the inner margin of the dactyl. The surface of the chelipeds is covered with scale-like tubercles, especially in adult males. The curve in the fixed finger does not seem to develop until the animal has attained maturity. Of two large males in the collection at my disposal, one has the curve and opposite tubercle very prominently developed, whereas in the other, which is only very slightly smaller, there is no trace of it, and the fingers are in contact throughout their entire length.

The spines on the chelipeds of the adult male are much reduced compared with those on the female or the young male.

The extreme tip of the chelipeds is characteristic of the species. Both fingers end in a broad, curved tooth which terminates the inner margin, and above this there is another smaller and sharper tooth in line with the outer margin.

The second, third, and fourth pereiopods resemble one another closely, and are of much the same size ; the merus and propodite are long, the other joints short. All three end simply.

The fifth pereiopods are very feeble, and are usually carried folded on themselves, and half inside the branchial chamber. The merus and carpus are long and slender, the flexure taking place at their point of articulation. The appendage ends in a small chela, thickly covered with setae.

The pleopods are quite different in the two sexes.

In the male the first pair of pleopods consist of a slender peduncle, which is followed by a single lamellar joint of peculiar structure. It consists of a thin plate, the inner edge of which is curved, and is fringed with short bristles ; the outer edge is not curved except near the distal end, where it is folded inwards, so as to form a flap, which bears some longer bristles. The second pleopods are longer than the first, and consist of a fairly stout peduncle, at the end of which there is a small blunt process of one joint which represents the exopodite. The endopodite slopes inwards and broadens out half-way to the tip, after which it narrows again ; the distal half has a covering of short, stiff bristles. This portion probably represents the *appendix masculina* united to the endopodite. The third, fourth, and fifth pairs of pleopods have thin lamellar peduncles, which are straight on the outer side and curved on the inner ; the latter bears a row of long plumose hairs from seven to fourteen in number. At the extremity of the exterior margin there is a short, blunt process representing the endopodite. Of this process Bonnier says : " à son extrémité distale . . . se trouve un rameau interne, d'un seul article et très réduit." In the large number of specimens collected by the *Helga* quite a number of males have this process composed of two joints. In the majority of cases those in which two joints are present are larger than those with one. Altogether fifteen males have only one joint, and eight have two. In some of the latter the second joint is much shorter than the first, while in others the two joints are equal. Probably the possession of one or of two joints depends upon age.

In the female the pleopods of the first segment are altogether absent. Those on the following segments are slender and three-jointed.

The borders of the uropods are furnished with fringes of long, pinnate setae, and also bear rows of large and small spines. The spines are best developed on the posterior edge of the endopodite. The surface also bears small groups of spines and bristles, all pointing backwards.

Epipodites are present on the chelipeds, but not on the other pereiopods.

Branchial formula :—

—	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.
Podobranchs.	ep.	—	ep.	ep.	—	—	—	—
Arthrobranchs.	—	—	2	2	2	2	2	—
Pleurobranchs.	—	—	—	—	1	1	1	1

Size.—This is by far the smallest of the British species of *Galathea.* Adult specimens usually measure from 12 mm. to 20 mm. The largest specimen taken by the *Helga* is an ovigerous female which is 21 mm. long.

General Distribution.—The species is found in all the seas of western Europe. Norway (Lilljeborg, G. O. Sars), Skagerrak and Kattegat (Meinert), Scotland (Norman, Kinahan, Henderson) ; North Sea (Hoek), Cornwall (Carrington), English Channel (Crawshay), Bay of Biscay (Bouvier), Spain (Göes), Mediterranean (Milne-Edwards), Madeira, Azores (Barrois).

Irish Distribution.—It is very plentiful all round the coast, and is often taken in very large numbers. A large proportion of the females taken by the *Helga* are ovigerous, especially those taken in March, April, and May.

Vertical Distribution.—It extends from the littoral zone down to considerable depths, the *Talisman* having taken a specimen in 123 fathoms. It occurs in greatest abundance in depths of 8–50 fathoms.

Galathea squamifera, Leach.

Galathea squamifera, Bell, 1853.
Galathea squamifera, Kinahan, 1861.
Galathea squamifera, Bonnier, 1888.

Both upper and lower surfaces of the chelipeds, and the upper surface of the rostrum are densely covered with scaly tubercles. The chelipeds are somewhat flattened, and bear long spines on the inner surface, except on the propodite, where the spines are on the outer margin.

The basal joint of the antennular peduncle has three sharp spines.

The ischium of the third maxillipedes is shorter than the merus. On the distal half of the inner margin of the merus there is a row of three or four small teeth, and beyond these, at the distal extremity, a single large spine.

The endopodites of the third, fourth, and fifth pairs of pleopods of the male are three-jointed.

The first three pairs of pereiopods have epipodites.

Size.—It is usually considerably smaller than *G. strigosa,* 0–60 mm., being a common size for adults.

General Distribution.—The range is very much the same as that of *G. intermedia.* Norway (G. O. Sars, Loven), Kattegat (Meinert), Skagerrak (Stephensen), British and French coasts (Bell, Norman, Bonnier), Mediterranean and Adriatic (Heller), Azores and Cape Verde (Barrois).

Irish Distribution.—Common all round the coast, but not occurring in such large numbers as *G. intermedia.*

Vertical Distribution.—Commonest from tide-marks to about 3–4 fathoms, but occasionally it is found at depths of about 40–50 fathoms. The species migrates shorewards in spring, being found in large numbers under stones between tide-marks.

Galathea nexa, Embleton.

Galathea nexa, Embleton, Proc. Berwickshire Nat. Field Club, 18—.
Galathea nexa, Bell, 1853.
Galathea dispersa, Bate, 1859.
Galathea nexa, Kinahan, 1861.
Galathea dispersa, Kinahan, 1861.
Galathea nexa, Henderson, 1886.
Galathea dispersa, Henderson, 1886.
Galathea nexa, Bonnier, 1888.
Galathea dispersa, Bonnier, 1888.
Galathea nexa, Milne-Edwards and Bouvier, 1899.
Galathea dispersa, Milne-Edwards and Bouvier, 1899.
Galathea dispersa, Milne-Edwards and Bouvier, 1900.
Galathea nexa, Appellöf, 1906.
Galathea nexa, Hansen, 1908.
Galathea nexa, Kemp, 1910.
Galathea nexa, Crawshay, 1912.
Galathea dispersa, Crawshay, 1912.

The majority of recent writers on the Galatheidae have united *G. nexa* and *G. dispersa* as one species ; this is done by Appellöf, Hansen, Kemp, and others, while Milne-Edwards, Bouvier, and Crawshay keep the two separate. The most detailed description is that given by Bonnier (1888). The character on which he chiefly relies for their separation is the number of spines on the inner margin of the merus of the third maxillipedes. In *nexa* there is a single large spine on the middle of the joint, and in *dispersa* a large spine in the same position, followed by a varying number of more distal and smaller spines, usually three or four. Bonnier's figure does not show this correctly, the drawing being out of proper perspective, so that the spines appear to be at the distal end of the joint. Milne-Edwards and Bouvier correct this (1899), and give a list of distinguishing characters, most of which are of very little value.

The specimens taken by the *Helga* all approach more or less closely to the *dispersa* type. One hundred and eighty-eight

specimens were taken, and in examining these I have found that there is very considerable variation in many of the characters on which Milne-Edwards and Bouvier base their distinctions. For instance, the spines on the sides of the rostrum vary in length and sharpness, and in those most nearly approaching the *nexa* type they are not blunter or thicker than in many of the *dispersa* type. The rostrum also varies in length, and it is often impossible to say whether it " almost reaches the extremity of the antennular peduncle " or " just passes the base of the last joint." It depends very much on the way in which the antennules are extended. Another character given by Milne-Edwards and Bouvier concerns the teeth or spines on the transverse furrow immediately behind the rostrum. They say that in *dispersa* "il y a au moins deux paires de saillies spiniformes ou d'épines," and in *nexa* "il n'y a pas de saillies, ou seulement une paire de saillies à peines distinctes," yet in many of the *Helga* specimens of undoubted *dispersa* form there are no teeth or spines on this line, and in others only a single pair. Again, in the great majority of the *Helga* specimens of the *dispersa* type the lateral margins of the carapace are distinctly convex, not " sensiblement droits."

The spines on the third maxillipedes show considerable variation. In some cases the large spine is followed by three or four smaller ones, in others by only one. In two large males from the west coast there is only one very small spine distal to the large one. These two specimens approach more nearly the *nexa* type than any of the others, and this lends support to Hansen's view that *nexa* has been founded on large male specimens of *dispersa*. Bonnier's description of *nexa* was taken from a single large male, and Milne-Edwards and Bouvier also saw only a single specimen, a male, whereas Appellöf and Hansen both had a large amount of material.

More recently Crawshay (1912) has separated the two forms by the character of a small group of three or four setae on the third maxillipedes close to the base of the large meral spine. In *nexa* these are simple, and in *dispersa* pinnate. They are pinnate in all the *Helga* specimens except the two large males mentioned before (from Ballynakill Harbour, Co. Galway), in which they are simple. These two also possess the strong spination and hispidation of the chelipeds of which Crawshay speaks, but the third maxillipedes bear a spine distal to the large central one, so that the characters of *nexa* and *dispersa* are here to some extent combined.

I am quite convinced, with Hansen, that the species *nexa* has been erroneously founded on very large male specimens of *dispersa*. The *dispersa* forms are very much commoner than the other, but the name *nexa* has priority and so must be used for the united species.

Size.—The largest specimen in the Irish collection is a male measuring 40 mm.

General Distribution.—The distribution of this is practically

the same as that of the two preceding species. It extends from West Finmark along the coasts of Norway and Denmark (Sars, Stephensen); it is found on all the coasts of Great Britain (Norman, Henderson, Kinahan, etc.), on the French and Spanish coasts (Milne-Edwards and Bouvier), in the Mediterranean and Adriatic (Heller-Hansen), and at the Azores and Canaries (Milne-Edwards and Bouvier). It has also been recorded from Iceland.

Irish Distribution.—The species is found all round the Irish coasts. It has been recorded from Dublin and Belfast (Kinahan, Thompson), from the south-west coast (Calman), Clare Island, Co. Mayo (Farran), and has been taken with very great frequency by the *Helga* in the Irish Sea, and on the south and west coasts. It was found plentifully at Ballynakill and Bofin Harbours and in Blacksod Bay.

Vertical Distribution.—*G. nexa* seems to be most plentiful at depths of about 25–40 fms., but it may be found from the shore line down to 260 fms. (Bonnier). The greatest depth at which it was taken by the *Helga* was 199 fms. On the west coast it was several times captured in more than 100 fms., and was very common at about 40 fms. On the east coast it occurs most plentifully in depths of about 20–30 fms.

Galathea strigosa, Linne.

Galathea strigosa, Bell, 1853.
Galathea strigosa, Kinahan, 1861.
Galathea strigosa, Bonnier, 1888.

This may be distinguished from the other British species of *Galathea* by its large size, the great length of its chelipeds, furnished on both edges with strong spines, by the absence of epipodites on all the pereiopods and by the form of the third maxillipedes.

Size.—Adult specimens may sometimes grow to a very large size. One specimen found in Cork Harbour is 102 mm. long, and individuals measuring 80–90 mm. are fairly common.

General Distribution.—This species extends along the coasts of the east Atlantic from the North Cape to the Canaries and Azores (Sars, Appellöf, Bouvier, Bonnier, etc.) It extends extends into the Mediterranean and Adriatic (Heller, Senna), and according to Heller has been found n the Red Sea.

Irish Distribution.—Found all round the coast.

Vertical Distribution.—It is frequently found under stones between tide-marks, but also extends to considerable depths. It is common in about 4–7 fathoms. One specimen was taken by the *Helga* in 37 fathoms off the Calf of Man, and Bonnier mentions a case in which it was taken in 328 fathoms.

Genus **Munida**, Leach.

The two species occurring in Irish waters may be separated as follows :—

Cornea of eyes surrounded by circlet of hairs, some at least of which extend far out on the pigmented surface; the sternal plates are thickly covered by scale-like tubercles or ridges, which are bordered anteriorly with short setae, ... *M. bamffica.*

Circlet of hair at base of cornea absent or quite rudimentary; sternal plates smooth or with at most a very few setiferous ridges, *M. tenuimana.*

Munida bamffica (Pennant).

Pl. XI, figs. 13–14.

Munida Rondeletii, Bell, 1853.
Munida rugosa, G. O. Sars, 1882.
Munida Rondeletii, G. O. Sars, 1882.
Munida bamffica (*ex parte*), Milne-Edwards and Bouvier, 1894 (*a*).
Munida bamffica (*ex parte*), Milne-Edwards and Bouvier, 1899.
Munida bamffica (*ex parte*), Milne-Edwards and Bouvier, 1900.
Munida bamffica, Appellöf, 1906.
Munida rugosa, Appellöf, 1906.
Munida bamffica, Hansen, 1908.

A great deal of confusion exists with regard to this and the following species. Some writers have looked upon *M. bamffica*, *M. rugosa*, and *M. tenuimana* as constituting three separate species, others as two, and others again as a single species.

Bell (1853) changed the name of the present species to *M. Rondeletii* on quite insufficient grounds, and this name should not be retained at all. Sars, however, uses it (1882) in giving three species of the genus *Munida* as occurring in Norwegian waters, *M. Rondeletii*, Bell, *M. rugosa*, Fabr., and *M. tenuimana*, Sars. He separates these mainly by the size of the eyes, and the presence or absence of a circlet of hairs at the base of the cornea, and also by the spines on the fourth (in Sar's description the third) abdominal segment. Milne-Edwards and Bouvier, after examining the specimens taken by the *Hirondelle*, came to the conclusion that there is a single very variable species containing several varieties, and they adhere to this opinion after seeing the specimens taken by the *Travailleur* and *Talisman*. Appellöf, on the other hand, maintains with Sars that there are three distinct species, and gives a list of characters by which they may

be distinguished. Lastly, Hansen (1908) comes to the conclusion that *M. tenuimana* is a distinct species, but regards *M. bamffica* and *M. rugosa* as synonyms.

After examining carefully all the specimens of *Munida* taken by the *Helga*, I have come to the conclusion that Hansen's view of the species is the correct one. The specimens of *M. tenuimana* are at once separable from the rest by well-marked characteristics, but it is impossible to divide the others into *M. bamffica* and *M. rugosa*.

Appellöf gives the following characters as distinguishing marks between *M. bamffica* (=*Rondeletii*) and *M. rugosa*.

M. bamffica.	*M. rugosa.*
(*a*) Eye-bulb hardly broader than the stalk.	(*a*) Eye-bulb distinctly broader than the stalk.
(*b*) Circlet of hairs more or less rudimentary.	(*b*) At least a few hairs extend far out on corneal surface.
(*c*) Hind margin of the carapace has one or two pairs of spines at the sides, the central part being quite unarmed.	(*c*) Hind margin of carapace normally has spines both at sides and in the centre.
(*d*) Fourth abdominal segment always without dorsal spines.	(*d*) Fourth abdominal segment with two dorsal spines.

Some of the Irish specimens agree with nearly all the characters of *M. bamffica* given above, and some with those of *M. rugosa*, but between these there are individuals in which the characters of both are combined. For instance, two specimens from station S. R. 196 agree with *M. rugosa* in regard to the eye and the fringe of hairs round it, yet the hind margin of the carapace is practically devoid of spines, having merely a hint of one at each side, and there are no spines on the fourth abdominal segment. Appellöf admits that in young specimens of *M. rugosa* of less than 15 mm. these last spines may not be developed, but the Irish specimen is much larger than this, measuring 27 mm.

Of the ten adult specimens taken by the *Helga*, those from stations S. R. 194, S. R. 215, and S. R. 185 agree with Appellöf's characters of *M. rugosa* as regards the eyes, the circlet of hairs, the spines on the hind margin of the carapace and on the fourth abdominal segment. Those, on the other hand, from S. R. 178, S. R. 196, and S. R. 201 all possess some of the characters of *M. rugosa* and some of those of *M. bamffica*. Several of those in which the eye and circlet of hairs are of the *rugosa* type have no spines on the middle part of the hind margin of the carapace, and in some even the spines at the sides are wanting. Three specimens, again, which have the *rugosa* type of eye and circlet, have no spines on the dorsal surface of the fourth abdominal segment.

It will be seen that very few of the *Helga* specimens have all the characters of *M. rugosa* and that none have all those of *M. bamffica*. The majority have some of the characters of the one and some of the other. I therefore follow Hansen in regarding *M. bamffica* as a somewhat variable species in which the circlet of hairs is usually well developed, with some hairs extending far out on the cornea, in which the hind margin of the carapace may or may not bear spines on the central portion and sides, and in which spines may or may not be present on the fourth abdominal segment.

Size.—One very large specimen measuring 75 mm. was taken at station S. R. 215. Other large individuals, measuring 52 mm. and 42 mm., were also captured. Hansen' slargest specimen was 53 mm. long.

General Distribution.—The most northerly record for this species is one given by Birula, between Jan Mayen and Greenland, at 73° 34′ N., 17° 20′ W. It is also known from the Varanger Fjord in the Murman Sea (G. O. Sars) and from the south and west of Iceland (Hansen). It extends along the whole west coast of Norway (Sars, Appellöf), is known from Bohuslän (Göes), and from the Skagerrak (Stephensen, Björck). It occurs round all the British coasts from the Shetlands to Falmouth, off the Breton coast (Bonnier), in the Bay of Biscay (Kemp), and extends southwards along the coasts of Spain and Portugal and west Morocco to Cape Bojador (Milne-Edwards and Bouvier). It also extends into the Mediterranean (Adensamer) and the Adriatic (Senna).

Vertical Distribution.—The species is commonest in depths 100–300 fathoms, though it is also frequently taken in much shallower water—Appellöf records it from 5½ fathoms at Byfjord, and also from very much greater depths, Hansen having taken five specimens off the south of Iceland, in 691 fathoms.

Irish Distribution.—Pocock, Bourne, and Calman all record this species from the south-west coast, and Thompson mentions it as having been found off Co. Down and at Youghal, Co. Cork.

Helga.

Helga LXXVII.—29 VI '01. 124 mls. W. by N.½N. of Cleggan Head, Co. Galway, 53° 24′ 30″ N., 13° 36′ W., 91 fms., in stomach of fish.—One.

Helga CXVII.—23 VIII '01. 30 mls. W.N.W. of Cleggan Head, Co. Galway, 74½ fms., shelly sand and gravel. Dredge.—One, small.

Helga CXXI.—24 VIII '01. 64 mls. N.W.½W. of Cleggan Head, Co. Galway, 199 fms., sand. Trawl.—Twenty, all quite small.

S. 44.—12 II '02. 7 mls. off Howth, Co. Dublin, 25-27 fms., sand. Trawl.—Two.

S. 70.—9 VII '02. 7 mls. off shore, Lambay to Rockabill, Co. Dublin, 25-26 fms., fine sand and mud. Trawl.—One.

S. 107.—17 IV '03. 2 mls. outside Kish Light, off Co. Dublin, 20–23 fms. Trawl.—One.

S. 201.—23 I '04. 10 mls. off Rockabill, Co. Dublin, 44-48 fms. Trawl.—Two, 23 mm.

S. R. 145.—24 VIII '04. 50 mls. W.N.W. of Slyne Head, Co. Galway, 53° 24′ 30″ N., 11° 38′ W., 112 fms., fine sand. Trawl.—Two.

S. R. 178.—16 XI '04. 53° 36′ 30″ N., 11° 15′ 30″ W., 74½ fms., coarse gravel. Dredge. Temperature at depth 10·8° C.—One, 32 mm.

S. R. 185.—30 I '05. 50° 20′ N., 10° 20′ W., 82½ fms., fine sand and shells. Trawl. Temperature at 80 fms., 11·05° C., salinity 35·62 °/₀₀.—Four, 15–52 mm.

S. R. 194.—10 II '05. 54° 49′ N., 10° 30′ W., 366 fms., rock. Dredge. Temperature at 340 fms., 9·6° C., salinity 35·44 °/₀₀.—Three, 20–33 mm.

S. R. 196.—11 II '05. 54° 42′ N., 10° 34′ W., 242 fms., stones and coral. Dredge. Temperature at 235 fms., 9·8° C.—Three, 27–42 mm.

R. 8.—3 V '05. 16½ mls. S.W. of Coningbeg Lightship, 51° 47′ 30″ N., 6° 52′ W., 40 fms., mud. Trawl. Temperature at 40 fms., 8·9° C.—Two.

R. 9.—3 V '05. 17½ mls. S.W.½W. of Coningbeg Lightship, 40 fms., fine sand and shells. Trawl.—Three.

S. R. 215.—9 V '05. 52° 1′ N., 11°21′ W., 106 fms., fine sand. Trawl.—One, 75 mm.

S. 323.—21 VIII '05. 6 mls. off Howth Head, Co. Dublin, 21½–23½ fms., fine sand. Trawl. Temperature at depth 13·5° C.—One.

S. R. 360.—8 VIII '06. 52° 4′ N., 11° 27′ W., 108–120 fms., fine sand. Trawl.—Two.

S. R. 367.—11 VIII '06. 51° 38′ N., 11° 37′ W., 287–332 fms., mud and sand. Trawl.—Two, 22 mm.

R. 29.—17 VIII '06. 15 mls. S.E. by S. of Mine Head, Co. Waterford, 40–42 fms., shelly sand and gravel. Trawl. Temperature at depth 9·6 C.—One, small.

S. 457.—15 X '06. 19½ mls. W.S.W. of Chicken Rock, Isle of Man, 41–80 fms., mud. Trawl.—Two.

S. 476.—19 X '06. 6 mls. E.S.E. of Bailey Light, Co. Dublin, 23 fms., shelly sand. Trawl. Temperature at depth 12·6° C.—One.

S. R. 399.—5 II '07. 51° 28′ N., 11° 33′ 30″ W., 342 fms., mud and stones. Dredge.—One, 12·5 mm.

S. R. 447.—18 V '07. 50° 20′ N., 10° 57′ W., 221–343 fms., fine sand. Trawl. Temperature at 300 fms., 9·87° C., Salinity 35·48 °/₀₀—One, small.

S. R. 581.—31 VII '08. 44 mls. S.W. by S. of Hook Light, Co. Wexford, 48 fms., coral sand and gravel. Trawl. Temperature at depth 8·8° C., Salinity 35·05 °/₀₀.—One.

Munida tenuimana, G. O. Sars.

Pl. XI, figs. 15–16.

Munida tenuimana, G. O. Sars, 1871.
Munida tenuimana, G. O. Sars, 1882.
Munida tenuimana, Appellöf, 1906.
Munida tenuimana, Hansen, 1908.

This species is very closely allied to *M. bamffica*, but it is separable from the latter by certain well-marked characters.

Appellöf (1906) gives the following summary of its characters : " Eye-bulb broader than in *M. rugosa* (=*bamffica*) ; circlet of hairs quite rudimentary or altogether absent ; spines always present on the middle part of hind margin of carapace ; two spines on fourth abdominal segment ; dorsal surface of abdominal segments with 6–7 furrows ; limbs slenderer than in *rugosa* (=*bamffica*)."

All these characters are reliable, but Hansen points out that Appellöf has not observed the best distinguishing mark, viz., the surface of the sternal plates. He says : " In both species the sternum is divided into four segments by raised cross-lines furnished with marginal hairs. In *M. bamffica* it is further, as if covered with scales almost everywhere, which is due to the presence of numerous large and small, slightly-arched tubercles, the convex, anterior, or outer margin of which is well marked off and provided with hairs. . . . In *M. tenuimana* the sternum is very shining and without the scale-formations as in *M. bamffica* ; there are some rows of bristles on a part of the first sternal segment, but the scale-like tubercles are rudimentary, and as a rule the second, third, and fourth segments are smooth, with altogether extremely few short rows of hairs, chiefly out towards the lateral margins ; sometimes, also, we meet with a small number of such rows scattered over the surface of the segments, but the scale-formation, *i.e.*, the raised, seemingly imbricate areas are never developed."

M. tenuimana is, on the whole, more slightly built than *M. bamffica* ; the carapace is not quite so broad, and its margins are not so convex as in the latter species. The pereiopods, and in particular the first pair, are longer and more slender.

The circlet of hairs round the eye is almost entirely absent, and in some specimens completely so. The eyes are usually slightly larger than in *bamffica*. The sternum is as described by Hansen in all the specimens taken by the *Helga*. In some cases there are a few hair-fringed ridges on the second and third plates, but otherwise they are absent except near the anterior edge of the first sternal plate. In all the specimens of *bamffica*, on the contrary, the sternum is covered throughout with curved ridges and tubercles.

In all the specimens which I have examined the supra-orbital spines are elevated at a greater angle than they are in *bamffica*, in which, indeed, they lie almost in the same plane as the rostrum.

Another character which holds for all the Irish specimens, is the difference in the antero-lateral spines of the carapace. In *bamffica* these are barely half as long as the supra-orbital spines, and are thickened near the base; in *tenuimana*, on the other hand, they are very slender throughout, and are often very nearly as long as the supra-orbital spines.

Appellöf's distinction, based on the number of tergal furrows, is reliable only in the case of adult specimens, as the number of furrows varies with age. In *bamffica* there are from nine to fifteen, and in *tenuimana*, only six or seven.

The differences between the two species may, therefore, be tabulated as follows :—

M. bamffica.	*M. tenuimana.*
Eyes surrounded by circlet of hairs, some of which extend far out on corneal surface.	Circlet of hairs absent or rudimentary.
Sternal plates covered closely with raised tubercles and ridges which are bordered anteriorly with hairs.	Sternal plates devoid of such ridges and tubercles altogether, or having at most a few widely-scattered.
Spines on middle part of hind margin of carapace sometimes present.	Spines always present on middle part of hind margin, and usually larger than in *bamffica*.
Spines sometimes present on tergum of fourth abdominal segment.	Spines always present on fourth abdominal segment, and larger than in *bamffica*.
Supra-orbital spines horizontal or very slightly elevated.	Supra-orbital spines elevated at a considerable angle.
Spines at antero-lateral angles of carapace, about half as long as the supra-orbital spines.	Spines at antero-lateral angles of carapace, very long and slender, very nearly as long as the supra-orbital spines.

Dr. Lundbeck, of Copenhagen, has kindly sent me a specimen of *M. bamffica*, from the Faeroes, and three of *M. tenuimana* from the Skagerrak. These were named by Dr. Hansen, and I find that they agree exactly with the Irish specimens of the respective species.

Size.—The largest specimen measures 59 mm., and others in the collection are 58 mm., 53 mm., 51 mm., and 46 mm. Hansen mentions a female taken in the Skagerrak which was 87 mm. long, and a male taken by the *Ingolf* was about 74 mm. long.

General Distribution.—It is difficult to tell which records of this species are trustworthy owing to its having been confused with *M. bamffica* by Milne-Edwards, Bouvier, Senna, Adensamer, and others. It has been taken in the Norwegian fjords (Sars), in the Skagerrak (Stephensen, Björck), at a large number of stations to the west and south of Iceland (Hansen), and in Davis Straits (Stephensen). The *Helga* records are the first for the Irish marine area, but it is known from the Shetlands (Norman). It is at present impossible to mention a limit to its southern extension owing to its probable confusion by various authors with the last species.

Vertical Distribution.—*M. tenuimana* is a deep-water form, uniformly inhabiting greater depths than does *M. bamffica*. Sars took it in the Norwegian fjords in depths of 300–672 fms. Hansen records a remarkable haul of 104 specimens taken by the *Ingolf* off the south-west of Iceland, in a depth of 799 fms., the greatest yet recorded for the species. The *Helga* specimens were taken in 550–795 fms. Occasionally it seems to be found in comparatively shallow water, as Björck (1913 (*a*)) records it from 53 fms., from the Skagerrak.

Irish Distribution.—All the stations at which this species was taken lie close together, about 60 or 70 miles south-west of Tearaght, Co. Kerry.

Helga.

S. R. 331.—9 v '06.—51° 12′ N., 10° 55′ W., 610–680 fms., ooze. Trawl. Surface Temperature 10·75° C.—Two, 43–50 mm.

S. R. 353.—6 VIII '06. 50° 37′–50° 40′ N., 11° 32′ W., 250–542 fms., mud and sand. Trawl. Temperature at 500 fms., 8·58° C. Salinity 35·46°/₀₀.—Two, 26–46 mm.

S. R. 363.—10 VIII '06. 51° 22′ N., 12° W., 695–720 fms., ooze. Trawl.—24–58 mm.

S. R. 364.—10 VIII '06.—51° 23′ 30″ N., 11° 47′ W., 620–695 fms., ooze. Trawl. Temperature at 600 fms., 7·92° C., Salinity 35·37 °/₀₀.—One, 32 mm.

S. R. 401.—5 II '07. 51° 14′ N., 11° 51′ W., 600–660 fms. Trawl. Temperature at 580 fms., 8·35° C., Salinity 35·5 °/₀₀.—One, 34 mm.

S. R. 477.—28 VIII '07. 51° 15′ N., 11° 47′ W., 707–710 fms., ooze. Trawl. Temperature at depth 7·19° C.—Four, 28–53 mm.

S. R. 491.—7 IX '07. 51° 57′ 30″ N., 12° 13′ W., 491–520 fms. Trawl. Temperature at depth 8·53° C., Salinity 35·44 °/₀₀.—One.

S. R. 497.—10 IX '07. 51° 2′ N., 11° 36′ W., 775–795 fms., ooze. Trawl.—One, 43 mm.

S. R. 499.—11 IX '07. 50° 55′ N., 11° 29′ W., 666–778 fms. Trawl. Temperature at 600 fms., 8·22° C., Salinity 35·41 °/₀₀.—One.

S. R. 504.—12 IX '07. 50° 42′ N., 11° 18′ W., 627–728 fms., coral. Trawl.—One.

S. R. 506.—12 IX '07. 50° 34′ N., 11° 19′ W., 661–672 fms. Trawl. Temperature at 600 fms., 8·22° C., Salinity, 35·53 °/₀₀.—One.

S. R. 593.—6 VIII '08. 50° 31′ N., 11° 31′ W., 670–770 fms., ooze. Trawl. Temperature at 650 fms., 7·75° C., Salinity, 35·53 °/₀₀.—Two, very small.

S. R. 752.—16, 17 V '09. 51° 48′ N., 12° 11′ 30″ W., soundings 523–595 fms., ooze. Midwater otter trawl, 0–595 fms. Temperature at 500 fms., 8·9° C., Salinity 35·43 °/₀₀.—Five, small.

S. R. 753.—17 V '09.—51° 24′ N., 11° 59′ 30″ W., 561–572 fms., ooze. Trawl. Temperature at 550 fms., 8·79° C., Salinity 35·46 °/₀₀.—One, 59 mm.

S. R. 805.—14 VIII '09. 60 mls. W.½N. of Tearaght Light, Co. Kerry, 51° 50′ 30″ N., 12° 14′ W., 539–544 fms., ooze. Trawl.—One, 21 mm.

S. R. 1242.—14 VIII '11. 51° 27′ N., 11° 55′ W., 550–590 fms. Trawl.—Two, 44–51 mm.

Genus **Munidopsis**, Whiteaves.

Munidopsis, Whiteaves, 1874. *Galathodes*, A. Milne-Edwards, 1880. *Orophorhynchus*, A. Milne-Edwards, 1880. *Elasmonotus*, A. Milne-Edwards, 1880. *Anoplonotus*, S. J. Smith, 1883. *Galathopsis*, Henderson, 1885. *Munidopsis*, Henderson, 1888. *Elasmonotus*, Henderson, 1888. *Munidopsis*, A. Milne-Edwards and Bouvier, 1894 (*b*). *Galathodes*, A. Milne-Edwards and Bouvier, 1894 (*b*). *Elasmonotus*, A. Milne-Edwards and Bouvier, 1894 (*b*). *Orophorhynchus*, A. Milne-Edwards and Bouvier, 1894 (*b*). *Bathyankeristes*, Alcock and Anderson, 1894. *Munidopsis*, Faxon, 1895. *Munidopsis*, Alcock, 1901.

Following Faxon and Alcock, I have united the various genera into which this group has been split up, in the single genus *Munidopsis*. The two species which have been taken in Irish waters, *M. tridentata* and *M. curvirostra*, are widely different, and might well be placed in separate genera were it not for the fact that they are connected by transitional forms which make it impossible to draw any hard and fast line between the various groups. Alcock (1901) gives the genera proposed by Milne-Edwards and Bouvier, and his own genus *Bathyankeristes*, the rank of sub-genera with a synopsis of their characters.

The two Irish species are easily separable by the form of the rostrum :—

Rostrum spiniform ; strongly upturned, *M. curvirostra.*

Rostrum broad, ending in three teeth, the central one the longest, .. *M. tridentata.*

M. tridentata belongs to Alcock's sub-genus *Galathodes*, and *M. curvirostra* to *Munidopsis* proper.

Mundiopsis (Galathodes) tridentata (Esmark.)

Pl. XII, figs. 1–5.

Galathea tridentata, Esmark, 1856.
Galathodes rosaceus, A. Milne-Edwards, 1881.
Galathodes tridentata, G. O. Sars, 1882.
Munidopsis rosacea, Alcock and Anderson, 1899.
Galathodes tridentata, A. Milne-Edwards and Bouvier, 1899.
Munidopsis tridentata, Alcock, 1901.
Galathodes tridentata, Appellöf, 1906.

The carapace, excluding the broad, flattened rostrum, is roughly quadrilateral. The two lateral margins are very slightly convex, and each bears four small teeth. The posterior tooth is situated immediately behind the cervical groove, and the anterior and largest one forms the antero-lateral angle of the carapace. The rostrum is less than half the length of the carapace, and is slightly but distinctly carinated in the median line, ending in a trifid tip, the central point of which is the longest. Between the base of the rostrum and the antero-lateral spine there is a sharp tooth above the base of the antenna. The hind margin of the carapace is smooth and very slightly concave. The whole dorsal surface is rugose and covered with short hairs. The cervical groove is most distinct at the sides and is more vague in outline in the middle. On the central part of the cardiac region there is a short transverse furrow which extends about half way to either lateral margin and has at each end a circular depression. There is another depression just in front of the hind margin. The *linea anomurica* is distinct. The sub-lateral surface of the carapace is rugose like the dorsal part.

The abdomen, when straightened out, is of about the same length as the carapace, excluding the rostrum. None of the terga bear spines. The covering of setae is not so dense as on the carapace.

The second and third abdominal segments have a dorsal transverse groove which is wanting on the other segments. The pleura of the second segment are broader than the others. The basal part of the telson is bounded by a straight line in front and rounded behind. It is followed by a very small triangular plate. The hind part of the telson is divided by a deep median and two oblique lateral grooves.

The eyes are not facetted and are devoid of pigment. They are terminal on the sub-cylindrical eyestalks. Immediately to the exterior of each stalk there is a small sharp tooth.

The antennules are short, reaching only slightly beyond the tip of the rostrum when extended. The basal joint is massive

and bears two long spines. The second and third joints are about equal and become thicker distally. The two flagella are both quite short, the internal one consisting of only four joints, and being slender throughout, while the outer is made up of about fifteen joints and is broad at the base but narrows rapidly into a long, thin distal portion. The tip of the last peduncular joint bears a semicircle of long plumose hairs which surround the base of the exterior flagellum, which also has a dense fringe of hairs along its inner margin.

The antennal peduncle consists of four joints, the basal one of which is embedded in a sinus in the sub-marginal part of the carapace just at the end of the *linea anomurica*. It gives off an internal and an external spine, of which the former is the larger ; both are thick and blunt. The second joint has a sharp spine at the outer side. The flagellum is very slender and is about one and a-half times as long as the carapace, including the rostrum.

The ischium of the third maxillipedes is triangular in section. It thickens very considerably towards the distal end, which bears two sharp teeth. The merus has two long spines on the inner side ; the carpus is swollen and rough ; the propodite is club-shaped.

The chelipeds are as long as, or longer than, the body from rostrum to tip of extended telson. They are well developed in both sexes, but are more massive in the male. They are covered above and below with little elongated tubercles or scales, from which spring groups of setae. The three basal joints are slender compared with the others. On the merus, which is more or less quadrilateral in section, there is a dorsal row of four or five teeth ; on the upper distal part of the internal face a single large spine ; near the proximal end of the lower side and pointing inwards, a row of three large spines ; and at the distal extremity four sharp teeth. The carpus is short and bears several spines, including one large one on the inner face. The propodite is the largest joint of the appendage ; the palm is nearly twice as long as the fingers ; it bears no spines. The fixed finger curves slightly outwards at its base and touches the dactyl at the tip only. The interior edges of the fingers are minutely serrate. Opposite the hollow of the fixed finger the inner margin of the dactyl curves towards the latter, but not far enough to bring the two into contact.

It should be noted that the form and dimensions of the chelipeds of this species are extremely variable. Among 237 specimens Alcock could not find two in which the arrangement of spines was identical.

The next three pairs of legs are very similar in appearance. The dorsal side of the merus bears a row of sharp, forward-directed spines, the last of the row projecting distally beyond the joint. There is also a distal spine at the lower end of the merus. The carpus bears a similar sharp dorsal tooth at the tip, but the row of spines is continued on this joint merely by

a very fine denticulation. The propodite is sub-cylindrical with a slight dorsal ridge ; the lower side bears two small distal teeth. The dactyl is only about half the length of the propodite, and its posterior edge bears about ten small teeth ; it terminates in a sharp curved claw.

The fifth legs are feeble and are carried folded in the manner usual in this group of Decapods.

The first pair of pleopods arise very near the median line in the male ; they have a stout basal part and a distal joint, which expands into a broad lamella which is curved downwards. The basal joint has a distal tuft of setae, and the inner edge of the lamella is fringed with hairs, which are longest at the proximal end. The second pleopods in the male have a very long and thick peduncular part which bears at its end a short, blunt tubercular process which represents the exopodite. The inner branch and the *appendix interna* are united to form a large flattened and twisted structure. It is heavily fringed with setae, and the outer portion at the broadest part is covered with short, stiff bristles. It is this part which constitutes the *appendix masculina*, and has become fused with the endopodite of the pleopod.

The pleopods of the third, fourth, and fifth segments are feeble and rudimentary.

In the female, pleopods are present on the second to fifth segments, and are all slender and feeble.

The exopodite of the uropods is rough and calcareous towards the outer edge, but the inner part is smooth. The endopodite is rough all over, and bears short transverse ridges armed with groups of little teeth. Both have marginal spines and fringes of setae.

Size.—The largest specimen taken by the *Helga* is a male which measures 33 mm.

General Distribution.—The species is found, but not commonly, on the west coast of Norway : Lofoten (Esmark), Hardangerfjord (Sars), Trondhjemfjord (Norman). It has been recorded from the Bay of Biscay (Caullery, M. Edwards and Bouvier), off the west coast of Morocco and the Sudan, from the Azores, and Cape Verde (M. Edwards and Bouvier). It has also been taken plentifully in the Indian Ocean : Arabian Sea, North Maldive Atoll, Travancore coast, off Ceylon (Alcock).

Irish Distribution.—This species has not previously been recorded from British waters.

Helga.

S. R. 335.—12 v '06. 51° 12′ 30″–51° 17′ 30″ N., 12° 18′–12° 16′ W., 893–673 fms. Trawl and Sprat net on Trawl.—Four.

S. R. 504.—12 IX '07. 50° 42′ N., 11° 18′ W., 627–728 fms., coral. Trawl and Sprat net on Trawl.—Two, one male and one immature.

S. R. 1004.—12 VIII '10. 51 mls. W½S. of Great Skellig, 51° 22′ 30″ N., 11° 44′ 30″ W., 641–636 fms., fine sand. Trawl. Temp. at 630 fms., 7·12° C.—Two, one male, 33 mm., one female, 28 mm.

Vertical Distribution.—Like the other members of the genus, it inhabits deep water, occurring most commonly in depths of 550–750 fms. In the Bay of Biscay it was taken in 808 fms. In the Indian Ocean it apparently inhabits shallower water, the depths given by Alcock ranging from 210 fms. to 430 fms.

Very often the specimens are found clinging to coral, especially *Lophohelia prolifera.*

Munidopsis curvirostra, Whiteaves.

Pl. XIII, figs. 1–4.

Munidopsis curvirostra, Whiteaves, 1874.
Munidopsis longirostris, A. Milne-Edwards and Bouvier, 1900.
Munidopsis curvirostra, Hansen, 1908.
Munidopsis curvirostra, Stephensen, 1912.

Hansen (1908) examined a specimen of M. *longirostris* taken by the *Talisman* off the west coast of the Sudan, and found that it agreed perfectly with the specimens of *M. curvirostra,* taken by the *Ingolf.* Neither the *Talisman* nor the *Ingolf* specimen, however, agrees with Milne-Edwards and Bouvier's figures (1900), which show the carapace wider in front than behind, and with very long and broad antero-lateral processes.

The sides of the carapace are almost parallel, converging very slightly in front. The lateral margins are entire and do not come to a sharp edge. The postero-lateral angles are rounded, and the posterior margin is feebly concave and unarmed. At each antero-lateral angle there is a large horizontally-projecting spine, with a broad, rounded base, and tapering rapidly to a fine point. The anterior edge of the spine bears a small accessory tooth near the tip. The front of the carapace is rounded and unarmed, except for the very long and slender upturned rostrum, which is usually about two-thirds the length of the carapace. The gastric region is more or less inflated and bears a variable number of spines. Behind this lies the deeply-channelled cervical groove, which on either side gives off a groove which runs forwards to the antero-lateral angle. On the middle of the cardiac region there is a sharply-defined transverse ridge bearing a single large spine. Almost the entire surface of the carapace is marked by low, short transverse ridges which are most numerous near the sides.

The arrangement of the spines on the gastric area is extremely variable. In the ten specimens taken by the *Helga,* six different arrangements can be seen. Normally there is a pair of spines in front, some distance behind the base of the rostrum, and

behind these one or two median unpaired spines. In some cases, however, as many as five median spines are present. (See also Hansen, 1908, Pl. III., figs. 2A–2D.)

The *linea anomurica* is distinct, and the sub-marginal part of the carapace is covered with low oblique ridges.

The carapace, excluding the rostrum, is as long as the straightened abdomen without the telson.

The first abdominal segment is partly hidden by the carapace and is very narrow. The second, third, and fourth segments have each a transverse furrow on the tergum. The second and third terga each bear a median spine which points forwards. Sometimes a spine is present on the fourth tergum also; it occurs in only one of the *Helga* specimens.

The pleura are well developed, and are long and narrow, with blunt ends, except those of the second segment which are broad and rounded. On the first segment they are rudimentary. On the anterior margin they are all fringed with setae, and on the sixth segment on both margins. The telson differs somewhat in structure from that of *M. tridentata*. The basal plate comes to a truncate end and is followed by three small plates in the middle, the central one of which is prolonged in a narrow process extending to the posterior margin.

The eyes are large but quite devoid of pigment. They vary somewhat in shape; in some the cornea is more or less pointed in front, and in others is quite globular.

The antennules resemble those of *M. tridentata*, except with regard to the basal joint of the peduncle, which bears three long spines instead of two. One of the spines, immediately at the base of the second joint, is divided into three points, and bears also two or three small teeth between the larger ones.

The antennal peduncle differs from that of *M. tridentata* in having the spines of the basal joint represented by blunt tubercles. The flagella are as long as the body excluding the telson.

The third maxillipedes are similar to those of *M. tridentata*, except that the two teeth on the internal margin of the merus are shorter, and the terminal teeth on the ischium are more rounded.

The chelipeds are long and slender. One is usually slightly larger than the other; this may be either the right or the left. They are covered throughout with small scales, some of which are fringed with extremely short setae, but they are devoid of long hairs, such as are present in *M. tridentata*. The first three joints are slenderer than the others, the thickening beginning at the base of the merus, which is more or less quadrangular in section. Each of the four edges of the merus ends in a sharp distal spine. The carpus terminates in two double spines above, and a broader spine below, which has also sometimes a double point. The propodite is broadest at the base of the fingers, which are in contact throughout their whole length. The cutting edges are serrate. The palm is longer than the fingers.

The next three pairs of legs are sub-equal and also bear a covering of small scales. The merus is unarmed except for one or two distal spines. On the carpus there is sometimes a distal spine on the dorsal side, but this is often absent in the third and fourth pairs. There is a small tuft of setae at the distal end of the propodite. The lower edge of the dactyl is furnished with a row of sharp teeth which increase in size towards the point, which has the form of a strongly-curved claw. These teeth are accompanied by fringes of setae.

In the male, the first pair of pleopods is practically identical in form with those of *M. tridentata*, but their point of attachment is not so near the median line. The second pair differs only in detail from that of the last species. The other pairs are reduced to the merest rudiments in the male. In the female, five pairs are present and are long and slender.

The uropods have no transverse suture on either exopodite or endopodite, and are usually carried half concealed under the telson.

All the female specimens taken by the *Helga* are ovigerous. The eggs are large and few in number. In the different individuals the eggs number 12, 20, 25, 30, 38 and 45. They measure from 1·2 mm. to 1·4 mm. in diameter.

Size.—The largest specimen taken is a male measuring 31 mm. Hansen's largest one was 35 mm. long.

General Distribution.—The species was first taken in the Gulf of St. Lawrence (Whiteaves), and has since been recorded from the east coast of the United States between 33° 35′ N. and 40° N., and off Newfoundland. More recently it has been taken in Davis Straits (Hansen, Stephensen), and to the south and south-west of Iceland (Hansen). It has also been recorded, under the name of *M. longirostris*, from the west coast of the Sudan at 30° N. (Milne-Edwards and Bouvier).

Irish Distribution.—The *Helga* has taken this species on only one occasion.

S. R. 944.—17 v '10. 86 mls. W.¼N. of Great Skellig, Co. Kerry, 51° 22′ N., 12° 41′ W., 982 fms., ooze. Shrimp-Trawl.—Ten, three males, and seven ovigerous females, 31–25 mm.

Vertical Distribution.—Usually found in depths of about 700–900 fms., but has been taken in 180 fms. (Gulf of St. Lawrence), and in 1,175 fms. (off Sudan).

Family *PORCELLANIDAE.*

Genus **Porcellana,** Lamarck.

Chelipeds bear a dense fringe of long setae on their outer edge ; carpus has a denticulated lobe at its inner lower angle ; hands very large, ... *P. platycheles.*

Chelipeds devoid of setae ; no denticulated lobe on carpus ; hands narrow, .. *P. longicornis.*

Porcellana platycheles, Pennant.

Porcellana platycheles, Bell, 1853.
Porcellana platycheles, Heller, 1863.

The chief specific characters are the following : dense fringes of long setae on the propodite of the chelipeds ; denticulated process near proximal end of carpus ; carapace slightly longer than broad ; its margins setiferous ; front of carapace divided into three lobes, the central one having a slight median groove, but not divided as in *P. longicornis* ; chelipeds, very massive, and practically equal ; edges of abdominal segments heavily fringed with setae, especially in the female ; walking-legs also setiferous.

Size.—Large specimens measure about 14–16 mm., from front to back of carapace.

General Distribution.—This species has a more limited distribution than *P. longicornis.* It occurs on all the British coasts, even as far north as the Orkneys and Shetlands (Bell). It is also found plentifully on the French side of the Channel, and in the Bay of Biscay (Milne-Edwards), off the Spanish and Portuguese coasts, and at the Canaries (Heller). It is very common throughout the shores of the Mediterranean and Adriatic (Heller).

Irish Distribution.—Found abundantly all round the coast. It is not apparently quite so common on the east as on the west coast, but the larger amount of shore-collecting done on the latter may explain the comparative paucity of records from the east.

Vertical Distribution.—Very common between tide-marks, and extending only a short distance beyond the low-water line.

Porcellana longicornis, Linn.

Porcellana longicornis, Bell, 1853.
Porcellana longicornis, Heller, 1863.
Porcellana longicornis, Meinert, 1877.

Carapace almost circular ; the frontal margin divided into three lobes, the central one divided by a deep groove ; the margin of the central lobe is denticulate. Antennules reach beyond the merus of the chelipeds. Antennae, long and very

slender. Eyes deeply sunk in their orbits, so as to be scarcely visible from above. Chelipeds, large and unequal. The inner edge of the carpus is smooth and unbroken. The fingers touch only at their tips and are slightly twisted. The wrinkles on the carapace are more conspicuous in the females than in the males.

Size.—Large specimens are sometimes 10 mm., from front to back of carapace, but the average measurement is about 6–8 mm.

General Distribution.—The species extends from the south-west of Norway, along the coasts of western Europe into the Mediterranean and the Black Sea. South-west of Norway (G. O. Sars, Appellöf), Skagerrak and Kattegat (Meinert, Björck), Sweden (Goës), Heligoland (Ortmann), British coasts (Bell), Bay of Biscay (Milne-Edwards), Spanish and Portuguese coasts (Heller), Canaries (Heller), Mediterranean and Adriatic (Heller, Carus), Black Sea (Heller).

Irish Distribution.—Very common all round the coast.

Vertical Distribution.—From between tide-marks down to about 20 fms.

Tribe THALLASSINIDEA.

The families containing Irish species may be separated as follows :—

A.—No *linea thallassinica;* abdominal pleura large, ... Axiidae.

B.—*Linea thallassinica* present ; abdominal pleura usually small :—

1. Both endopodite and exopodite of uropods with transverse suture ; podobranchs on at least first three pairs of pereiopods, ... Laomediidae.
2. Neither endopodite nor exopodite of uropods with transverse suture ; pereiopods without podobranchs, Callianassidae.

Family *AXIIDAE.*

The family contains four genera *Axius*, *Axiopsis*, *Calocaris*, and *Scytoleptus*, but we are concerned here with only two of these, *Axius* and *Calocaris*, which may be separated by the following characters :—

Body compressed ; no median dorsal ridge on carapace ; no suture on the exopodite of the uropods, ... *Axius.*

Body almost cylindrical ; a median dorsal ridge on the carapace ; a suture on the exopodite of the uropods, ... *Calocaris.*

Genus **Axius**, Leach.

Borradaile (1903) has divided *Axius* into five subgenera *Axius*, *Neaxius*, *Iconaxiopsis*, *Eiconaxius*, and *Paraxius*. The only one of these with which we have to deal is the first, which is distinguished by having "the flat area of the back and the cervical groove well marked, the eyes well-pigmented, the antennal thorns both of a good size, pleurobranchs on the second to fifth legs, vestiges of a podobranch and an arthrobranch on the second maxillipede, and a shallow-water habitat."

Axius stirhynchus, Leach.

Pl. XIV, figs. 1–4.

Axius stirhynchus, Bell, 1853.
Axius stirhynchus, Norman, 1868.

The carapace is strongly compressed, and very slightly narrower in front and behind than in the middle. The rostrum is short and flat, triangular in shape and furnished with a slight ridge on either margin, and a median crest; its edges are lined with short, blunt teeth, and it bears setae on the dorsal surface. The gastric area is slightly flattened. The cervical groove is very distinct. The posterior margin of the carapace is deeply concave in its central part; the lateral parts of the margin project slightly over the first abdominal segment, and buckle it to the carapace. The ridges from the margins and centre of the rostrum are continued backwards on the gastric area, but do not extend more than one third of the distance to the cervical groove. The whole carapace surface is sparsely punctate.

The abdomen is very nearly twice as long as the carapace. The first segment is shorter and narrower than the others, which are practically uniform. The segments are all quite smooth, bearing no ridges, and are sparsely punctate. They have a slight sprinkling of fine setae. The pleura of the first segment are narrow and taper to a fine point, while those of the other segments are very broad and quite shallow, with rounded angles. On each pleuron of the third, fourth, and fifth segments there is a low oblique ridge from which springs a row of backward pointing hairs.

The telson is as long as the preceding abdominal segment, and slightly narrower at the base, from which it tapers very slightly towards the posterior end, which is truncate. The posterior angles are rounded, and the margin between them is fringed with setae. There are two small spines about the middle of the dorsal surface of the telson, and also a few scales from which spring tufts of bristles all pointing backwards. There is also a median tooth on the posterior margin.

The eyes are small and the eyestalks short. They are half hidden beneath the rostrum, and are fairly well pigmented.

The antennulary peduncle extends beyond the tip of the

rostrum. The two flagella are of about equal length, but the outer is slightly thicker than the inner.

The antennal peduncle is five-jointed. The basal joint is short and broad, the second much larger, ending at its upper and outer angle in a strong fixed spine. Springing from the base of the latter, and lying between it and the fourth joint, is a long mobile spine representing the scale. The third joint lies more or less alongside of and below the second. The fourth and fifth joints are roughly cylindrical; the fourth is about one and a half times as long as the fifth. The flagellum is more than twice as long as the antennules, and almost twice as long as the carapace. The lower surface of the last three peduncular joints and of the proximal half of the flagellum is fringed with heavy plumose setae of a brownish yellow colour. This fringe is not absent in the female, as stated by Bell (1853).

The exopodite of the second maxillipedes reaches very nearly to the distal end of the propodite, which is broad and inflated; the carpus and the dactyl are both very short; the longest joint is the merus, which is about three times as long as the ischium. The appendage bears an epipodite, a podobranch and a rudimentary arthrobranch.

The third maxillipedes are pediform and unarmed. No one joint is much longer than the others. Each joint bears a heavy fringe of setae. The exopodite reaches slightly beyond the end of the merus.

The chelipeds are massive and unequal. The basal joints and the first half of the merus are very strongly compressed. The distal part of the merus, however, expands suddenly. The carpus is very short and broad. The prododite is the largest joint of the appendage; it is slightly compressed; the palm is one and a half times as long as the fingers; the lower margin bears a fringe of fine setae, and both fingers are covered with tufts of stiff bristles. The tips of the fingers curve towards one another, and cross when closed. The dactyl has a well marked ridge on the outer side, and bears more bristles than the fixed finger. The cutting edges are very minutely serrate, and, in the larger cheliped, there are also a few large crushing tubercles.

The second pereiopods are much more slender than the first. They terminate in equal chelae, and are strongly compressed.

The fourth pereiopods are the largest, with the exception of the first pair, and the fifth the shortest. The last three pairs all end simply, and are compressed and slender.

In the second pereiopods setae are present on the lower edge of the merus, on the distal half of the carpus, and on the whole of the propodite and dactyl; there are tufts of longer hairs at the extremities of carpus and merus.

In the third pair the lower edge of the merus has only a row of short bristles; the propodite, dactyl, and carpus have setae on their lower margins.

The setae on the fourth pair are more sparsely scattered than on the third.

In the fifth pair they are most plentiful at the end of the propodite and on the dactyl.

Both the perfect specimens taken by the *Helga* are females, so I can give no description of the form of the pleopods in the male. The pleopods in the female are well developed and fringed with long plumose setae. To the inner branch there is attached a small *appendix interna.*

The uropods are as long as the telson, fringed with setae, rounded ; neither endopodite nor exopodite has a suture. The endopodite has a strengthening midrib which bears four small spines ; the exopodite has two similar ribs which end in small spines on the margin.

The gills are trichobranchiate, with the filaments arranged in one plane. The branchial formula is as follows :—

—	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.
Podobranchs.	ep.	1+ep.	1+ep.	1+ep.	1+ep.	1+ep.	ep.	—
Arthrobranchs.	—	*r*	2	2	2	2	2	—
Pleurobranchs.	—	—	—	—	1	1	1	*r*

In the female specimens I have seen there is a curious structure situated between the coxae of the fourth pereiopods. It appears to correspond to the " thelycum " of the Peneidae. It consists of two lateral plates, the outer edges of which are curved upwards to form sharp ridges. These extend forwards parallel to one another, but posteriorly they converge, and ultimately coalesce, at the same time becoming much flatter. Their anterior extremities are narrow and pointed, and between them there is a third plate, roughly triangular in outline, and situated transversely to the first two. Its anterior edge is upturned to form a ridge, but this is not so high as those of the lateral plates. These three plates together form a triangular hollow in the centre of which appears a small opening.

Size.—The largest specimen examined measures 72 mm.

General Distribution.—There are very few records of this species, its fossorial mode of life making it difficult of capture. Probably it has a considerably wider range than is indicated by the list of localities given here. It is known from the south coast of England (Spence Bate), Channel Islands (Sinel), France (Milne-Edwards), and the Mediterranean (Beil).

Vertical Distribution.—Littoral; of burrowing habits.

Irish Distribution.—Two female specimens have been taken by the *Helga,* one in the Irish Sea and one in Ballynakill Harbour, Co. Galway. Half-digested remains have also been found on four occasions in the stomach of *Raja clavata,* each time in Galway Bay. In one case five specimens were found in one fish.

So far as I have been able to discover, the species has not previously been recorded from Irish waters.

Helga.—

L. 288.—3 II '04.—Ballynakill Harbour, Co. Galway.—One· 72 mm.

S. 259.—21 II '05. 15 mls. off Clogher Head, Co. Louth, 32½ fms., mud. Trawl.—One.

Genus **Calocaris**, Bell.

Calocaris, Bell, 1853. *Calocaris*, Alcock, 1901.

Body almost cylindrical; the back arched so that its middle point is considerably higher than the base of the rostrum. From either margin of the rostrum there extends backwards and outwards on the sides of the gastric area, a ridge armed with teeth; it does not reach the cervical groove, which is distinct. A low but distinct carina runs from the rostrum to the posterior margin along the dorsal median line of the carapace. There are no pleurobranchiae. There is a suture on the exopodite of the uropods. Deep-water habitat.

Calocaris Macandreae, Bell.

Pl. XIV, figs. 5–7.

Calocaris Macandreae, Bell, 1853.
? *Calocaris Macandreae*, Alcock, 1901.
Calocaris Macandreae, Hansen, 1908.
Calocaris Macandreae, Wolleback, 1909.
Calocaris Macandreae, Björck, 1913 (b).

This species has been so well described by Bell and Alcock, that it is unnecessary to give here more than a brief summary of the main characters.

Carapace compressed, shorter than abdomen. Rostrum slightly upturned, reaching very nearly to the end of the antennal peduncle; its margins are continued as prominent divergent ridges on the gastric area, and bear teeth.

Abdomen slightly tapering, smooth; pleura broad with rounded angles, except in the first somite. Telson broad; often more or less excavated on posterior margin; sometimes with a minute tooth at the tip; the sides sometimes bear two or three proximal teeth; there are two diverging rows of spines running down the telson, but not reaching the margin.

Eyes large and pigmentless; practically no eyestalk.

The fourth joint of the antennal peduncle is by far the longest; the scale is represented by a small spine, and to the inside of this there is a second still smaller one. The flagellum is slightly longer than the body.

The two branches of the antennules are lashlike and slender; they are longer than the carapace.

The third maxillipedes are pediform and slender; the ischium is long, and bears a row of strong teeth; the merus has a single large spine near the distal end of the inner margin.

The chelipeds are long and robust; the fingers especially are very much elongated; the merus, which is strongly compressed, bears a row of five or six teeth on the lower margin, and a single distal tooth above. The carpus is short and unarmed. The upper surface of the palm bears two crests, each of which ends distally in a tooth near the base of the dactyl. The fingers are long and compressed, and covered with tufts of setae. The fixed finger has its cutting edge serrate throughout; the proximal half of the dactyl, however, is quite smooth, and in the distal portion only very minute serration is present. At the base of the fixed finger there is a single large tooth. The fingers are not in contact except in their distal portions; the tips cross one another. The fingers are not quite twice the length of the palm.

The following pairs of pereiopods are slender; the second pair are chelate, the others simple.

The pleopods, except the first pair, are biramous, and have a small and slender *appendix interna*, furnished with hooklets.

The outer margin of the exopodite of the uropods bears two or three spines, the distal one the largest; the endopodite has only one spine in a position corresponding to the large one of the exopodite. The latter has an oblique suture near the tip.

Branchial formula :—

—	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.
Podobranchs.	ep.	*r*+ep.	1+ep.	1+ep.	1+ep.	1+ep.	ep.	—
Arthrobranchs	—	*r*	2	2	2	2	2	—
Pleurobranchs.	—	—	—	—	—	—	—	—

On the first abdominal somite there is a pair of simple appendages, the tip of which is expanded in the manner usual in male Decapods. This structure, however, is found in *all* adult specimens, and both the male and the female genital openings, on the coxae of the fifth and third pereiopods, respectively, are always present.

In 1909 Wollebaek published a paper calling attention to the fact that *Calocaris Macandreae* was normally hermaphrodite. The union of sexes is not confined to the outward characters alone, but extends to the internal sexual organs; in each specimen there are to be found testes, and also ovaries. Wollebaek examined more than fifty specimens in the Bergen Museum, all of which exhibited hermaphroditism.

This species was taken by the *Helga* on several occasions, and in fairly large quantities. The specimens agree entirely with Wollebaek's results. The male and female openings are distinctly developed, and I have dissected several specimens and found both testes and ovaries present.

Spermatophores and spermatozoa of the peculiar shape described by Wollebaek were found in the long and spirally-twisted *vas deferens*. The testes are very small compared with the same organs in some other Decapods, such as the Lobster. In the latter they consist of a long uniform tube on either side of the gut, the two parts being connected by a bridge in their anterior part. In *C. Macandreae*, on the other hand, the testes form merely a small sac-like continuation of the first part of the *vas deferens*. They are attached to the gut, and are also more or less adherent to the posterior extremity of the ovaries. The *vas deferens* consists of three distinct parts: (1) The part nearest the testes, which is fairly wide, is bow-shaped, and not spirally twisted; it slopes downwards and backwards, and leads to (2) the middle part, which is curled and twisted in a number of small spirals; and this in its turn leads to (3) the *ductus ejaculatorius*, which is wider than the last, and opens on the coxae of the fifth pereiopods.

The ovaries lie in front of the testes, and extend forwards on either side of the gut, more or less surrounded by the ramifications of the hepatic gland. In winter they are comparatively slender, but in specimens caught in summer the ova are very large, and fill a very large part of the thorax. For purposes of dissection winter specimens should be selected, as the relations on the various parts may then best be seen.

General Distribution.—This species was first taken by M'Andrew in Loch Fyne, and has since proved to extend over a very wide region. It is known from the south and west coasts of Norway (Norman, Appellöf), from Bohuslän, Sweden (Goës), the Kattegat (Meinert), and the Skagerrak (Stephensen). A single specimen was taken by the *Ingolf* off the south-west of Iceland (Hansen). It is found off the coasts of Britain (Norman, Scott, etc.), Holland and Belgium (Tesch), in the Mediterranean (Adensamer, Milne-Edwards), and the Adriatic. It has also been recorded from North American waters from the Gulf of St. Lawrence (Whiteaves).

Two dead specimens were found floating on the surface near New Zealand in 1878, but, so far as I know, it has not been recorded since from that region.

Alcock (1901) has recorded it from two localities in the Arabian Sea and the Bay of Bengal, near Ceylon. Hansen (1908) looks upon these records as doubtful and after comparing Alcock's description with the *Helga* specimens I am inclined to think that the Indian specimens may belong to a separate, though closely allied, species. Alcock says of the third maxillipeds "the inner border of the ischium is elegantly toothed, but that of the merus is unarmed." In all the Irish specimens the merus bears a single prominent tooth on the inner margin near the distal end. Further, when speaking of the chelipeds, he says, "the fingers are about three times as long as the palm,"

whereas in the specimens at my disposal the fingers are not quite *twice* the length of the palm.

Vertical Distribution.—The species has a wide vertical range, extending from about 25–30 fms. down to 600–700 fms. The *Helga* specimens were taken in comparatively shallow water from about 30–80 fms., with the exception of the single individual from the south west, which was captured at a depth of 447–515 fms.

Irish Distribution.—Bell and Stebbing mention the species as occurring in Irish waters, but give no localities. It does not occur in Kinahan or Melville's lists. The great majority of the numerous specimens taken by the *Helga* were found between the east coast and the Isle of Man. A solitary specimen was taken off the south west coast.

Helga.—

S. 42.—30 I '02. 12 mls. off Laytown, to Drogheda bar, 28 fms. Trawl.—One, 18 mm.

S. 146—29 V '03. 19½ mls. off Dunany, Co. Louth, 46 fms. Trawl.—One, 24 mm.

S. 163—11 VI '03. Off Calf of Man, 37–45 fms. Trawl.—One, damaged.

S. 201—23 I '04. 10 mls. off Rockabill, Co. Dublin, 44–48 fms. Trawl.—One, 7 mm.

S. 259—21 II '05. 15 mls. off Clogher Head, Co. Louth, 32½ fms. Trawl.—One, damaged.

S. 274—24 V '05. 11 mls. S. of St. John's Point, Co. Down, 32½–39 fms. Trawl.—Three.

S. 300—14 VIII '05. 12 mls. S. of St. John's Point, Co. Down, 38–42 fms. Trawl. Temp., 11·9° C.—Sixteen, 44–16 mm., one ovigerous.

S. 344—2 XII '05. 18 mls. off Clogher Head, Co. Louth, 48½–50 fms. Trawl. Temp., 10·2° C.—Six, 43–15 mm.

S. 429—24 VII '06. 11 mls., S. ½ E. of St. John's Point, Co. Down, 33–45 fms. Trawl. Temp., 9·8° C.—Two.

S. 457—15 X '06. 19½ mls. W. S. W. of Chicken Rock, Isle of Man, 41–80 fms. Trawl.—One, 24 mm., and 8 very small.

S. 458—15 X '06. 18 mls. W. ½ S. of Chicken Rock, Isle of Man, 65–80 fms. Trawl.—Eighteen, 37–18 mm.

S. 460—16 X '06. 17½ mls., E. by S. of Dunany Point, Co. Louth, 32–38 fms. Trawl.—Four, 23–17 mm.

S. 494—22 II '07. 23 mls. W. S. W. of Chicken Rock, Isle of Man, 40–43 fms. Trawl. Temp., 7·03° C., Salinity 34·42 °/₀₀.—Two, 42–29 mm.

S. 497—22 II '07. 15 mls. S. by W. of St. John's Point, Co. Down, 33–52 fms. Trawl.—Twenty-four, 46–16 mm.

S. R. 502—11 IX '07. 50° 46′ N., 11° 21′ W., 447–515 fms. Trawl. Temp., 8·8° C.—One, 26 mm.

S. 560—24 x '07. 15 mls. W. S. W. of Chicken Rock, Isle of Man, 38½–42 fms. Trawl.—Four, 44–40 mm., 3 ovigerous.

S. 561—24 x '07. 12 mls. W. by S. of Chicken Rock, Isle of Man, 34–38 fms. Trawl. Temp., at 30 fms., 12·75° C. Salinity 34.04 °/₀₀.—Seventeen, 44–14 mm., 2 ovigerous.

Family *LAOMEDIIDAE.*

Genus **Jaxea,** Nardo.

Jaxea nocturna (Chiereghin) Nardo.

Pl. XV, figs. 1–8.

Cancer nocturnus, Chiereghin, 1818.
Jaxea nocturna, Nardo, 1847.
Calliaxis adriatica, Heller, 1863.
Trachelifer (*juv.*) Scott, 1899.
Jaxea nocturna, Scott, 1900.

The carapace is laterally compressed and considerably shorter than the abdomen. It is covered with a fur of short setae, which are most densely crowded on the cardiac area. There is a very distinct *linea thallassinica* on each side of the carapace, which is thus divided longitudinally into three parts. The middle and dorsal part is almost smooth, and projects anteriorly to form the sharp triangular rostrum, which is furnished with very fine teeth on either side. The upper surface of the rostrum is hollowed out, but this depression is not continued on the carapace proper. The lateral parts of the carapace are slightly inflated, and are covered with little tubercles which are most numerous near the lower margin. On the front margin there are three or four small teeth immediately below the beginning of the *linea thallassinica.* The anterior margin merges gradually into the lateral one without any sharp angle. The cervical groove is deeply marked, and does not cross the *linea thallassinica.* The posterior margin of the carapace is strongly concave, and is overlapped on each side by a short process of the first abdominal segment. The carapace is broadest about the middle of the cardiac region, and narrows slightly before and behind this.

The abdomen is longer than the carapace, and is of uniform breadth throughout. The terga are quite smooth, and bear a fairly thick covering of very short setae, set close together. The pleura of the first segment are sharply triangular, those of the other segments broadly so ; they have a small projecting lobe on the posterior margin, except in the first and sixth segments. The anterior edge of the first pair of pleura bears three or four small teeth. On the following segments, both anterior and posterior edges of the pleura bear a number of very minute denticules, but these are apparently absent altogether in some cases.

The telson is quadrate, and its distal part is not so strongly

calcified as the rest, and is almost transparent. A median groove bounded by two ridges runs down the middle. There is also another ridge exterior to this on each side, and these converge and meet near the base of the telson.

The eyes are very minute and almost completely hidden by the rostrum. They are only slightly pigmented.

The antennules arise close together just under the rostrum, which is about one third as long as the peduncle, reaching to about the middle of the second joint. The first joint is the shortest, and the third the longest; it is about two and a half times as long as the second. The two flagella are each about as long as the third peduncular joint. They are both slender, but the outer one is slightly thicker, and very slightly longer, than the inner. The former bears a fringe of setae, and is composed of about twenty joints, the latter of fourteen or fifteen.

The peduncle of the antennae is five-jointed. The first three joints and the last are short, but the fourth is very long, longer than all the others together. The third joint lies partly hidden on the inner side of the second and fourth, and is not easily seen except from below. At the upper distal end of the second joint there is a broad, slightly-movable process which may represent the scale. In profile it appears as a sharp thorn. Its anterior edge bears two or three small teeth. The first joint also bears a pair of small teeth at its interior lower angle. The peduncle is longer than that of the antennules.

The mandible has a three-jointed palp, and a cutting edge furnished with sharp teeth.

The first maxillae have a long slender palp divided into two joints, the distal one much more slender than the proximal. The two inwardly-turned endites are fringed with teeth, which are very long and curved in the proximal one, and short and straight in the distal one.

At the posterior truncated end of the scaphognathite of the second maxillae there are three or four setae which are longer than the scaphognathite itself. There is a slender endopodite.

The first maxillipedes have a two-jointed endopodite, the distal joint of which is broad and expanded. The exopodite has a well-developed flagellum, which reaches beyond the tip of the endopodite. There is a large broad epipodite and a small podobranch.

The exopodite of the second maxillipedes is long, and bears a flagellum reaching beyond the endopodite. The epipodite is long and slender, and its margins bear delicate teeth. There is a large podobranch. The merus is the longest joint; all the others are uniformly short, and the propodite is greatly broadened by an expansion on its outer side.

The third maxillipedes are long, slender, and pediform. The exopodite is not so long as the endopodite. There is a long epipodite bearing small marginal teeth and giving off a slender process near the tip. There is a fair-sized podobranch. The

coxa bears a tuft of long hairs with serrate edges. The joints of the endopodite are unarmed, but bear fringes of setae.

The chelipeds are enormously developed, being very nearly as long as the body, from rostrum to end of telson. They are of equal size on each side. All the joints are more or less laterally compressed. The two basal joints are very short. The ischium is also short, and bears a row of four or five small teeth on its lower margin. The merus is more than twice as long as the ischium, and is strongly compressed. It is broader distally than at the proximal end, and its inner or lower border bears fourteen or fifteen teeth in a row, which is a continuation of that on the ischium; on the outer edge there is a faint crest. At the inner distal angle there is an excavation allowing the carpus to fold back close to the merus. The carpus is very short and broad, and much thickened at its distal end, where it has a tooth on the under side. The propodite is by far the largest joint of the whole appendage. The hand is broad and massive, and shorter than the finger, which is thin and tapering. Both the fixed finger and the dactyl are straight for the greater part of their length, and curve towards one another only near the tip. In their proximal part they are furnished with large and rather blunt teeth, whereas distally they have a row of small denticules. The dactyl is slightly longer than the fixed finger. The lower border of the propodite is very minutely serrate. The inner margin of the whole appendage bears a fringe of setae. The surface of the propodite is not smooth, but slightly granular.

The second pereiopods are very much shorter and more slender than the chelipeds. They are strongly compressed, and bear fringes of setae. The merus is the largest joint. The propodite is very much flattened, and the dactyl can be folded back against it, forming a subchela. The edge of the dactyl is sharp, but has no teeth.

The next two pairs of pereiopods end simply, but the fifth are subchelate, like the second. The third are slightly longer than the second, and also longer than the fourth, which in turn are longer than the fifth. In the third pereiopods the lower edge of the dactyl bears on its proximal half a row of ten or twelve sharp curved spines, which are longest near the base of the joint, and decrease in size distally. This row of spines extends only half way along the dactyl, on the distal half of which it is continued as a very close-set series of much smaller spines extending to the tip. A similar arrangement may be seen in the fourth pereiopods.

In the male the pleopods of the first segment are altogether wanting; in the female they are very slender and feeble. On the next four segments they are well developed, with strong basal joints, and two lanceolate blades fringed with pinnate setae. Both outer and inner branches of the uropods have a transverse suture guarded by a row of teeth. The outer margin of each branch has also three or four small teeth. There are two

divergent strengthening ribs on the outer branch and a single midrib on the inner, which bears a row of small spines.

Each gill has the form of an axis which gives off rows of slender, somewhat flattened processes, which all lie in one plane, and decrease in size towards the tip of the axis.

The branchial formula is as follows :—

—	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.
Podobranchs.	1+ep.	1+ep.	1+ep.	1+ep.	1+ep.	1+ep.	ep.	—
Arthrobranchs	—	1	2	2	2	2	2	—
Pleurobranchs.	—	—	—	—	—	—	—	—

Size.—The single Irish specimen measures 41 mm. Two specimens from the Adriatic measure 42 mm. and 49 mm.

General Distribution.—The species is found most plentifully in the Adriatic, specimens from which were described by Heller and Nardo. It appears to be extremely rare in the other parts of the Mediterranean. Lo Bianco says it has been taken only once in twenty-five years in the Bay of Naples, though the larval form, the peculiar free-swimming stage known as *Trachelifer*, is frequently found there from May to September. So far as I know no adult specimen had been taken outside the Mediterranean until the single Irish specimen was taken in the Irish Sea in 1905.[1] Dr. Scott informs me that an adult specimen was taken by the Scottish Fishery Board cruiser, *Goldseeker*, in Loch Fyne, in 1908. Though these are the first two adult specimens to be found in British waters, fragments of *Jaxea* were found in fish taken near Ailsa Craig, in the Firth of Clyde, in 1899 (Scott, 1899).

The larval form, *Trachelifer*, has been taken with considerable frequency in the Irish Sea, and on the west coast of Ireland and Scotland. It is found fairly widely distributed in the Mediterranean.

Irish Distribution.—Only a single specimen, an adult male, has been found within the Irish marine area.

Helga.

S. 259.—21 II '05. 13 mls. off Clogher Head, Co. Louth, 32½ fms., mud. Trawl.—One, 41 mm.

Vertical Distribution.—The Irish specimen was taken in 32½ fms., and the Scottish in 34 fms.

[1] I have compared the Irish specimen with several from the Adriatic, which were sent to me through the kindness of Prof. Steuer of Innsbruck, and find complete agreement in all the characters.

Family *CALLIANASSIDAE.*

There are two sub-families which are separable by the following characters :—

Rostrum large ; first pereiopods equal ; no *appendix interna* on pleopods three to five, .. Upogebiinae.

Rostrum small ; first pereiopods unequal ; an *appendix interna* on pleopods three to five, .. Callianassinae.

Sub-family *CALLIANASSINAE.*

Genus **Callianassa**, Leach.

Callianassa, Heller, 1863. *Callianassa*, Spence Bate 1888. *Callianassa*, Borradaile, 1903.

The eyes are flattened against one another. The ischium and the merus of the third maxillipedes are broader than the carpus and propodite. The propodite of the third pair of pereiopods usually much flattened and expanded. Fifth pereiopods more or less subchelate. There are no epipodites on the third maxillipedes, or on the pereiopods, but there is a large one on the first maxillipedes, and usually a small one on the second maxillipedes.

Borradaile (1903) divides Callianassa into five subgenera, *Calliactites*, *Cheramus*, *Trypœa*, *Callichirus*, and *Scallasis*.

To *Cheramus* belongs the genuine *Callianassa subterranea* (Mont.), the name of which, as Stebbing (1893) has shown, has been wrongly applied to another species. Borradaile has given to this second species the name *C. Stebbingi*. The Irish specimens belong to this second species; indeed it is doubtful whether the real *C. subterranea* has been taken anywhere except on the south coast of England.

Callianassa Stebbingi, Borradaile.

Pl. XIV, figs. 8–10.

? *Callianassa subterranea*, Bell, 1853.
Callianassa subterranea, Heller, 1863.
Callianassa subterranea, Carus, 1885.
Callianassa subterranea, Ortmann, 1892.
Callianassa subterranea, Stebbing, 1893.
Callianassa Stebbingi, Borradaile, 1903.
Callianassa Stebbingi, Calman, 1911.

Some confusion has arisen as to the character of the third maxillipedes in this species, some writers calling them pediform, and others, operculiform. The explanation appears to lie in the fact that there are two distinct species which have been called by the same name. Stebbing (1893) points out that the original

specimens described by Leach and Montague have the third maxillipedes pediform. A large number of authors, however, say that the third maxillipedes are operculiform, and Stebbing has seen specimens from Jersey, in which they could not be called pediform, and in which the telson was more quadrate than in the original Devonshire specimens. These specimens in which the third maxillipedes are operculiform, really belong to a different species which has been mistaken for the genuine *C. subterranea*. Borradaile, (1903) has given this second species the name of *C. Stebbingi*. This species belongs to the subgenus, *Callichirus*, Stimpson, whereas the real *C. subterranea* of Montague and Leach belongs to another subgenus, *Cheramus*, Spence Bate. The two species may be separated as follows :—

Third maxillipedes pediform, slender ; telson as long as the inner branch of the uropods, .. *C. subterranea.*

Third maxillipedes operculiform, third and fourth joints very broad, last three joints slender ; telson distinctly shorter than the inner branch of the uropods, ... *C. Stebbingi.*

It is not certain which species Bell had before him when he wrote his description. Under " Generic characters " he says,— " External pedipalps with the second and third joints very broad, constituting when in contact a broad oval disk, and terminating in a small seta formed of the last three joints." Farther on, however, he says,—" The external pedipalps are rather broad, pediform."

I have compared Irish specimens with two from the Bay of Naples, and find complete agreement between them.

The species has been several times described under the name of *C. subterranea*, and so it will be sufficient to give here merely a brief summary of its chief characteristics.

Carapace smooth, less than half as long as the abdomen. *Linea thallassinica* and cervical groove well marked. Rostrum practically absent, represented by at most a minute projection between the eyes, which are pressed close together. Corneal surface black. Antennules short, lash-like ; peduncle as long as flagella. Antennae considerably longer than the carapace. Third maxillipedes have the ischium and the merus very broad and flattened, so that they form an opercular plate when closed. Chelipeds extremely unequal, sometimes the right being the larger, sometimes the left. The last three joints of the large cheliped are very massive, and very much broader than the slender basal joints, which support them. The inner side of the merus bears a large curved process, the edges of which are slightly serrate, and the tip of which is sharp. Lower border of ischium slightly serrate. Lower margin of carpus and propodite fringed with setae, which are also present on the upper margin of the dactyl, which also bears tufts of bristles. The second pereiopods are

chelate ; next three pairs simple. The propodite of the third pair is expanded into a broad quadrilateral plate.

The abdomen is slightly narrower before and behind than in the middle ; the second segment is the largest. The telson is distinctly shorter than the endopodite of the uropods ; it is not quite quadrate, its angles being rounded. Pleopods of first and second segments slender ; those of third, fourth, and fifth segments much more robust, and expanded into wide plates fringed with setae.

Size.—The largest specimen taken by the *Helga* measures only 33 mm. Adults are often about 50 or 60 mm. long.

General Distribution.—The species has been found in the Black Sea (Czerniavsky), in the Mediterranean (Heller, Carus, Adensamer, etc.), the Adriatic (Heller), the Bay of Biscay (Fischer), at Cape Gris Nez and Boulogne (Giard), on the coasts of Holland (Tesch, Metzger), in the Channel Islands (Sinel), coasts of England and Scotland (Bell, Scott, Sim). It does not extend as far north as the Danish and Norwegian coasts.

Irish Distribution.—Few specimens have actually been recorded but this is due to the burrowing habits of the species, and there is little doubt that it occurs all round the coasts, with the exception perhaps of the north. It is more frequently found in the stomach of bottom-living fishes such as *Raia clavata* than in the trawl or dredge.

Helga.—

L. 298—3 III '04. Ballynakill Harbour, Co. Galway. Shore collecting.—One.

L. 299—3 III '04. Ballynakill Harbour, Co. Galway. Shore collecting.—One, 33 mm.

S. 561—24 X '07. 12 mls., W. by S. of Chicken Rock, Isle of Man, 34½–38½ fms., mud. Trawl. Temperature at 30 fms., 12·75° C., salinity 34·04 °/₀₀.—One large cheliped.

It has been found frequently in specimens of *Raia clavata* taken in Galway Bay and the surrounding areas.

Vertical Distribution.—It occurs from between tide marks down to considerable depths as is shown by the record from S. 561 above. It is common in depths of about 10 or 12 fms.

Genus **Upogebia**, Leach.

Upogebia, Leach, Edin. Encyclop., art. Crustaceology, 1814. *Gebia*, Leach, Trans. Linn. Soc., Vol. 5, 1815. *Thallassina*, Risso, 1816. *Gebios*, Risso, 1826. *Gebia*, H. Milne-Edwards, 1837. *Gebia*, Bell, 1853. *Upogebia*, Stebbing, 1893. *Upogebia*, Stebbing, 1900 (*b*). *Upogebia*, Borradaile, 1903.

Borradaile divides *Upogebia* into two subgenera, *Gebiopsis* and *Upogebia*, distinguished as follows :—

> The thumb of the chelipeds almost or quite as long as the movable finger ; no small tooth on anterior edge of carapace above the antenna, ... *Gebiopsis*, A. Milne-Edwards.
>
> The thumb of the chelipeds distinctly shorter than the movable finger ; a small sharp tooth on anterior edge of carapace above the antenna, ... *Upogebia*, Leach.

There are two British species, *U. deltaura* and *U. stellata*, but the latter has not so far been recorded from Ireland.

Upogebia (Gebiopsis) deltaura, Leach.

Gebia deltura, Bell, 1853.
Upogebia deltaura, Borradaile, 1903.
Gebia deltura, de Morgan, 1910.
Gebiopsis deltura, Stephensen, 1910.

It has been doubted by several writers whether *U. deltaura* and *U. stellata* are really separate species. This is probably due partly to the difficulty of obtaining specimens for comparison, owing to the fossorial habits of the animals. Bell, though he gives separate descriptions, is doubtful on the subject, and is inclined to regard the differences between them as sexual, and Norman (1906) looks on the two as synonymous. Borradaile (1903), however, places them in different subgenera, separated by the characters given above. The presence of the small tooth above the antenna in *U. deltaura* and its absence in *U. stellata* has also been noticed by de Morgan (1910) who has examined numerous specimens, including ovigerous females of both species, so that there can no longer be any doubt of the differences between them being specific and not merely sexual.

The two species, then, may be distinguished by the following characters.

The abdominal plates are much broader in *deltaura* than in *stellata* and the rostrum is less acute. *Stellata* is a much smaller animal and when alive is covered with orange-coloured spots. With regard to the chelipeds, the dactyl is very much larger than the fixed finger in *stellata*, so that the appendage might almost be called subchelate ; in *deltaura*, on the other hand, the two fingers are nearly equal and the dactyl is thicker. The rostrum and gastric area of the carapace are thickly covered with setae in *deltaura* ; they are much shorter and not so dense in *stellata*.

Size.—Full-grown individuals are often about 100 mm. long.

General Distribution.—It is difficult to make out the xact distribution of the species, as it is impossible to say how

far it has been confused with *stellata*. It has been recorded from the Kattegat (Stephensen), the north-east of Scotland (Sim), the Channel Islands (Sinel), the south of England (Norman) and the Mediterranean (Adensamer).

Irish Distribution.—It is not mentioned in the lists of Kinahan, Melville, and Thomson, but must nevertheless be fairly common all round the coast. Its burrowing habits make it difficult of capture.

Helga.

Bofin XCIX.—21 VIII '99. Shore collecting.—One male, 22 mm.

Bofin CLXXVII.—7 VIII '00. Between Inishskinny and Dog-fish Rock, 6–10 fms., Mosquito net on surface.—One, immature, 5·5 mm.

W. 40.—7 IX '05. Galway Bay, Black Head to Loo Rock. 12 fms., in stomach of *Raia clavata*.—Three males, 80–48 mm.

R. 30.—17 VIII '06. 9½ mls. S.E. by S. of Mine Head, 37½–39 fms. Sand Grab.—One, 30 mm.

Vertical Distribution.—From littoral zone down to about 40 fms.

Upogebia stellata, (Montagu.)

Gebia stellata, Bell, 1853.
Gebia stellata, Meinert, 1893.
Upogebia stellata, Borradaile, 1903.
Gebia stellata, Stephensen, 1910.
Upogebia stellata, de Morgan, 1910.

A good description of this species will be found in de Morgan's paper (1910).

Size.—It is usually about half the size of the preceding species.

General Distribution.—It has been recorded from the south-west coast of Norway (G. O. Sars), Bohuslän (Loven), the Kattegat (Meinert), Heligoland and the Dutch coast (Metzger), Belgium (Tesch), Channel Islands (Norman). It is also known from the following British localities: Moray Firth (Scott) Aberdeen (Sim), St. Andrews (M'Intosh), Northumberland (Norman), and Plymouth (de Morgan).

Irish Distribution.—This species has not so far been recorded from the Irish coasts.

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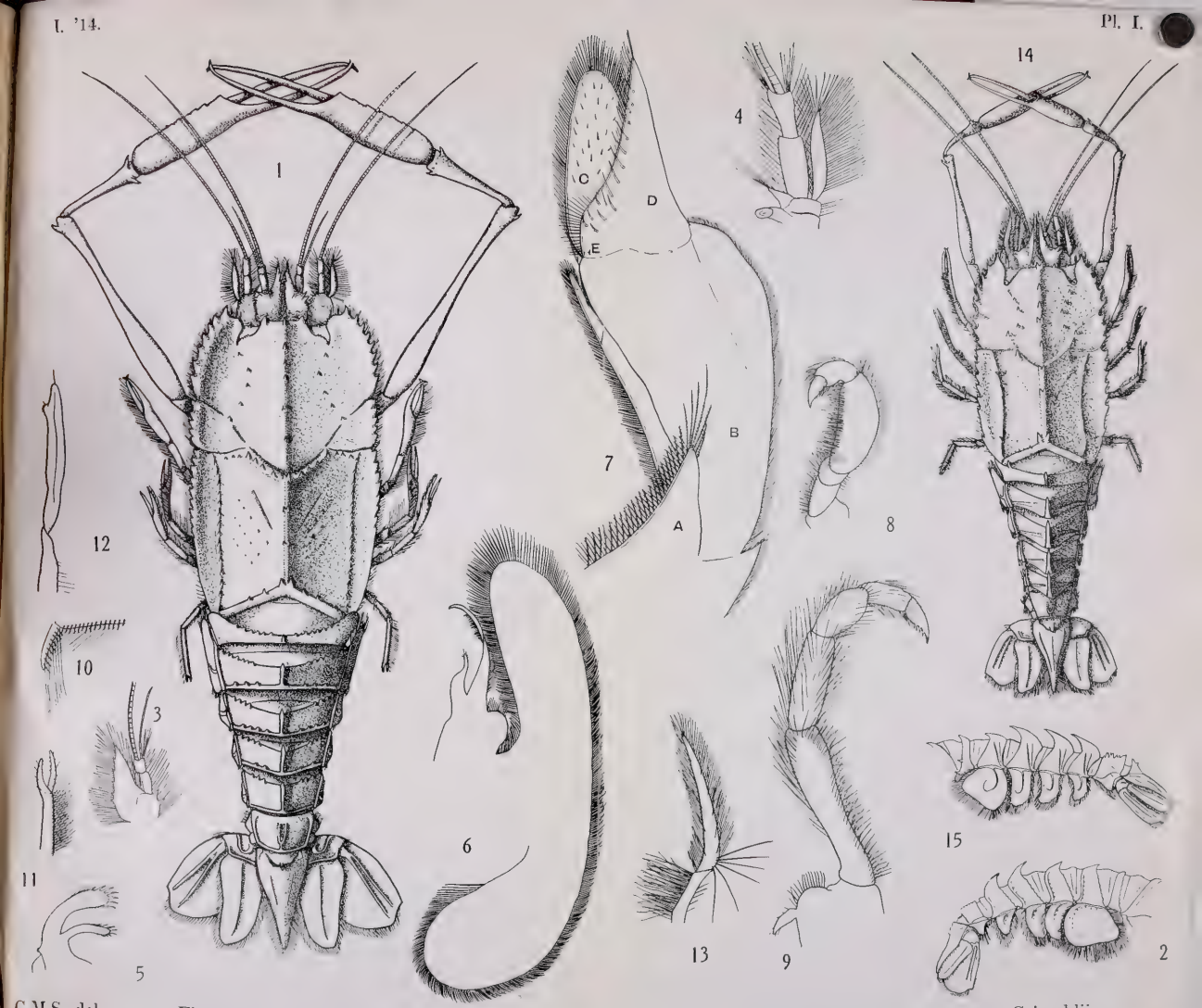

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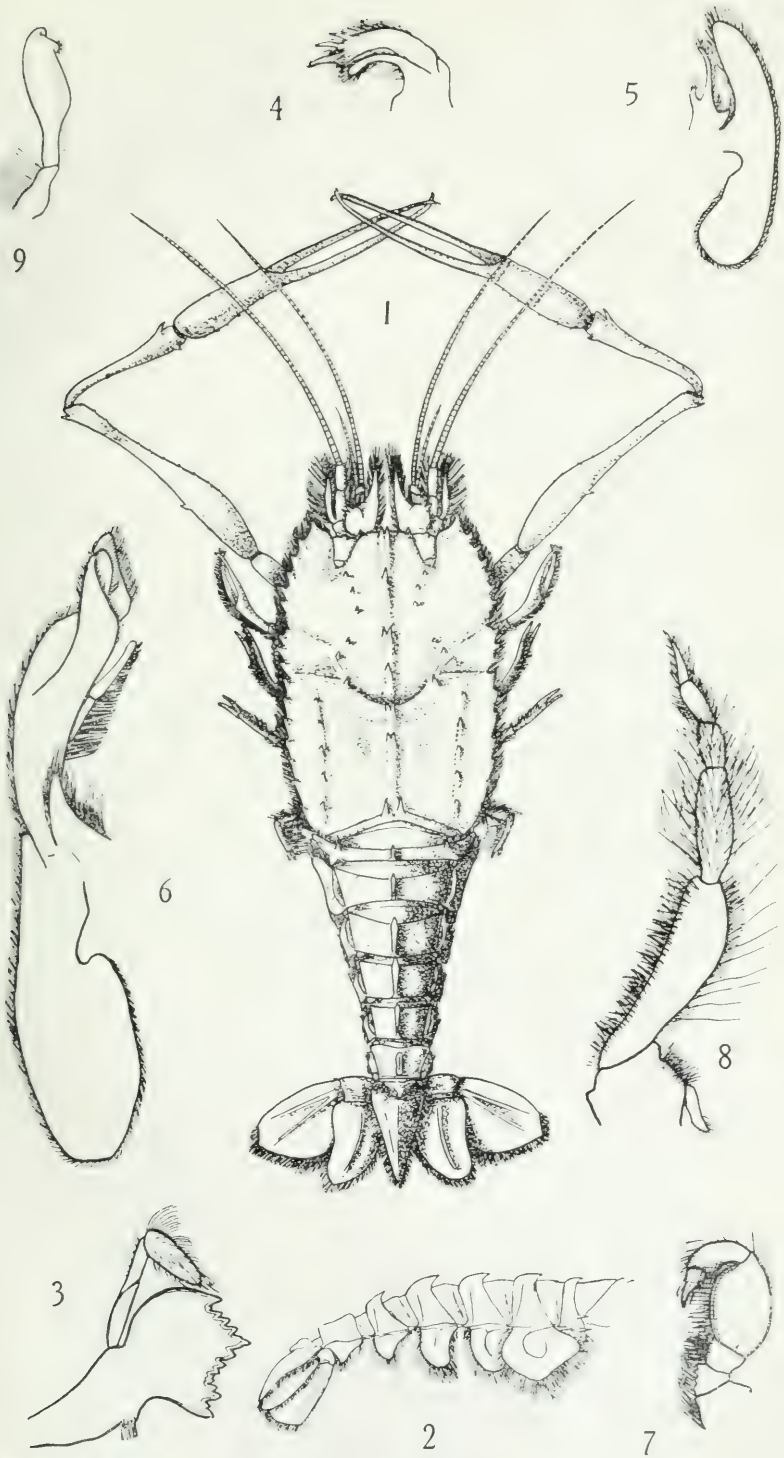
Figs, 1-13.—Polycheles typhlops.

Figs. 14. 15.—P. nanus, *var.* Grimaldii.



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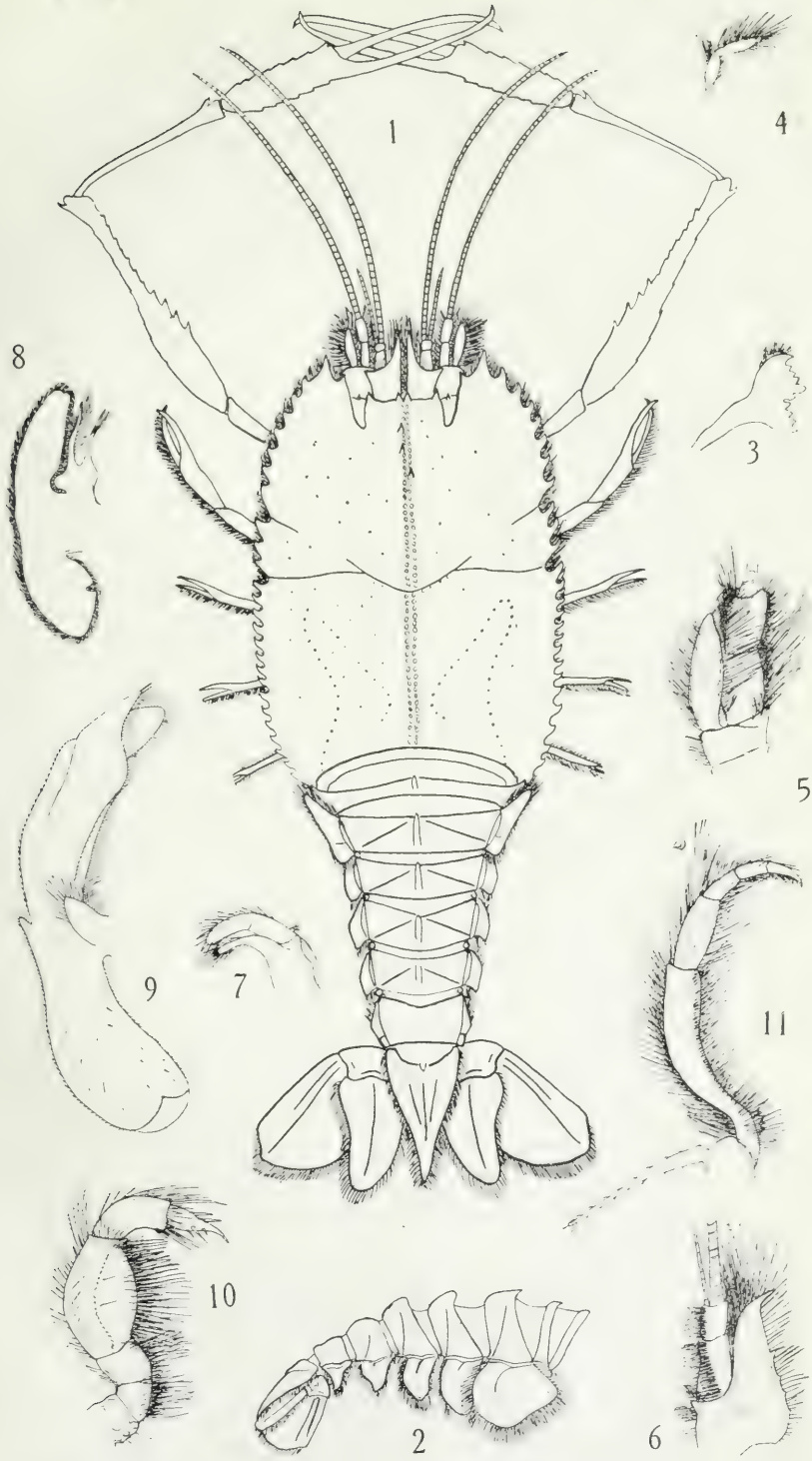

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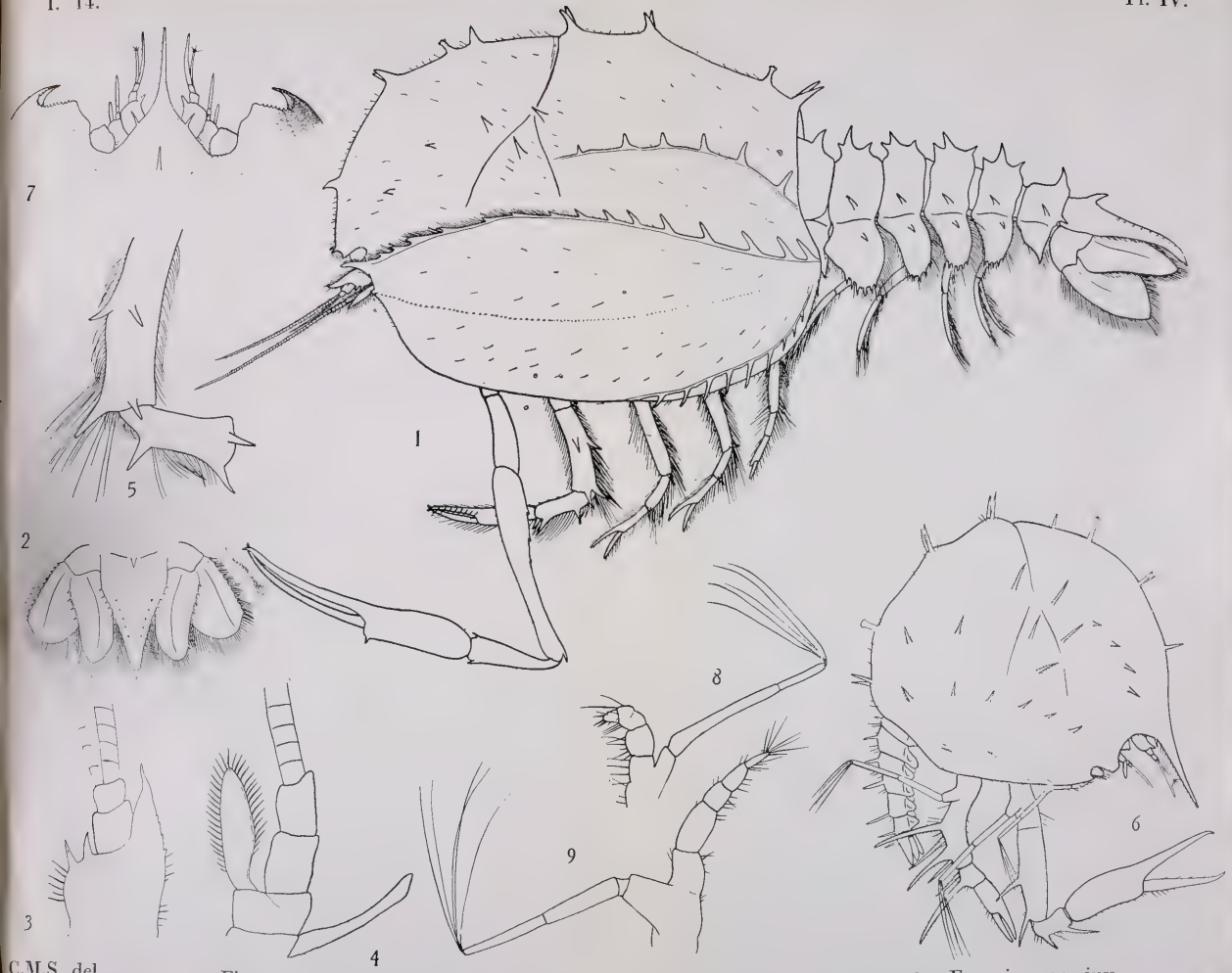

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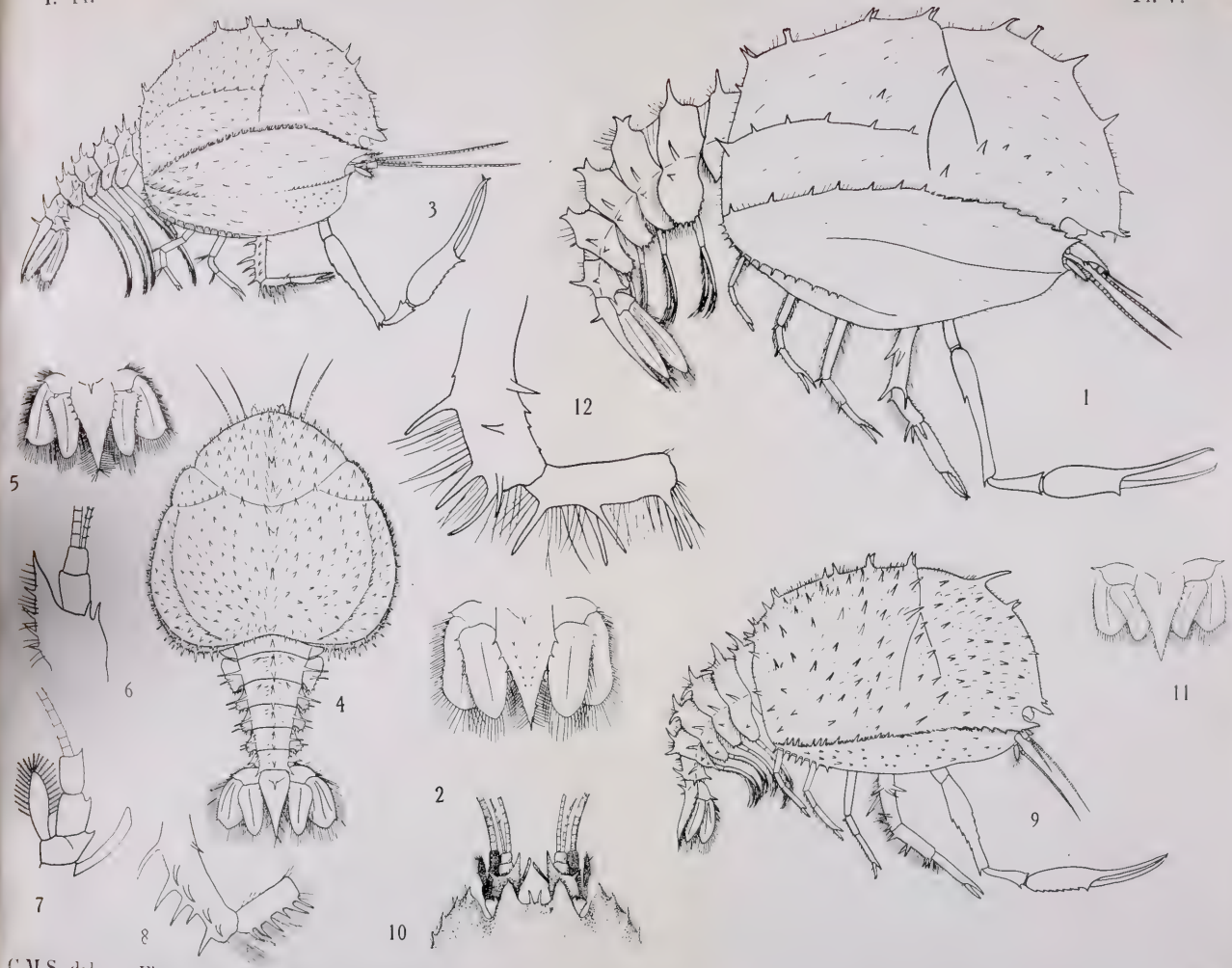
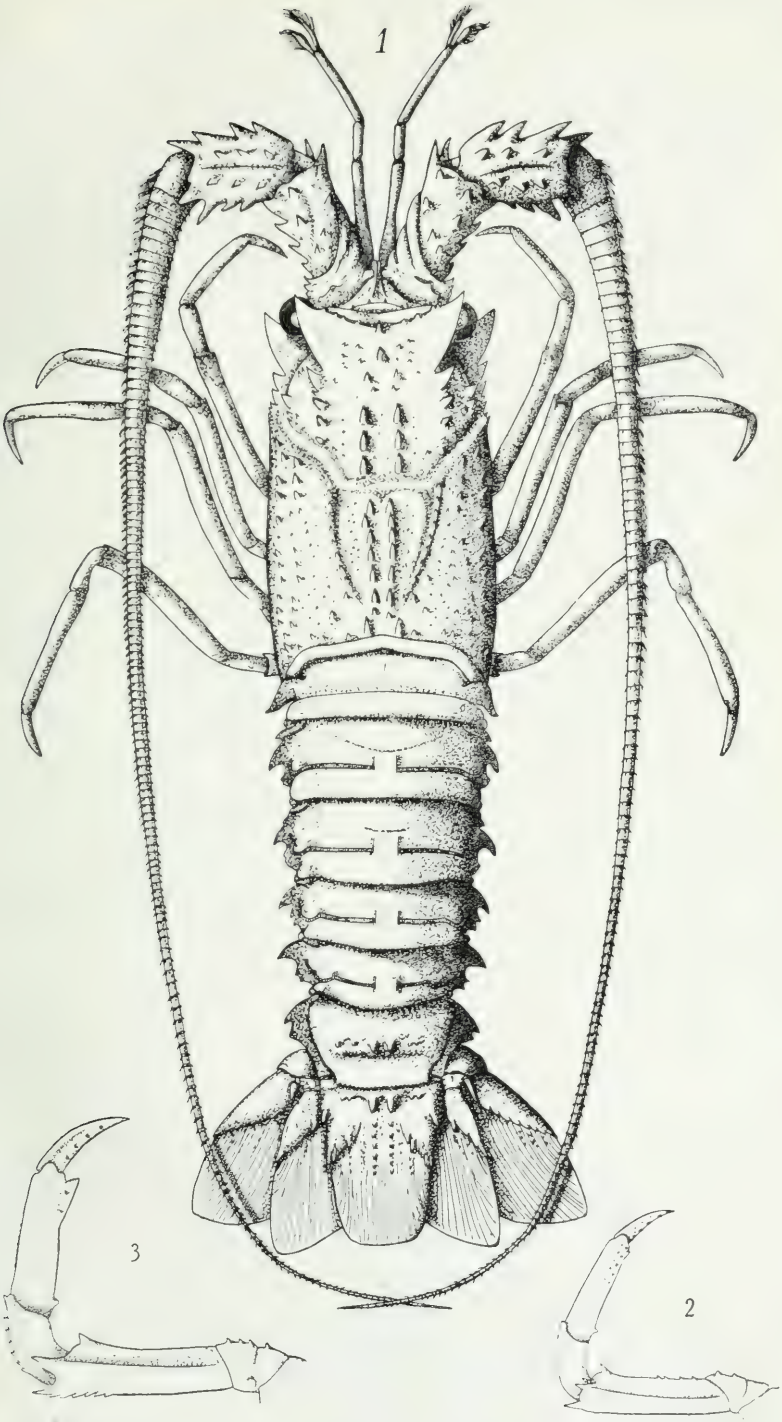
Figs. 1–5.—Eryonicus Faxoni.

Figs. 6–9.—Eryonicus sp. juv.



C.M.S. del. Figs. 1, 2.—Eryonicus hibernicus. Figs. 3–8.—E. Kempi. Figs. 9–12.—E. Scharffi.



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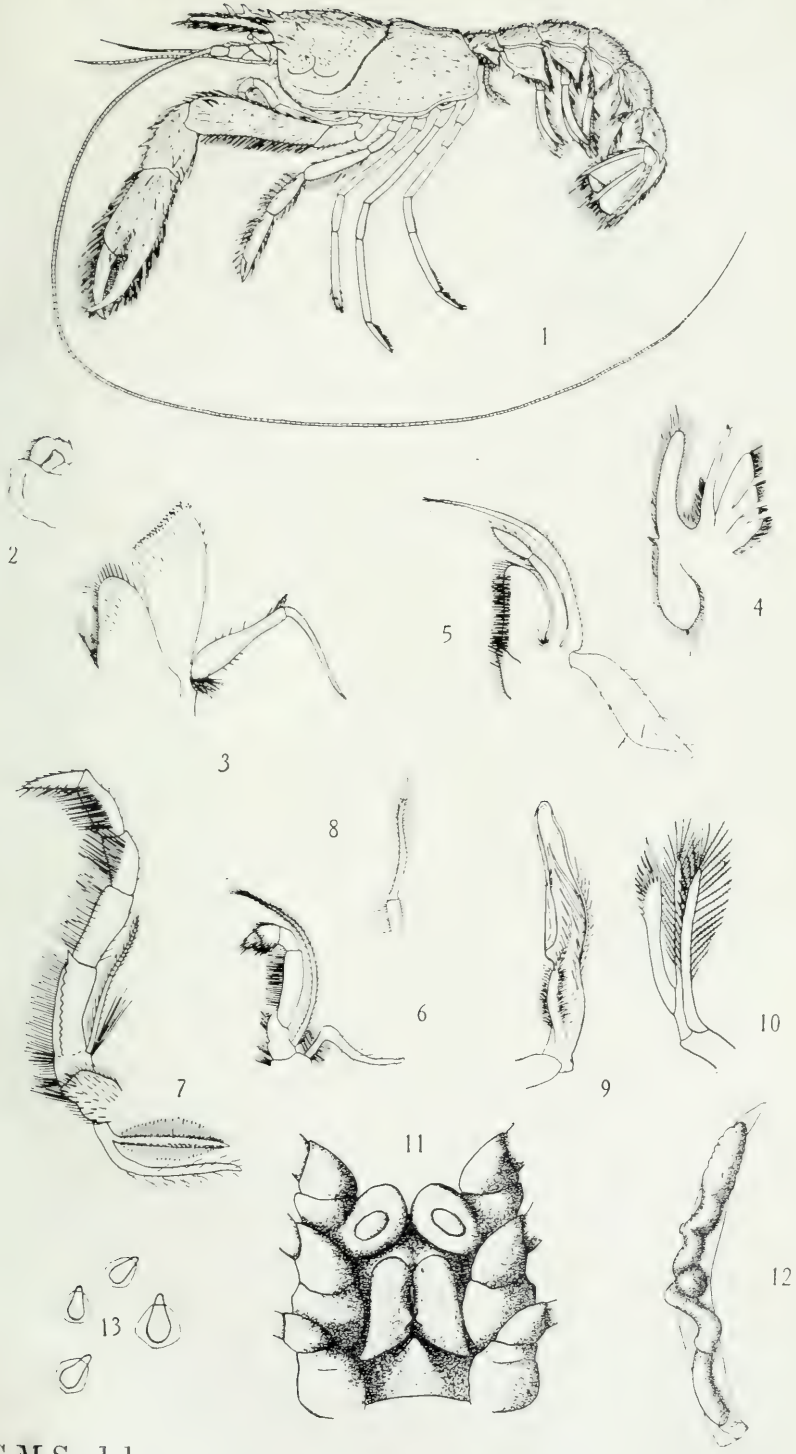
Figs. 1, 2.—Palinurus Thomsoni.
Fig. 3.—P. vulgaris.



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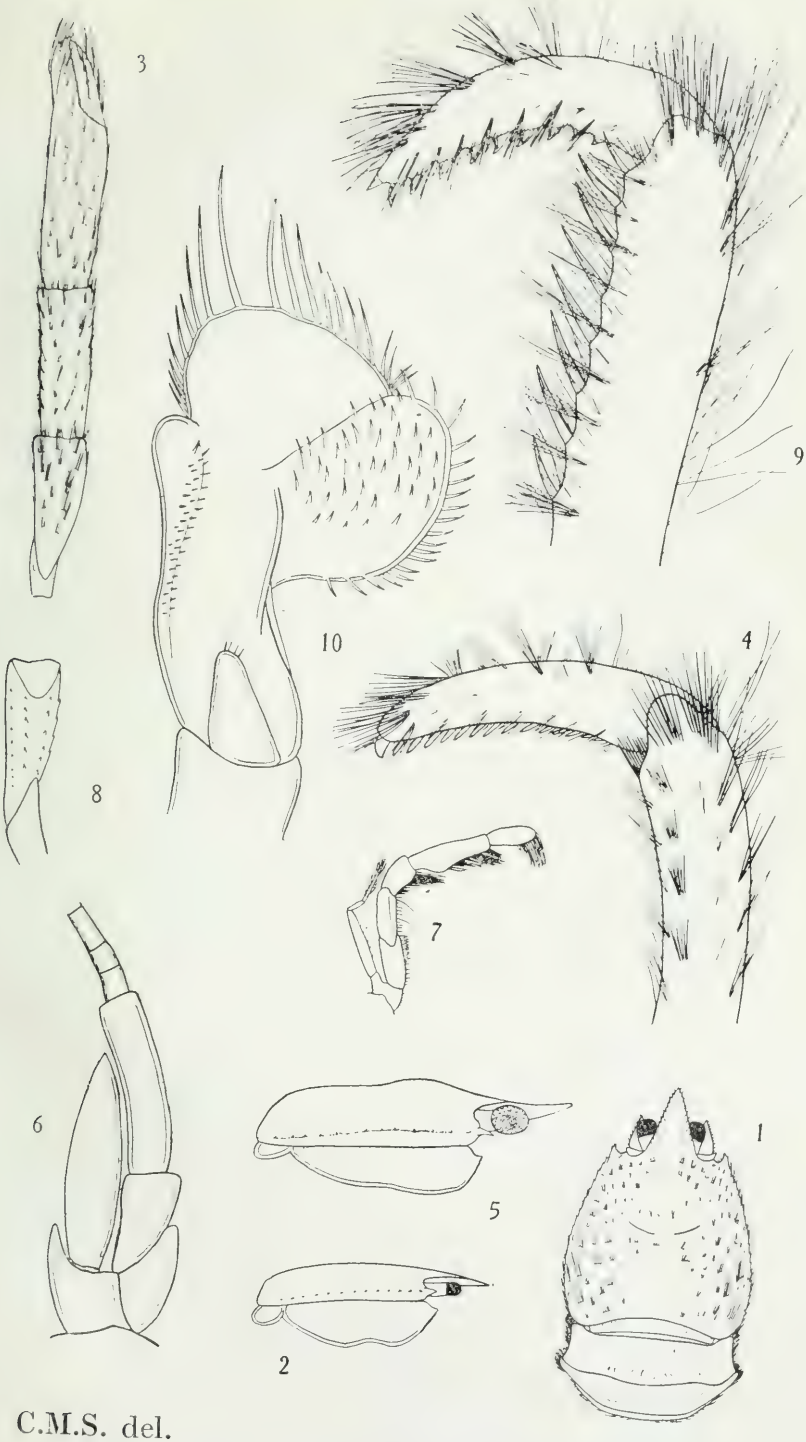
Nephropsis atlantica.



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Figs. 1–4.—Uroptychus rubrovittatus.
Figs. 5–10.—U. nitidus, *var.* concolor.

C.M.S. del.

Fig. 1.—Uroptychus nitidus, var. concolor.
Figs. 2–8.—Gastroptychus formosus.

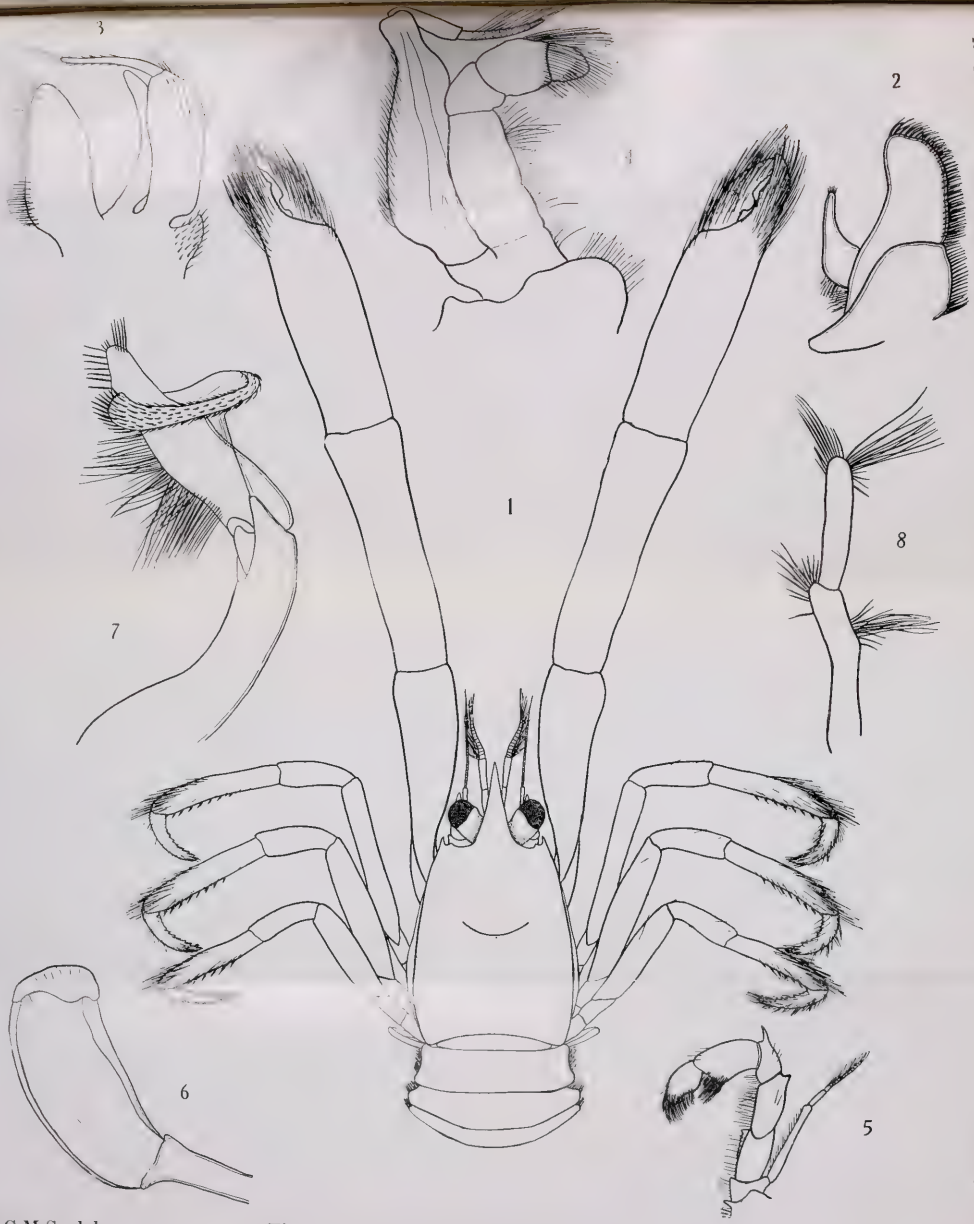

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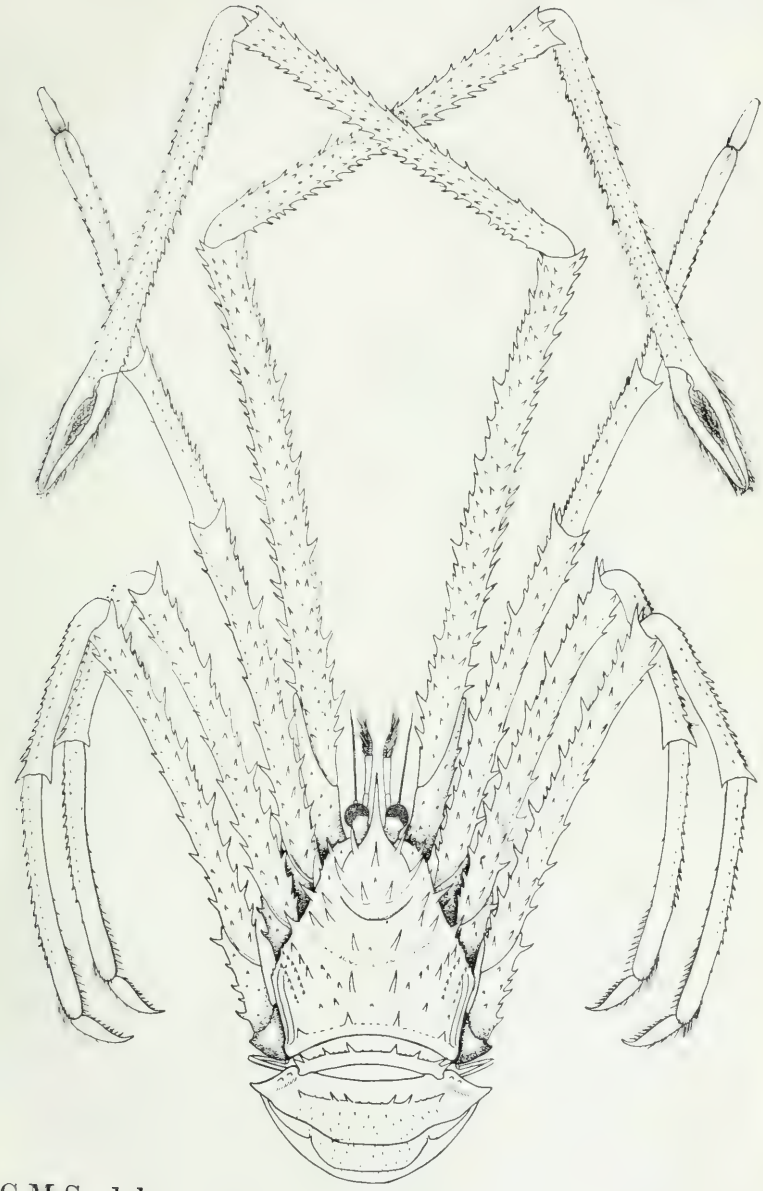
Fig. 1.—Uroptychus nitidus, var. concolor.
Figs. 2–8. Gastroptychus formosus.



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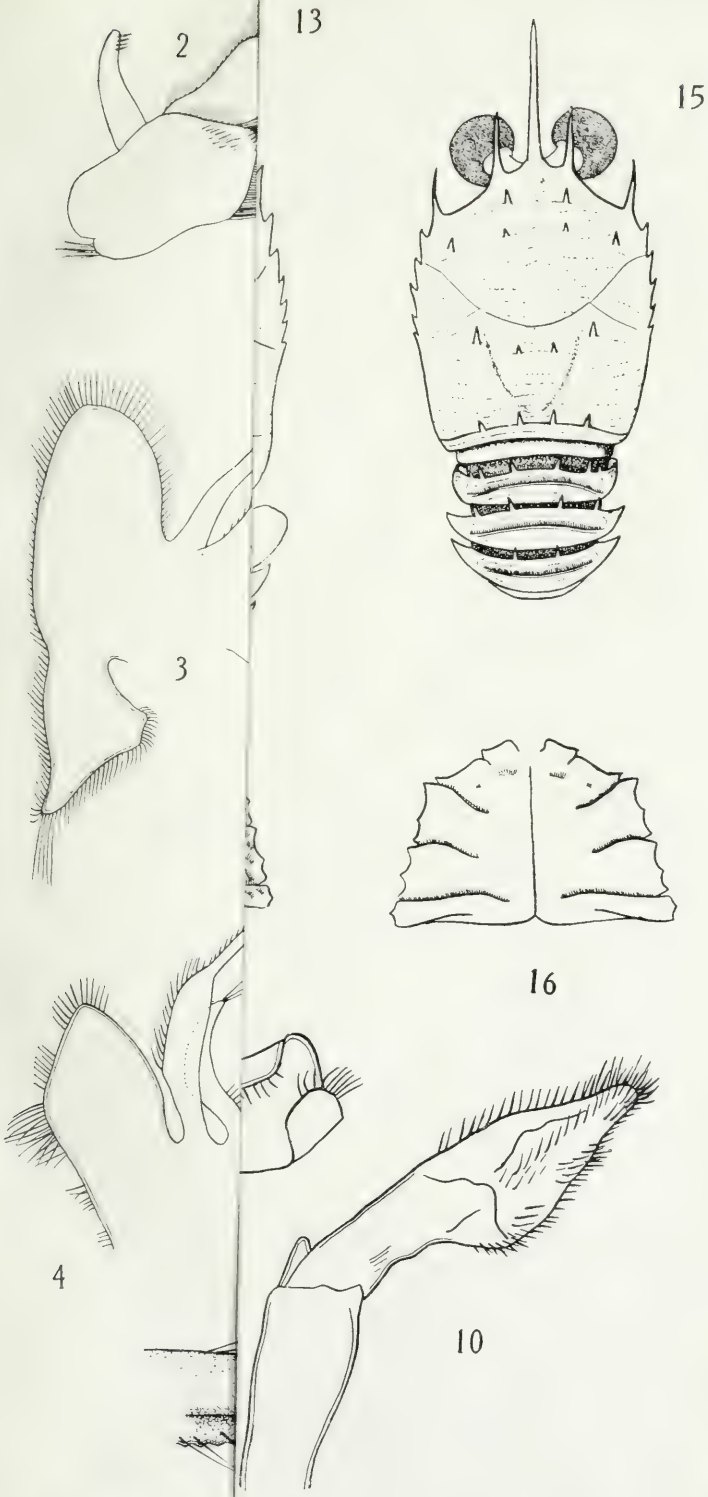
Gastroptychus formosus.



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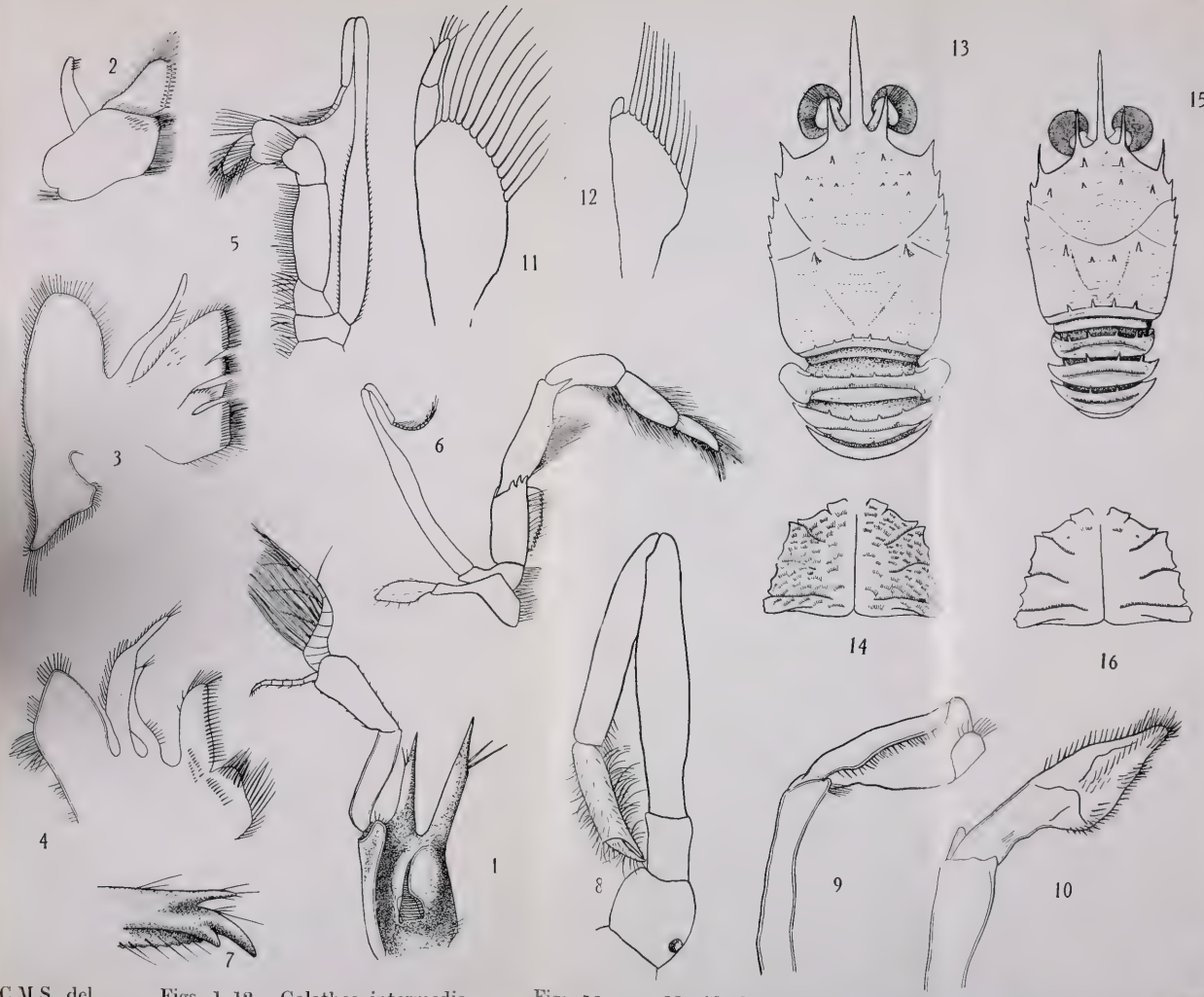
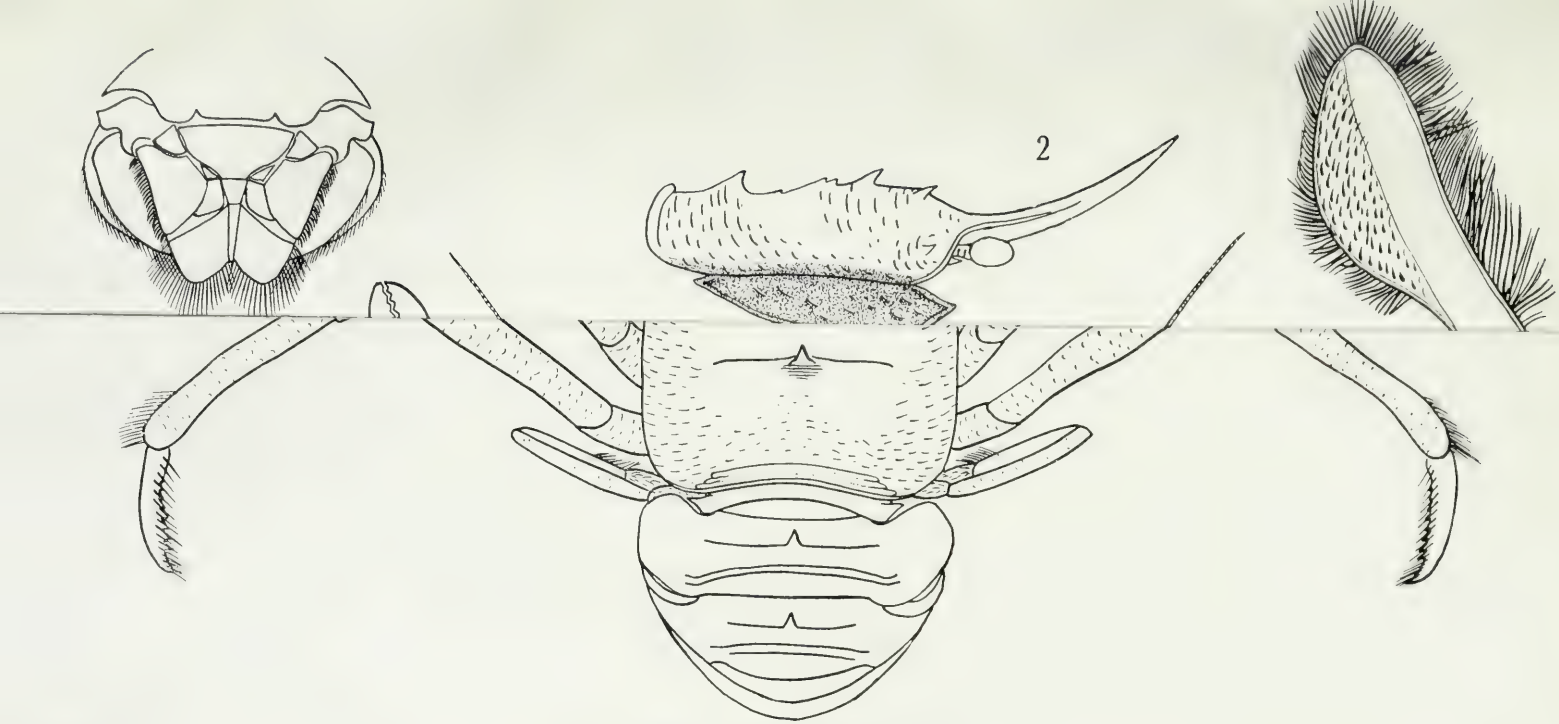


C.M.S. del. Figs. 1–12.—Galathea intermedia. Figs. 13, 14 —Munida bamffica. Figs. 15, 16.—M. tenuimana.

C.M.S. del.

Munidopsis tridentata.



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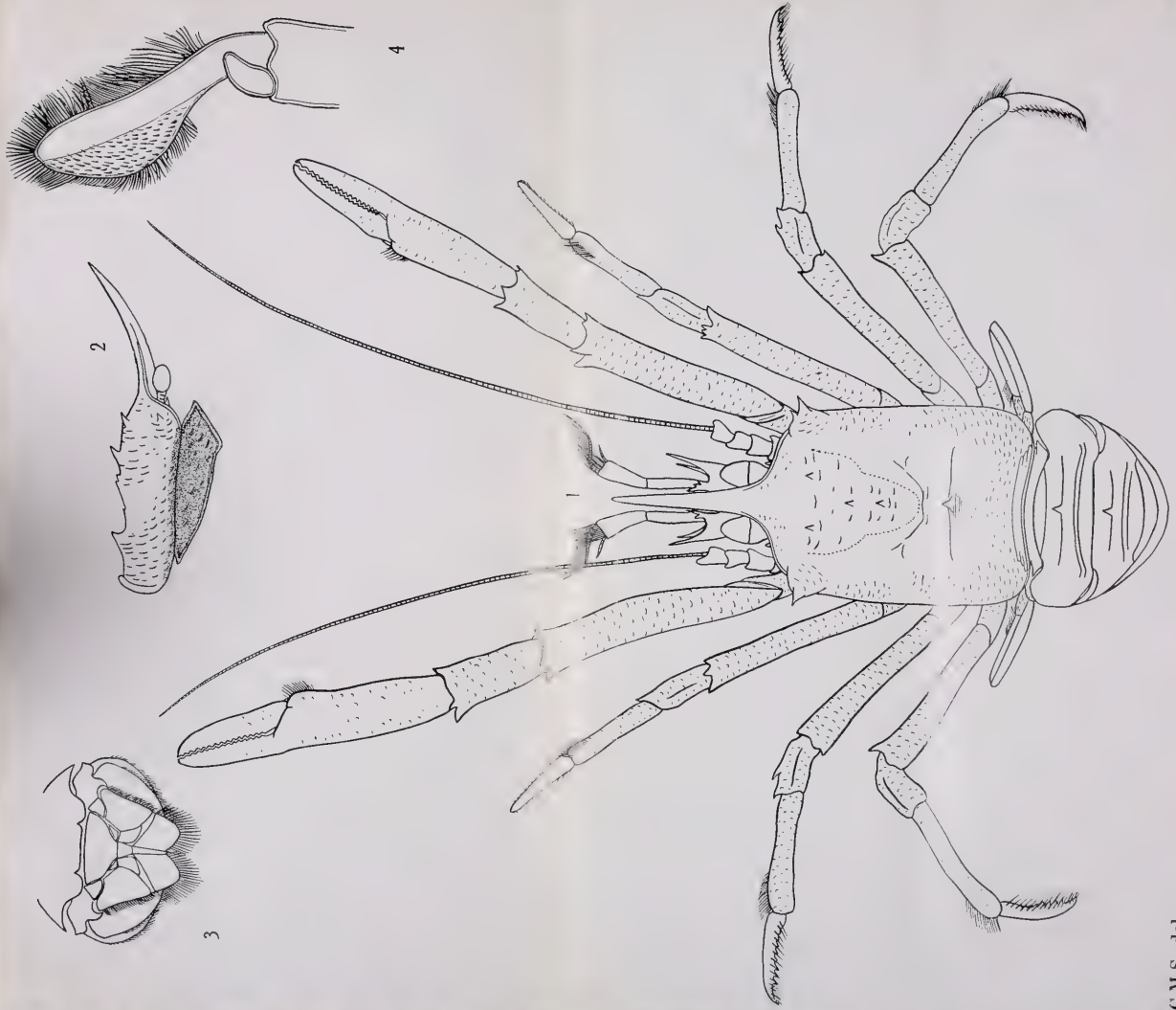
Munidopsis curvirostra.



Munidopsis curvirostra.

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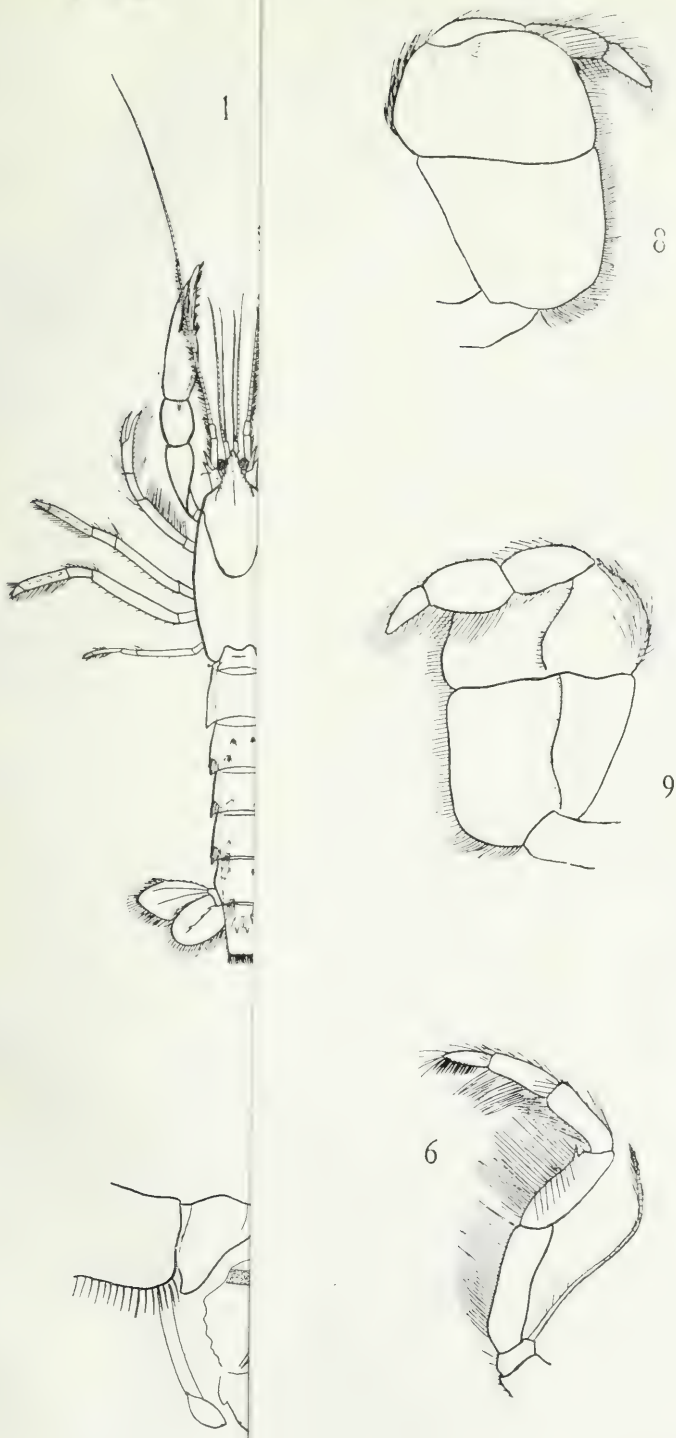
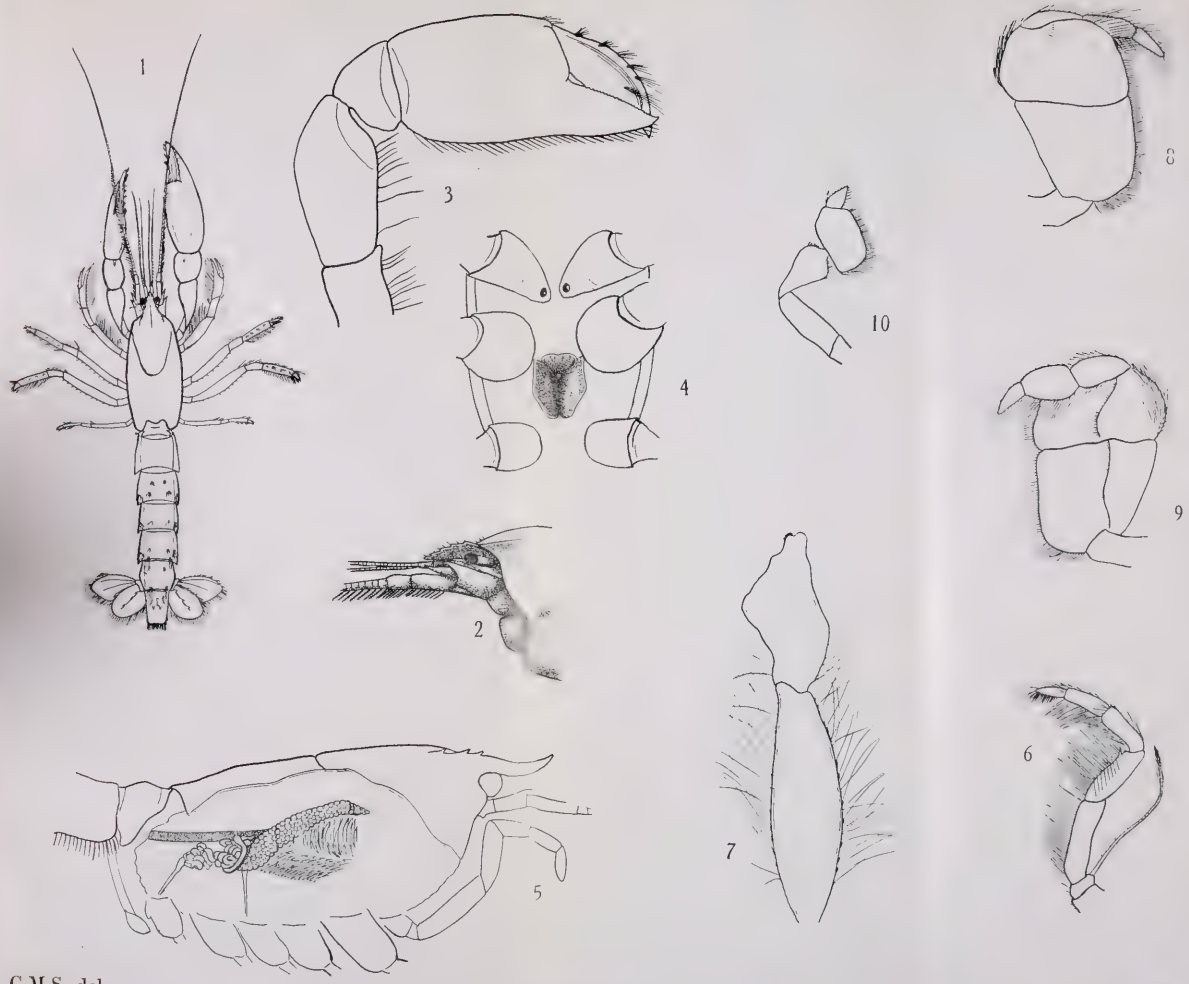


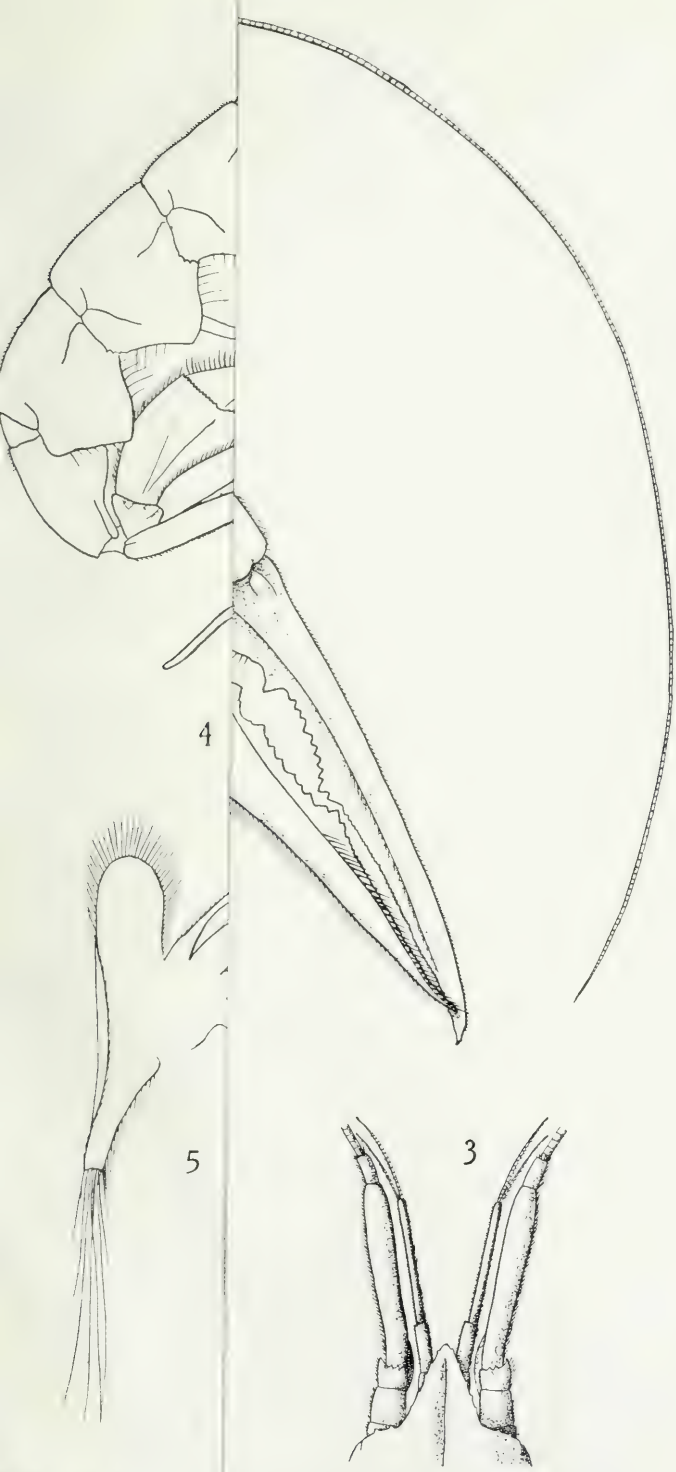
C.M.S. del.

Figs. 1–4.—Callianassa Stebbingi.

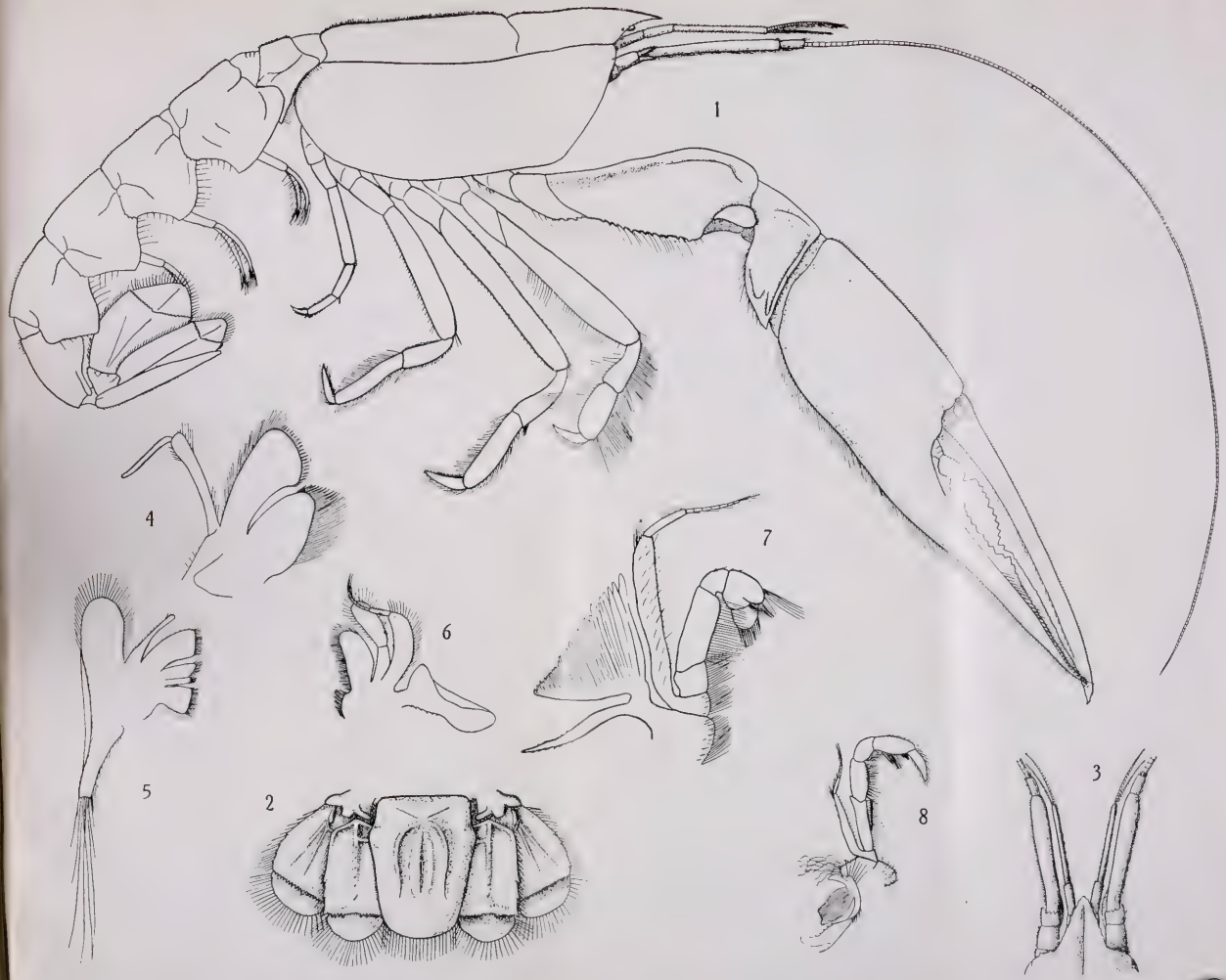


C.M.S. del.

Figs. 1–4.—Axius stirhynchus. Figs. 5–7.—Calocaris Macandreae. Figs. 8–10.—Callianassa Stebbingi.



M.S. del.



C.M.S. del.

Jaxea nocturna.

REPORT ON THE OUTBREAK OF FURUNCULOSIS IN THE RIVER LIFFEY IN 1913.

BY

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PLATES I–III.

Furunculosis, a very serious infection of fish, lately made its appearance in the River Liffey, and as I had the opportunity of examining the fish and conducting a few experiments with the object of determining the cause, an account of the disease may prove of some general interest. The term "Furunculosis," which really means a development of boils, is applied to the condition in the fish because in diseased fish abscesses or boils may be present not only under the skin but also in the deeper structures of the flesh. The term is sufficiently expressive when the boils are present, but unfortunately fish may die from the infection without any boils developing at all and from the same cause as that which give rise to the boils. There is little doubt, as Dr. Plehn says in her work on Furunculosis in the fish of Bavarian rivers, that the term would hardly have been used to describe the disease if present day material had alone been at hand for investigation.

In her experience the infection is not necessarily accompanied by the development of boils, "the boils are probably a pretty sure sign of the disease, but then absence proves nothing against its existence." As will be found later, there is no doubt that fish may be infected and show no evidence of boils—a fact that should be remembered when fish are dying from some mysterious or unascertained cause—for there is plenty of room to believe that this disease of fish is not uncommon.

Furunculosis was first discovered in the Salmonidae and described as a bacterial infection by Emmerich and Weibel in 1894.[1] In the abscesses or boils they observed a micro-organism which they isolated, cultivated and inoculated into trout in which were produced symptoms and lesions identical to those occurring in naturally infected fish. The authors described the organism, noting its peculiar properties when growing upon solid media, such as the production of a pigment when grown on agar ; the colour diffusing through the medium ; the liquefaction of gelatin ; the unsuitability of potato as a culture medium, etc. The organism described was given the name of *Bacillus salmonicida.*

[1] Emmerich and Weibel "Ueber eine durch Bacterien erzeugte Seuche unter und den Forellen," *Archiv. fur Hygiene*, T. XXI., 1894.

Some years later an American investigator, Marsh, described an organism causing disease and death in trout,[1] and in the Bulletin of the United States Fish Commission, Vol. XXII., 1902, he gave a more complete description of the same organism with illustrations. He makes no reference to Emmerich and Weibel's work and names the organism *B. truttae*. He describes it as pathogenetic to trout, especially brook trout (*Salvelinus fontinalis*). The organism has also been isolated from Loch Leven trout (*Salmo trutta levenensis*) and in some few cases also from "lake trout" (*Cristivomer namaycush*). Marsh states that the organism was not found in wild fish from natural waters, apparently his specimens came from artificial breeding ponds. Healthy trout, on inoculation, succumb in a few days and when fed on food contaminated with cultures, after a longer interval. He states that the organism is not pathogenetic to frogs—not even when the frogs receive 1 per cent. of body weight of culture inoculated into the dorsal sac. He also states that trout dead of the disease may be eaten with impunity after cooking, and that a cat fed upon diseased trout suffered no ill consequences. This statement is quite comparable with the results obtained by incubating cultures of the organism at the mammalian body temperature, the organism refuses to grow and dies in a few hours. The organism could not therefore grow and develop in mammals, in other words it could not produce infection, and experiments upon the ordinary laboratory animals were quite unnecessary. The American author describes the organism as pleomorphic, as generally coccus-like in agar cultures with a diameter approaching 1μ[2]; occasionally longer forms appear the length being greater than the breadth; in broth, in liquefied gelatine and in blood serum the organism may be distinctly rod-shaped (bacillary) with occasional spherical forms. He noticed also—a fact of common if not universal occurrence—that the organism is somewhat larger in the lesions than when grown upon culture media. The organism is described as staining by the Gram method but I am not aware that any other author claims it as staining by the Gram method. The author noted the production of a diffusible pigment and that the organism liquefied gelatine and blood serum; that it did not grow upon potato until the natural acidity of the potato had been neutralised and that the organism was peculiarly sensitive to acids. The organism grown on milk peptonises it but it does not form indol in peptone solutions. Fermentation does not occur in media containing glucose, lactose or saccharose. In the glucose medium some acid formation occurred but no colour, in lactose or saccharose media no acid was formed but colour developed. The colour formation appeared to depend upon

[1] *Science*, N.S., Vol. XVI., No. 409, page 706, Oct. 31, 1902.

[2] The Greek μ is the unit of measurement in microscopy and represents 1–1,000 mm. It is therefore approximately equal to 1–25,000 of an inch.

the absence of acid in the medium. No odour is formed in culture. The organism is non-motile. Growth occurred at room temperatures but not in the incubator at 37° C. at which temperature the organism soon dies. Sealed agar tubes were found to contain living organisms after seven months. There appears to be little doubt from the description of the organism given by Marsh—despite the staining reaction—that he had re-discovered the organism described earlier by Emmerich and Weibel and which has been isolated recently by different workers. The name suggested for the organism *B. truttae* cannot stand however as the organism had already been named the *B. salmonicida* and this therefore has precedence.

Taking papers upon diseases of fish, and especially those affecting the Salmonidae, in order of publication, the next of importance to appear was a report on Salmon disease by J. Hume Paterson and published by the Fishery Board of Scotland in 1903. In his general introduction to the report the author refers to a report by Prof. E. J. McWeeney in 1893 entitled "Report on the examination of specimens of diseased salmon presented to the Inspectors of Irish Fisheries." I have had no opportunity of examining this report and must rely entirely upon Paterson's statement of the facts. McWeeney found on examination of the fish a diplococcus. The organism was found in the clefts and vessels of the tissues of the bladder and also in the liver of the diseased salmon which came from the river Bush in Co. Antrim. Apparently no cultures were made nor were any experiments instituted, and the organism may have been putrefactive, as McWeeney suggested, or a terminal infection. It is a pity there is no further information as to the condition of the fish and the characteristics of the organism observed if only from the historical point of view. It would have been interesting to learn if Furunculosis had been observed previously in fish inhabiting or visiting Irish rivers.

The organism described by Paterson as the causal agent in salmon disease is not the same as that producing Furunculosis. The cause of salmon disease according to Paterson is a short thick bacillus with rounded ends, of variable length, occurring singly or in pairs lying end to end, actively motile, non-spore bearing, which does not stain by the Gram method and grows rapidly and profusely at the room temperature but little or no growth occurs at 37° C. and at this temperature culture dies in about six days. It is pathogenetic to fish but not to frogs, mice or guinea pigs. It coagulates and digests milk. Clearly therefore this organism is not the same as that isolated by Emmerich and Weibel and by Marsh and, as will be seen later, by more recent investigators.

During the year 1911 an important outbreak of Furunculosis occurred in several rivers in England and a very valuable report on the outbreak by Dr. A. T. Masterman entitled "The Epidemic amongst Salmonidae in the Summer of 1911," was

published by the Board of Agriculture and Fisheries. The report also includes an account of the investigations undertaken by Dr. Arkwright of the Lister Institute—an account which may be read with profit by all interested in this disease of fish. According to the account of the distribution of the disease by Dr. Masterman the rivers involved were the Wye, Exe, Teign and Dart. The disease in the Wye attacked salmon, trout, grayling, and such coarse fish as eels, pike, dace and chubb. The duration of the disease in this river lasted at least 66 days. The first dead fish was found in April and the last in August so the disease existed for a longer time than the estimated period. The mortality in this river appears to have been very serious. In the river Exe the first death amongst the salmon was reported on May 12th, and the last in a trout on July 15th. In this river the fish affected included salmon, trout and grayling. To show how very serious indeed the infection was in this river I quote from the Report : " by the 16th of June the bailiffs had taken out no less than 255 dead salmon and 718 trout . . . in three days there were taken out no less than 521 trout." " After June 16th the mortality decreased with great rapidity." "The bailiffs who were watching the progress of the disease and were removing and burying the dead fish were of the opinion that the outbreak could be traced to a *certain definite run of salmon* which occupied the reaches of the river indicated and, in dying, spread the disease to the other fresh-water species, such as trout and grayling." The words of the quotation above which I have italicised are of great importance as they convey the opinion of the bailiffs that fresh run fish are affected—that fish fresh from the sea enter and journey up the rivers when already infected with disease. If this is the case,—and I have heard of fresh run fish dying in the Liffey presumably from Furunculosis,—then the question of prevention or of eradication of the disease is almost hopeless. For how can a river be kept free from invasion by the disease if salmon from the sea are already infected ! Only by netting every salmon which enters the river and then in the mouth or estuary of the river ! It is of course possible that diseased fish do enter a river from the sea but do the fish become contaminated in the sea or have they left one river and entered a second. I am not aware if salmon once having reached fresh water from the sea return to the sea before spawning and enter another river. It is possible, but I have no information. It is a remarkable fact that fish do return to the same river year after year but whether they visit during the year other rivers is unknown. It can easily be understood how one river may be infected from another if fish from the latter visit the former in the same season. It is also remarkable—whilst on this subject—that of the English rivers infected in 1911 three of them, the Exe, Teign and Dart, open into the English Channel and within a comparatively restricted coast

line. The Wye joins the Severn and its waters reach the Bristol Channel but I have not heard if any other rivers pouring their waters into St. George's Channel or the Irish Sea have produced infected fish.

In the Teign the first dead fish was reported on June 2nd and the last on July 29th. The fish affected were salmon, peal and grayling. The epidemic lasted about 52 days. The last occurrence of the disease was in salmon far up the river.

In the Dart the first deaths were reported about July 8th and the latest on August 15th in peal, though on the 27th September salmon were found with Saprolegnia (fungus). Saprolegnia however attacks salmon that are injured or diseased from other causes. In the Dart it is stated that the trout became affected after the salmon and that the numbers affected were approximately the same as in the Teign though the proportion of trout was greater. It may not be out of place to draw attention here to the times when the diseased fish were noticed in these Devonshire rivers. It is to be presumed that the salmon will commence to run up these three rivers at about the same time, that there will be no great difference in time between the Exe and the Dart.

We may give in a tabulated form the dates when the disease first appeared and when it was last seen as follows :—

River.	Date of appearance of disease.	Last day noticed.
Exe,	May 12th.	July 15th.
Teign,	June 2nd.	July 29th.
Dart,	July 8th.	Aug. 15th.

The Wye may also be included but the times are less definite.

Wye,	April.	August.

It will be seen that the Exe—the most eastern of the three rivers—was the first to show disease. The Dart, the most western, was the last. If the run of salmon took place in all three rivers at about the same time, and so far as I know there is no reason against the supposition, then why did not the disease occur more or less simultaneously in all the three rivers if infected fish come up from the sea—that is into the rivers for the first time ?

It appears to me without further labouring the point that it is not improbable that one river may be infected by fish entering it from another river via the sea. It would be interesting to learn if the Camel was infected or any of the rivers of North Devon opening into the Bristol Channel, and if any disease was prevalent during the time that the fish of the Wye were dying from the infection.

Dr. Masterman when discussing in general terms the incidence of the infection refers to the fact that 1911 was a very hot year and that the waters in the rivers were low and that Dr. Arkwright suggests that one of the points " requiring

further investigation is the effect of the temperature of the water on the production and prevalence of the disease." A certain number of experiments were made at the Brighton Aquarium but apparently upon healthy fish and it was found that whiting (*G. merlangus*) could resist and thrive in a temperature "up to 79° F. after which they sicken and die"; that trout (*Salmo fario*) fed well and were active and were thriving up to 85° F. Carp (*C. carpio*) have even greater resistance as they showed no sign of detriment or distress till after a temperature of about 120° F. In this connection it is perhaps well to mention the experiments of Dr. Plehn who found that a temperature of 15° C. (59° F.) was fatal to trout that were infected but which were apparently recovering from infection when in cooler water.

The quotation from Dr. Plehn's paper which I venture to give is as follows :—"It has been remarked that apparently healthy fish when placed in relatively warm water (15° C.) died in a few days of Furunculosis bacteriaemia. The trout had been kept for weeks with diseased fish but had not fallen ill. They were regarded as healthy and were exposed to fresh infection in an aquarium which was only ventilated and into which a bacteria culture had been poured. Death supervened in two or three days so could not have been due to this latter infection, it must have been of older date. It might be assumed that it had remained latent and had manifested itself when the fish were removed from the cool freshness of the running water to a temperature 7° C. higher (12.6° F)."

In another experiment "A brook trout was placed in company with a rainbow trout, which had gone through the same treatment and had survived it well, in an aquarium containing pure water but which received no fresh inflow of water though it had a plentiful supply of fresh air. A fresh infection could not be carried out here but the water gradually rose in temperature from 8° to 15° C. (46.5° F. to 59° F.), this means for a trout a considerable disimprovement in their conditions of life. The result was striking in case of the brook trout. Already on the second day it had a sick appearance and on the fourth day it was at the point of death. Here the post-mortem examination gave negative results, but on the other hand there was an enormous bacteriaemia (bacteria in the blood in which they have multiplied) which alone was quite sufficient to cause death."

Dr. Plehn affirms "the possibility of latent infection existing for a long time may be taken as proved" and consequently it may be deduced that anything which lowers the powers of resistance of the fish will favour infection and rapid bacterial growth. The bacteriological researches of Dr. Arkwright showed that the causal organism of the disease in the English rivers was in all probability a pigment forming bacillus which agreed in its main features with those described previously by Emmerich and Weibel and by Marsh. Experiments made

with cultures of the isolated organism upon trout show that the organism is pathogenetic to trout. It was possible to infect trout by scratching the side of the fish and rubbing in the pure culture. Goldfish were infected by injecting beneath the skin or into the muscles small quantities of the culture. In both experiments cavities full of puriform matter, pus, developed locally in the fish resembling those present in the naturally acquired disease.

The most recent work which I have been able to consult is a paper by Dr. Marianne Plehn on Furunculosis among the Salmonidae.[1] The fish were trout taken from one of the best fishing streams of Southern Bavaria and enquiry showed that the disease was wider spread than had been anticipated. In 1909 the infection was known to exist in 25 Bavarian rivers. Further investigations brought further information, and it was found that the disease occurred in Silesia, Thuringen, Baden, Wurtemburg and Alsace in the German Empire and in Austria, Switzerland and France abroad. Previously it was thought that the infection was one proper to hatcheries—we have seen that one of the earliest investigators, Marsh, was of opinion that the disease did not occur among " wild fish," but according to Dr. Plehn researches have shown that Furunculosis is not a disease of young fish. Later it was also declared that there was no connection between Furunculosis and pollution, nor between the disease and low water though in some cases the infection diminished after the rivers had been in flood.

Infection, however, is not confined to members of the salmon family. Grayling and other coarse fish as dace, perch, bullhead, tench, pike, carp, barbel, bleak and eels become infected and die. Still, however, mortality is heavier among the Salmonidae ; whether they are more susceptible or more exposed to infection it is difficult to say.

Certain experiments carried out by Dr. Plehn are of interest ; they show how infection occurs, and that certain fish are more susceptible than others.

Like Arkwright and previous workers Dr. Plehn shows that subcutaneous inoculation is followed by the development of an abscess and death in from five to eight days. One injection is sufficient even if the amount inoculated be small.

Adult fish were fed three times upon flesh of fish dead of the disease and then on non-contaminated food. Brook trout died in from three to four weeks ; no naked-eye lesions were to be seen, but the organism was recovered from the blood of the dead fish. In one fish infection appeared to be latent or that the fish was recovering from infection, but when the temperature of the water of the tank was raised the trout sickened and died and the organism was recovered from it. It is possible that this latent infection may persist for a long time—how long it is not

[1] " Die Furunculose der Salmoniden " *Centralbl. fur Bakt.*, Abt. 1., Bd. 60, Heft 7. Aus der Kgl. Bayr. Biolog. Versuchsstation für Fischerei in München.

known. Rainbow trout did not develop infection. Yearling trout were also fed upon contaminated food but all did not die.

Fish with latent infection may be the means of infection spreading to others. Three char were placed in a tank along with a fish which though apparently in good health had been fed upon infected material. In three weeks the char began to die and the organism was isolated from them. The fish was evidently a carrier—giving off into the water infective organism which proved fatal to the char.

Infection may occur through the gills or through the skin since if cultures of the organism be poured into the water of the aquarium the fish inhabiting the water die and the organism can be recovered from the blood of the fish. In these cases abscesses did not occur, there was intestinal congestion in some of the cases, but not in all.

Attempts were also made to infect eggs and fry, but the fry were apparently not sensitive to infection. There is no mention if any investigations were made to see if the fry though not sensitive to infection could act as carriers : if for instance fry reared in infected waters could carry infection to the streams in which they were liberated.

Quite recently another paper has appeared on Furunculosis as affecting the Salmonidae and in the paper is included observations upon the disinfection of contaminated waters.[1]

The author refers to Furunculosis as an infectious disease caused by a specific bacterium *B. salmonicida.* The disease is usually characterised by the presence in the muscles of boils containing blood and pus. These however are often absent and the intestine becomes inflamed and bloody infiltrated patches make their appearance on the organs. The typical form of Furunculosis is a general infection of the blood having its origin in the intestine. Death often occurs before the appearance of the boils and according to the author it may occur even before the organisms are formed in the blood, death being due to a poison or toxin produced by the bacteria. He believes also that there is a latent form of Furunculosis, the bacteria being present in the intestine but having no effect upon the health of the fish.

The author also speculates upon the causes of different outbreaks and discusses the probability of *B. salmonicida* varying in virulence or as to the existence of different varieties of the organism. He points out that in some outbreaks in open water only a few fish may die. In other cases the whole stock may die. He also indicates that the resistance offered by the fish may account for not only the symptoms and lesions shown but also for the lowered or exalted mortality in different outbreaks. Reference is made to the immunity enjoyed by fry

[1] "Contribution to the study of Furunculosis, especially with regard to the Salmonidae." Karl Hulsow, *Allgemeine Fischerei Zeitung.* Year 38, No. 10 and No. 18, May 15 and Sept. 15, 1913.

and the relative freedom of one year old fish from attack when in open waters ; and not only is this so, but yearlings even offer considerable resistance to inoculation.

In the case of waters becoming infected the author recommends as the result of his investigations at the Experiment Station at Munich the removal from water of all dead or infected fish. Such fish continue to infect the water. All instruments employed in handling the fish should be disinfected either by boiling water or by the use of 1:100,000 permanganate of potash solution.

If a virulent form of the disease occurs it may be prudent to destroy all the fish and if the disease develops in breeding ponds these should be disinfected with the permanganate solution.

In the reference to the paper—the original I have not seen—it states as to the disinfection of the ponds " that the germ content of the water is first ascertained, then the required amount of salt (permanganate) is dissolved in water and poured into the pond. A pond with 62,550 germs per c.c. when thus treated by the author was found after one hour's time to contain only 98 germs. After 24 hours had elapsed the number of germs per c.c. had increased to 3,830 and in two days to 12,580."

It is said that water containing fish may be treated with permanganate of potash to a dilution of 1:150,000 without harming the fish, but it is necessary to treat the water after intervals of from 2 to 3 days.

The Liffey Outbreak.

During the summer of 1913 diseased and dead fish from the River Liffey were reported, and on examination they were found to be affected with Furunculosis. It is not known how many fish died nor indeed how many dead or dying fish were recovered from the river, but that the disease was present and that some fish died there is no doubt whatever.

Like previous observers we found that the fish dead from Furunculosis may show numbers of well developed boils beneath the skin and in the subcutaneous and muscular tissues, but other fish, equally infected with the organism, may not show any development of boils. In my experimental cases, save where the fish had been deliberately inoculated, infection did not as a rule or even frequently cause the production of boils. It should therefore be clearly understood that infection may be present, may cause the death of fish and yet no local lesions such as boils be present. On July 7th, 1913, I received from Mr. G. Synnot, Clerk to the Dublin Board of Conservators, two female salmon of about eight to ten pounds weight. They had both been recognised as diseased whilst swimming in a pool of the river and had been captured by the stroke-haul for purposes of examination. Both fish gave vigorous play after being hooked and did not appear in any way to be exhausted or weakened. They were brought to the laboratory

with the least possible delay. I was informed that in this same pool some twelve fish had been found dead. An examination of the fish showed that the larger of the two had been in fresh water for some time, that the darker parts of the fish were yellowish green rather than olive green, and that the fins had a yellowish tint. From the vent a blood stained fluid exuded on pressure. The skin of the body showed a few low or flat elevations which had a boggy feel, and when cut into, from these swellings a peculiar purulent fluid escaped. The fluid was like to a mixture of blood and pus. The skin was then stripped from off the fish and numerous lesions were found not only under the skin but involving the tissues beneath the skin and extending into the muscles. These lesions varied in size from a mere speck as of blood to a well formed abscess the size of a walnut. The smaller lesions did not always contain a purulent fluid, many appeared to be composed of broken down muscle of red colour resembling crushed raspberry, and there was no well developed or clearly demarked cavity. In lesions from a pea upwards in size the abscess was more readily recognised as a closed cavity containing fluid pus. (Pl. I, Fig 1.)

Some of the subcutaneous abscesses were not sharply defined and there appeared rather to be a spreading suppuration or infiltration of pus than a true abscess.

Examination of the internal organs showed no characteristic lesions, save that the mid and hind gut appeared congested and the vessels full of blood. The membrane lining the bowel was of a brownish red colour somewhat swollen and covered with reddish blood stained mucus.

A microscopic examination of the pus from a lesion showed among the muscular debris and the few dying or dead red and white blood corpuscle an enormous number of small micro-organisms which in appearance are not unlike the well known cause of fowl cholera. The smaller fish did not show any abscesses or boils. A blood-stained fluid escaped from the vent on pressure. On opening the fish similar changes were found in the intestine as in the first fish, *i.e.*, an inflammation of the lower part of the intestine.

Cultures were made from the blood obtained from the heart in both cases and from the pus of the lesions of the first fish upon agar, glucose-agar, blood serum and gelatine and were incubated at room temperature. Upon these media *B. salmonicida* developed as will be described later, but similar media inoculated with the same materials and incubated at 37° C. gave no growth.

On July 14th I obtained another salmon from the Liffey. It had been found dead in a pool of the river near Lucan. It had been dead some time and portion of the head had gone, probably removed by eels or rats. The specimen was typical of Furunculosis. The skin was extensively under-run with pus of a creamy pink colour. There were abscesses in the

muscles of various sizes and stages of development. There was a peritonitis, the body cavity containing a quantity of blood stained fluid. There was in addition an inflammation of the mid and hind gut. The liver was soft, grey in colour, almost diffluent, apparently as the result of post-mortem changes. The pus examined microscopically showed the same organism as in the other cases and this was isolated from cultures made from the pus.

Other fish were examined from time to time but were mostly free from infection. This especially applies to certain fresh run fish which were obtained and examined with the object of ascertaining if fresh run fish were infected. In no case was there any evidence of disease in undoubtedly fresh run fish. Much later in the season a fish was sent in which had been found dead in the river and which it was claimed to be a fresh run fish, and in this there was distinct evidence of Furunculosis, but I am not convinced that the fish was fresh run and I prefer to consider it as having been in the river for some time. It came from a part of the river where fish were known to be infected.

Bacteriological Experimental Investigations.

The cause of Furunculosis is a minute micro-organism which has been named *Bacillus* or *Bacterium salmonicida* or *B. truttae.* The former name is the more correct. The organism can be readily found in smears made from the boils, in which it occurs in immense numbers. It is a short ovoid bacterium not unlike but scarcely as large as that causing fowl cholera, and it also shows bi-polar staining. There is some pleomorphism in that the organism varies in shape and size, especially in cultures; it is sometimes coccus-like or spherical inclining to ovoid, or it may be longer than broad and thus approximates to a bacillary form. Generally it is from 1 to 2 μ in length by rather less than 1 μ in thickness. It is an aerobe, it is non-motile, it does not form spores. It stains easily by ordinary laboratory stains, but not by the Gram method. The best temperature for growth is that of the room. Incubated at 37° C. cultures rapidly die.

Broth.—The organism grows freely in peptone broth. At the bottom of the flask a sediment collects, formed of numerous organisms. When the flask is shaken the sediment ascends in spiral currents and the medium becomes uniformly cloudy, but on resting the organisms fall to the bottom, the medium becoming clear. In old broth cultures flocculi composed of clumps of bacteria may be observed. Little or no pigment is formed in broth. There was no sensible difference between an inoculated flask in which there was profuse growth and a control flask of the same medium not inoculated maintained under the same conditions for a month. No odour could be discerned, no gas formation occurs and indol is not formed.

Gelatine.—The organism rapidly liquefies gelatine. Surface cultures on gelatine slants caused pitting and dimpling of the surface of the medium,—the depressions being occupied by liquefied gelatine and bacteria. In stab cultures the organisms proliferated along the course of the needle tract causing liquefaction eventually of the whole of the medium in the tubes. No colour is formed in or on gelatine.

Agar.—The best medium proved to be ordinary agar. Fish agar was also made, but it did not prove to be superior to ordinary agar. On the surface of the agar medium colonies of bacteria develop in about two days, and at first are small and transparent. If the colonies are not too numerous they grow to about 2 mm. in diameter, are smooth, round, flat and colourless. As the colonies develop or as the culture gets older the medium takes on a slight brown tint like to weak china tea, and this colour deepens with age. Eventually the colour of the medium becomes dark brown and the colour extends throughout the whole medium ; it is not confined to the neighbourhood of the colonies. Apparently colour formation is most active where oxygen is most abundant, for if a stab culture be made in agar, development of bacteria occurs, confined mainly if not entirely to the parts immediately below the surface of the medium where the needle entered it. Colour formation continues, however, and spreads gradually into the deeper parts of the medium from the upper part of the tube. If the tube be examined from day to day the colour at the surface of the agar is observed to increase in intensity and to diffuse into the medium and in time the whole of the medium in the tube is uniformly coloured dark brown.

In my experience this development of diffusible pigment is characteristic.

Blood Serum.—The organism grows readily on solidified blood serum which it eventually digests. It also forms pigment on this medium.

McConkey's Neutral Red Lactose Bile Salt Agar.—Cultures grow poorly or not at all on this medium.

Cultures were also grown in litmus peptone water containing 1 per cent. of certain carbohydrates as follows :—The seed material was a broth culture three weeks old of which ¼ c.c. was added to tubes containing :—

	Colour *Change*, if any.
Laevulose, ...	Red.
Mannites, ...	Red.
Salicin	Red.
Glucose, ...	Red.
Saccharose, ...	Blue : no change.
Lactose, ...	Thin Claret Colour
Multose, ...	Red.
Galactose	Red.
Raffinose, ...	Blue : no change.
Inulin, ...	Like lactose.
Litmus Peptone Water, ...	No change.

The tubes were allowed to stand in a cupboard at room temperature for thirteen days, August 8th to 21st, and were then examined and the changes if any noted. No gas formation occurred nor was any gas formed in glucose broth tubes.

Cultures made upon agar from the same material gave abundant growth and typical colouration of medium.

It is apparent from these experiments that some amount of acid is formed in broth containing certain carbohydrates, as indicated by the change in colour of the litmus.

Potato.—No visible growth occurs in ordinary potato even after a month, but yet some growth must occur for the following reasons :—There is no difficulty in finding micro-organisms on making smears from the surfaces of potatoes incubated for a month, and cultures from such potatoes made upon agar showed abundant growth after four days.

Milk.—In litmus milk the organism grows without difficulty. The litmus milk becomes a sepia brown tint in about three weeks. There is no formation of clot.

Experimental Infection of Fish.

A number of trout were obtained through the Department of Agriculture (Fisheries Branch) for experimental purposes. Some came from Adare in Co. Limerick where the disease was quite unknown and others were from the Liffey. The trout were kept under observation for some time before use, but they all remained in good health and in the best of condition.

Inoculations.—Cultures on agar eight days old were washed off with sterile normal saline solution and the washings were inoculated into two Liffey trout and two Adare trout. The fish were captured with care in a sheet of muslin and held in the muslin below water whilst being inoculated. The inoculations were made subcutaneously and into the muscular substance. About a fourth of a c.c. (4 drops) of suspension of bacteria was used in each case. After inoculation the fish appeared somewhat dull and listless and remained quiet in the Aquarium. The inoculated fish were placed together in a new Aquarium which had been thoroughly cleaned and which had been flushed with continuously flowing water for 24 hours prior to placing the trout therein. The inoculations were made on July 23rd, and on the morning of July 25th one of the smaller or Adare trout was found dead (Pl. I, Fig. 2). There was a purple coloured swelling at the site of inoculation 2 inches by 1½ inches, containing purulent fluid in which the organism was present in immense numbers.

Cultures were made from the heart blood and from the lesion, and in both instances the inoculated organism was recovered. No changes were found in the alimentary tract. On the same day the two Liffey trout were observed to be very dull and sick. The larger one (Pl. II) had a well developed boil shining

through the skin, which was of a pale pink or flesh colour. The fish had changed colour, it was lighter in tint than normal, *i.e.*, yellow rather than brown. The other Liffey trout (Pl. III) was also dull and stupid. It was breathing rapidly and was also light coloured. There was a well developed lesion near the vent, and the fish was passing or there was escaping blood stained muco-purulent matter. This was observed to leave the fish whilst it was stationary and when it moved a deposit of the discharge was left where it had been. There was no doubt that the fish was passing infective material into the water so I placed in along with the sick fish two normal Adare trout (see below, p. 15.) The inoculated Adare trout still living with the two Liffey trout had developed a light colour since inoculation,—a sign of ill health, and could be readily distinguished from the two newly added to the tank.

The larger of the two Liffey trout died at 5.30 p.m. the same day (25th July) and it was at once examined. The pink flesh-coloured lesion noticed during life had burst through the skin and was discharging pus exactly like that originally observed in the salmon. The skin was under-run with pus and there was considerable necrosis of the muscular and connective tissues. The pus contained numerous organisms free and in clumps, and cultures made from the pus and from the heart blood gave in the latter case pure cultures of the inoculated organism.

The second or smaller Liffey trout was captured when moribund, same day, July 25th, and it died in the hand. The lesion in this instance had burst and the pus was discharging through an opening in the skin quite close to the vent. The vent was very red and swollen and partially everted, but the remainder of the alimentary tract was to all appearances healthy. The pus from the lesion was like to a mixture of blood and cream and contained numerous bacteria. Cultures made from the gut, from the lesion and from the heart blood all gave colonies of the *B. salmonicida.*

The second of the Adare trout died on July 31st. A boil had developed behind the shoulder on the left side and it discharged pus in which the organisms were found. The intestine was somewhat congested. Cultures from this trout, made from the heart blood, were also positive.

There is no doubt whatever, therefore, that infection may be readily set up by direct inoculation, and, as Arkwright has shown, it merely suffices to abrade the skin and rub in effective material to cause a fatal result. Inserting the virus directly into the tissues is apparently in every case successful in producing infection and Plehn says that success follows no matter what is the dose injected.

Feeding Experiments.—Sheep's liver obtained from the butcher was squeezed through a meat press and the paste obtained was then mixed into a soup-like mess with a broth culture

of *B. salmonicida.* Four Adare trout were placed in a new, not previously used, aquarium, which had been thoroughly cleansed and through which clean water had been flowing for twenty-four hours. Into the water the liver-culture mess was thrown on July 23rd, the day the fish were placed therein. On July 28th one of the trout died at 5 o'clock. Blood stained fluid could be expressed from the vent, the mid and hind gut was congested, and the vessels of the mesentery were turgescent. Cultures were made from the heart blood and from the blood stained mucus of the intestine and *B. salmonicida* recovered in both instances.

On July 29th a second of these trout died. There was congestion of the fore gut, and the intestine contained a pea-soup-like fluid. A third trout died on July 30th. The remaining trout did not die until the night September 5–6. In both the second and third trout the heart blood contained the organism which was recovered in cultures.

The fourth trout died on September 6th. It had been noticed to have changed colour somewhat, as all sick fish do, and later to have developed a dull leaden colour. It showed a good deal of excitement, dashing about in the water, just previous to death. Cultures made from this fish from the heart blood also gave a few colonies of *B. salmonicida.*

I consider this experiment to be of great interest. The fish were only fed once on contaminated material though that must also have contaminated the water. A constant stream of pure fresh water flowed through the aquarium as long as the fish lived. Most of the fish died early, within a week, apparently from acute infection and in each instance the organism was recovered. In the fourth fish however infection remained latent throughout a whole month, the fish eventually dying forty-four days after taking infected food.

This experiment however is more interesting when read in connection with the following. The water is undoubtedly contaminated by diseased fish and infection can spread to healthy fish placed or coming into contaminated water. Two normal Adare trout were placed in the tank along with the fish inoculated on July 25th. We have seen that one of the trout had been passing pus from a lesion into the water. On August 5th one of the trout appeared to be sick and colonies of fungus developed on the skin. These white spots however disappeared next day but the fish was yellower in colour than on the day before. It died on August 6th and was at once examined. There was a loss of skin on the left side midway between the head and tail, the lesion was the size of a threepenny piece, and pus was oozing from several points. Cultures made from the heart blood gave abundance of *B. salmonicida* in pure culture. On September 4th the remaining trout, which had been in the tank since July 25th, was found dead. It had died during the night September 3–4. It will be remembered that it had been in

the water contaminated by the fish inoculated with cultures and which had developed consequently Furunculosis. This fish had become yellower in colour during its sojourn in the tank but just prior to death it also had taken on a leaden hue. A boil was present on the right side. The boil contained the pus of the usual kind and in it numerous organisms were found. The organisms were also recovered in culture from the heart blood. This fish proved to be most interesting. It had been long infected but had lived on apparently in good health, but it was capable of contaminating the water and infecting other fish as the following experience proves.

On August 21st, two Liffey trout and one Adare trout were placed in the tank with the above mentioned fish. This fish had been in the tank since July 25th, when it had been put in along with those inoculated with cultures. The water of the tank was in direct connection with the supply and the flow had never been interrupted.

On August 30th the Adare trout placed in on August 21st was dead. It had two slight excoriations upon the nose, the only lesions observed. Cultures were made as usual from the heart blood and after a few days were found to contain colonies of *B. salmonicida*, and by September 8th the colour was developed in the medium.

On September 3rd one of the Liffey trout died. Prior to death the fish appeared very wild, dashing through the water in the aquarium and apparently injuring itself against the sides. No lesions were present, save that the head was considerably bruised and a large subcutaneous haermorrhage had formed. Cultures made from the heart blood were negative.

On September 10th the remaining Liffey trout died. It also developed the yellowish colour. The head was discoloured—a greenish black. Cultures here were also negative. These two negative cases so far as recovery of the organism are concerned are quite counterbalanced by the positive result obtained with the Adare trout which was the first to die and in the blood of which the organism was present. It can only be concluded that certain fish not immediately succumbing to infection may act the part of carriers and may contaminate water to such a degree that healthy fish become infected and die. If this is so under experiment it is probable that such may occur in nature and that pools in a river containing diseased fish may act as foci or centres of infection for that river.

It is difficult to advise as to the best way to clear a river of infection. To net the river and destroy all fish found is out of the question and even if it were feasible we have no information how long infection might remain in the river. Apparently in ponds the organisms may remain in the mud, etc., at the bottom of the ponds and contaminate the water. There is no difficulty however in dealing with such ponds. The water can be easily run off and the ponds cleaned out.

In rivers containing fish infected with Furunculosis, diseased fish should be removed from the river with the least possible delay and they should be destroyed, burnt. It is no use merely removing them from the river and allowing them to remain on the bank or in the fields bordering the river. Rats will sooner or later attack the fish and it is quite possible rats may contaminate the water after having fed upon diseased fish. The organism will not grow in rats, it may even die in the intestines of the rat, but some may pass through and infect. Moreover, the fish or parts of the fish may again reach the river, being carried or dragged there, so it is better to get completely rid of the fish by burial or by fire.

Since the greater part of this report was written I have received two other specimens of diseased salmon from Dr. Leeper taken from his waters in the river Liffey, one early in October, the other in the middle of December. Dr. Leeper informs me that in his opinion the October specimen was a fresh run salmon. An examination of the scales appears to show that the fish had spent about two years in fresh water before migration as a smolt and that it had been two years and a summer in the sea and was now probably re-visiting fresh water for the first time. It is likely that the fish spent some time in the estuary at the mouth of the river before ascending. An examination of the body of this fish showed it to be very extensively infected. There were numerous abscesses both subcutaneous in situation and in the flesh and in the pus the causal organisms were in great abundance.

In the fish received in December numerous abscesses were found deeply placed in the muscles. It was not possible to make a complete examination of the specimen as it had been in part devoured by rats. There was no difficulty however in demonstrating *B. salmonicida* in the pus of the lesions. An examination of the scales suggested a life history of the fish somewhat similar to that of the October fish.

NOTE

BY E. W. L. HOLT.

It is probable that there was a slight outbreak of Furunculosis in the Liffey in 1912. In the early summer of that year it was reported to me that several dead salmon had been found in the neighbourhood of Ballymore Eustace, as well as a few trout, and a sickly pike was taken by means of a trout line used as a noose. This fish, I was informed, had a large dark sore on the roof of its mouth, but seems to have been otherwise normal in external appearance. I could obtain none of the salmon or trout in a fresh condition, but one salmon reached my hands some days after its death. It had been cleaned by the

man who had first found it and thrown back into the river, and was, when I saw it, bleached and somewhat putrid. On the isthmus was a pit of pinkish matter which I was told by its first captor was a deep reddish sore. The fish seemed to me too much decomposed to be worth submitting to bacterioscopic analysis. None of the trout—according to the accounts which reached me, showed any conspicuous external sores. They were, I think, taken between Poulaphouca and "Golden Waters"—a waterfall which salmon can only pass when the river is in flood.

If these fish were really affected by Furunculosis, it would lend support to the view that the disease is brought in by fresh run salmon, the latter in this case having run right through to the final barrier at Poulaphouca. A certain number of salmon seem to do this every year when there is anything like a flood in late spring or early summer.

On the definite recognition of the disease in the Liffey in 1913, the Clerks of all Fishery Districts in Ireland were requested to bring the matter to the notice of the Conservators, in order that the extent of the disease in Ireland might be ascertained. From replies received it is certain that there was nothing like a general outbreak, and it is really doubtful whether this particular disease was present anywhere except in the Liffey.

A few salmon and trout were found dead in the Slaney between the latter part of May and the end of July of 1913, but none of these fish exhibited macroscopic symptoms which could with reasonable certainty be attributed to Furunculosis, and no specimens could be obtained for bacteriological examination.

A certain number of salmon appear to have died in the Slaney, about Tullow, in 1911, but seem not to have exhibited any conspicuous external symptoms which could be assigned to Furunculosis.

In the Lismore district a number of salmon were found dead in the Bride River between 19th July and 23rd August, 1913. They showed no external marks of any kind, but were noticed to be showing the head over water and to make back into the deep pools before they died.

In the Blackwater 14 dead salmon were found between 14th August and 7th September near Banteer. So far as the description given of their condition by the bailiff who found them can be exactly interpreted, there is nothing to indicate with certainty that they showed any external symptoms of Furunculosis.

As is well known salmon and trout are found dead in any river from time to time, especially in hot weather when the water has run very low; and although (as Professor Mettam shows) a fish may suffer from Furunculosis without showing any external symptom or even apparent loss of condition, the acts noted above cannot in my opinion be taken as affording

any sort of proof that this disease has hitherto been present in any Irish river except the Liffey.

Taking into consideration the theory, which seems to me most probably correct, that the disease was brought into this country by salmon which had spent the previous season in some river in the South-west of England, one would naturally expect the disease to manifest itself in the nearest Irish rivers, which would be the Slaney, Nore, Suir, and Barrow, Blackwater and Bride, and Liffey.

By marking experiments one knows that there is at least an occasional migration from an Irish to an English river, and, presumably, *vice versa*, and it seems desirable that a close watch should be kept on all the Irish rivers most likely to be affected by the immigration of disease "carriers" from Great Britain.

Beyond at once taking out all dead and dying fish and destroying them, it is difficult to see what can be done to check the disease should it again appear, but it is imperative that nothing should be done which could possibly tend to spread it. It seems almost certain that it was spread over Europe, or that its dispersion was at least accelerated, by transfers of stock from one hatchery to another; and though there is as yet no proof that its germs can be conveyed by ova or fry, it is obviously possible that such germs may be present in the packing or water in which ova or fry are conveyed, and on this account it will, I think, be granted that to import ova or fry from any country in which the disease is known to exist, or to transfer them in this country from any river in which the presence of the disease is even suspected to any river in which it has not hitherto appeared, would be sheer folly, or something worse.

EXPLANATION OF PLATES I–III.

Plate I.

Fig. 1.—Photograph of flesh of salmon containing boils. The dark areas are the boils.

Fig. 2.—Adare trout, showing boil, the result of inoculation.

Plate II.

Larger Liffey trout, showing boil.

Plate III.

Smaller ditto.

Wt. P.28.—S.7. 750. 4/14. B. & N., Ltd.

Fig. 1.

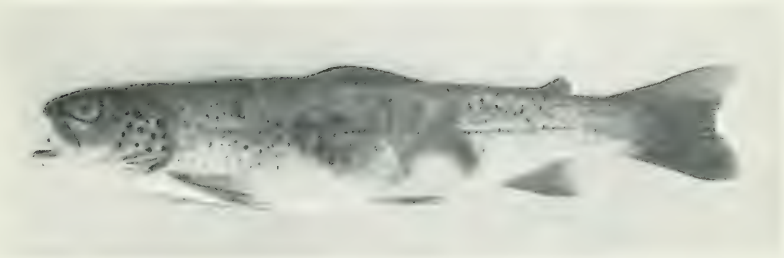

Fig. 2.

RESULTS OF A BIOLOGICAL SURVEY OF BLACKSOD BAY, CO. MAYO,

COMPILED BY

G. P. FARRAN,

With Notes on the Lichenes by M. C. KNOWLES, and on the Tunicata by R. HARTMEYER.

Plate I.

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i.—INTRODUCTION.

The materials, on which, with the assistance of Mr. R. Southern, I have based the following account of the Fauna and Flora of the west shore of Blacksod Bay, were gathered during a series of visits made by the naturalists of the Department between September, 1909, and September, 1911. The investigators present on each visit were, in September, 1909, G. P. Farran, S. W. Kemp, L. B. Smyth, R. Southern and W. M. Tattersall; in March and September, 1910, G. P. Farran, L. B. Smyth, and R. Southern; in March and September, 1911, G. P. Farran and R. Southern. Miss M. C. Knowles and Miss J. Stephens also visited the area in September, 1911, and investigated the marine Lichens and the Porifera and Coelenterata, and it is due to their help that these groups have been adequately dealt with here. Each visit was made at the equinoctial spring tides and lasted for about a week.

The primary object of the survey was to obtain evidence of the effect, if any, on the local fishing industries, of the establishment of a whaling station, in so far as such effect may be indicated by alteration of the constitution and distribution of the animal and vegetable life of the area adjacent to the station. For this purpose a definite record, not dependent on individual recollection but based on periodic inspection, appeared to be necessary.

It has often been asserted that the establishment of a whaling station in any locality is liable to cause great and widely-diffused changes in the biological conditions of the neighbourhood, and the proposal to establish such a station at the west side of Blacksod Bay appeared to the Department to afford a suitable opportunity of putting the matter to a practical test.

As the whaling station did not commence work until the summer of 1910, two of our inspections were made before any whales were brought in and three after whaling operations had commenced.

The actual number of whales dealt with at the station during the period covered by the survey was as follows:—

Year.	Right Whales.	Sperm Whales.	Blue Whales.	Finn Whales.	Sei Whales.	Knöl (hump-back) Whales.	Total.
1910	4	5	6	20	18	2	55
1911	—	2	6	53	2	—	63
	4	7	12	73	20	2	118

Two principal objections are usually made by those who are opposed to the establishment of whaling stations; one by fishermen, some of whom affect to consider the presence of whales as beneficial to herring fishing, whether by affording an indication of the locality of shoals of fish or by driving the herring into the bays or on to the accustomed fishing grounds, wheresoever they may be. On this point our observations do not bear at all, but whatever importance may attach to it elsewhere it has none on the Irish coasts, because whales seldom, if ever, come anywhere near the Irish herring fisheries. The other objection, on which it is hoped that our observations will throw some light, is that the various processes incidental to bringing in and utilisation of captured whales involve the

defilement of the shore and water, and the destruction of animal and vegetable life.

This last objection is one which in some instances appears to have been well founded, for it is apparent from the Report of the Departmental Committee on Whaling and Whale Curing in the North of Scotland that some of the whaling stations first established in the United Kingdom, namely, at the Shetland Islands, were not sufficiently equipped to deal with all the whales caught, and, in consequence, it frequently happened that only the more valuable parts of whales were treated, while the refuse was thrown into the sea and allowed to accumulate in large quantities along the shore. The resulting state of affairs seems to have been taken by most critics of whaling operations as the normal result of the establishment of a whaling station; but when a station is equipped with installations sufficient to deal promptly with all the fish brought in, there does not seem *a priori* any reason to expect such a result.

The Blacksod whaling station is built on the shore at the north side of Feorinyeeo Bay, the parts extending below high-water mark being the slip, up which the whales are drawn, and the jetty, which runs out into deep water and is constantly used by two or three steamers during the whaling season.

The station is so equipped that all solid material from the captured whales can be boiled and dried. All liquid matter, including the drainage of the flensing plane, is collected in a large tank where it is boiled by steam and the oil skimmed off, the remainder, consisting mainly of water with some organic matter in solution, being allowed to escape into the sea.

As the result of our observations up to September, 1911, it may be said that any changes observed on the shore were confined to the vicinity of the station, extending at most for 200 yards on either side. The most noticeable alteration was the greatly increased growth within these limits of the green alga *Ulva lactuca* which formed a dense band along and below extreme L.W.M. Within the same area the roots of *Laminaria* at L.W., when examined for the worms which generally abound in such a habitat, yielded a much smaller supply than is usual. Above L.W.M. the shore retained its usual aspect except in the limited area just below and on either side of the station, where a change was observable, consisting mainly in the increase of the green *Enteromorpha*, which usually denotes the presence of fresh water, and a corresponding decrease in the Fucoids and the animal life which they shelter, the rocks between the flensing plane and the jetty being almost bare of weed. It is doubtful whether these latter changes are all due directly to the whaling operations (flensing, trying, etc.), or whether they may not in part be ascribed to the use of the jetty and the ordinary traffic of a station where a large number of men are employed and where communications are chiefly maintained by sea.

A rough numerical comparison of the records of the various

visits to Blacksod shows that the average number of species per visit observed on the north shore of Feorinyeeo Bay, where the station is situated, in two visits made subsequent to the establishment of the station, was at least as high as in the two visits made before it was founded. This furnishes fairly reliable evidence that no marked detrimental change had taken place, in the period observed, on this section of the shore taken as a whole, and, *a fortiori*, on the shores of Blacksod Bay generally.

On a short visit of inspection to the station in July, 1913, the opportunity was taken of observing the condition of the shore at low-water spring tide after three and a half whaling seasons had elapsed.

On this occasion the Fucus began visibly to diminish at about 100 yards distance from the station, the rocks below the station being quite bare of weed except for a little *Enteromorpha* which seemed to be dead. Two large wooden trestles standing in the water at the foot of the slip were, however, overgrown with Fucus, which was also to be seen on the rocks and stones below L.W.M. The shore below the station was inhabited by *Patella*, *Littorina* and *Balanus* in large numbers, and a few specimens of *Actinia* and *Mytilus*, while in the rock pools, the water in which was somewhat milky in colour, *Anemonia sulcata* was living. Beyond a distance of 100 yards from the station no effects were noticeable, except the presence of the belt of Ulva referred to above, the upper margin of which was just uncovered.

Subsequent observation will probably show whether the small changes which have been noted are cumulative, or whether the long period (September to April), during which the factory is closed each year, is sufficient to allow the shore, beyond the immediate confines of the station, to retain its normal condition; but as far as can be seen up to the present there is no indication that, except in the small area adjoining the station, there has been any alteration in the fauna of the shore or in the abundance of the weeds which cover it.

G. P. F.

ii.—Description of the Area Investigated.

Geological.

The area investigated lies on the western shore of Blacksod Bay, stretching from the north of Barranagh Island southwards to Carrigeenmore. The shore consists of outstanding reefs or rocky points, alternating with beaches of scattered boulders or stones on a muddy or earthen foundation, or stretches of clean sand. The sandy beaches occur chiefly at the heads of the various bays into which the district is divided by the outstanding rocky points of Barranagh, Ardelly, Moyrahan, and Carrigeenmore. From Barranagh to midway between Moyrahan and Carrigeenmore the rocks forming the shore are composed, according to the maps of the Geological Survey, of hornblendic gneissose schists with numerous dykes of dolerite. South of

this point they suddenly change to a coarsely crystalline granite which becomes more quartzose as it passes away from the schist. Carrigeenmore is formed of pink and white tabular amorphous granite, the horizontal pavement-like sheets of rock contrasting strongly with the jagged and vertically-ridged and grooved schists of the rest of the area.

Along the northern shore of Elly Bay a deposit of peat passes down below low-water-mark, under a thin covering of gravel and sand, and in some places it is freely exposed on the shore.

Biological.

Littoral.

For the purposes of the Survey, the shore was divided into six sections denoted by letters as follows, commencing from the north :—

A—North, east, and south-east shores of Barranagh.
B—North shore of Elly Bay as far as the Coastguard Station.
C—West and south shores of Elly Bay as far as Ardelly Point.
D—Feorinyeeo Bay to the south end of the sandy beach.
E—Rocky shore from south end of D to Moyrahan Point.
F—Carrigeenmore reef.
The limits of these divisions are shown on the chart (Pl. I).

A—On the north-east of Barranagh the inter-tidal region is flat and of considerable width. The upper zone is formed of sand with traces of mud, and contains large numbers of cockles and lug-worms (*Arenicola marina*) and a small mussel bed. The intermediate zone is composed of coarse muddy gravel and loose stones, containing a rich fauna. The most characteristic species are *Sthenelais boa*, *Arabella iricolor*, *Lanice conchilega*, *Polymnia nebulosa*, *Polycirrus Smitti*, *Lagis Koreni*, *Chaetopterus variopedatus*, *Stylarioides plumosa*, *Arenicola branchialis*, *Sabella pavonina*, *Branchiomma vesiculosum*, *Tubifex Benedeni*, and *Phascolosoma vulgare*. The loose stones were thickly covered with Ascidians and Sponges.

The gravel is succeeded by extensive *Zostera* beds with a sandy foundation and containing the usual fauna described below. The sponge *Leucosolenia variabilis* was common here.

The south-eastern shore of Barranagh is very exposed, and the fauna poor. The inter-tidal region, at first very wide, narrows rapidly on passing southwards, and consists of large slabs and boulders overgrown with *Fucus* and resting on rock. At low water the belt of *Laminaria*, which both here and elsewhere throughout the area fringes the rocky shore, is exposed.

At the southern extremity the character of the shore alters. It is here formed of small boulders crowded together and resting on sand and gravel. This type of shore occurs in all the divisions of the area, and shelters a rich and varied fauna (see below). It is continued on the west shore of Barranagh into Section B.

B—This section consists of the west shore of Barranagh, the sandy neck connecting it with the mainland, and the north shore of Elly Bay as far as the Coastguard Station, the length of coast-line being about 1½ miles. The north shore of Elly Bay consists of stretches of sand and *Zostera* beds, interrupted by reefs of rock and patches of loose stones running down to low-water mark. The richest fauna is found in the patch of rocks just north of the Coastguard Station. It contains some fine rock-pools, and the loose stones exposed at low-water are covered with a rich growth of Sponges and Ascidians. The fauna of the rocky patches on the north side of the Bay is very poor. A narrow channel, two or three yards wide and a quarter of a mile long, entering the sea at this point, runs from Lough Leam. The latter is a shallow lake, about a quarter of a mile square, which the sea enters at high-water spring tides. It contains several species which are characteristic of waters of low salinity, viz. :—

Palaemonetes varians. *Neomysis vulgaris.*
Leander squilla. *Paludestrina ulvae.*

Other species were found which also occur on the adjacent shore, viz. :—

Macromysis flexuosa.
Crangon vulgaris.
Gobius minutus.

It is said that herrings and flounders are occasionally captured in this lake.

Near the exit of the stream is a partly submerged peat-bog which extends below low-water mark, and appears here and there through the covering of sand. The boring mollusc, *Barnea candida*, was found in considerable numbers in the peat near low-water mark.

C—This section comprises the west and south shores o Elly Bay, about two miles in length, from the Coastguard Station to Ardelly Point. The western shore consists entirely of a sandy beach about a quarter of a mile wide at low-water, and passing seawards into extensive *Zostera* beds, which can easily be investigated by wading. The south shore is very much steeper, covered for the most part with small stones and gravel, which afford very little shelter to animal life. Near Ardelly Point a more favourable habitat is afforded by the rocky outcrops with large stones, and the fauna characteristic of such ground becomes plentiful (see below).

D—This section consists of the north and west shores of Feor-inyeeo Bay, about one mile in length. The north shore is rocky. Although there is considerable exposure to the south-easterly swell, the gradual slope and the nature of the shore near Ardelly Point afford a very favourable habitat. The shore is composed of large stones and laminated schist. A large number of species

are found between the layers and in the crevices of the schist. The whole shore is thickly covered with *Fucus* and fringed with *Laminaria*. The fauna and flora, which are richest near Ardelly Point, gradually disappear on approaching the stretch of sand which occupies the whole western part of the Bay. This is due in part to the sand, which invades the bases of the rocky outcrops, altering its position with every gale of wind, and smothering the weeds and other sessile organisms. Near the middle of this rocky shore, the whaling Station and jetty are situated.

The sandy beach to the west of the Bay is not unlike that found in Elly Bay, except for its greater steepness.

E—This section stretches from the south side of Feorinyeeo Bay to Moyrahan Point. The shore is rocky, covered with *Fucus*, but with few loose stones, and the fauna is comparatively poor. A small sandy patch at the south end of the section furnished a few characteristic species. This section received less attention than the others, chiefly from considerations of weather, but even making allowance for this, its fauna was undoubtedly poorer than that found in the other sections.

F—This section consists solely of Carrigeenmore, a rocky reef which is completely covered at high-water, but at low-water forms a peninsula connected with the mainland by a narrow neck. It differs from all the other sections in consisting of tabular granite, forming level sheets of rock piled in many places with loose boulders. On the south side of the neck there is a small bay with very coarse sand and *Zostera*. This section is more exposed to the swell from the Atlantic, and is washed by water of higher salinity than the rest of the district. A small number of species were only found here, such as *Leucosolenia botryoides*, *Asterina gibbosa*, *Glycera siphonostoma*, and *Asclerocheilus intermedius*. The following species, which were commonly found elsewhere in the Bay, were absent from Carrigeenmore :—

Lanice conchilega.	*Cardium exiguun.*
Polymnia nebulosa.	*Craspedochilus onyx.*
Zippora membranacea.	

The rocks are covered with Fucoids, chiefly *Fucus serratus*, but *Ascophyllum nodosum*, which is abundant on all the other sections, appears to be absent. The absence of any muddy deposit under the stones, which is due to the distance from land, and the strength of the currents, is probably a factor of some importance in determining the fauna.

Sub-divisions of the Littoral Fauna.

The term "littoral" is here applied to that portion of the shore which is uncovered at low spring-tides. The rest of Blacksod Bay falls into the "sub-littoral" region. The division

between these two regions may not correspond to any well-defined natural boundary, but for collecting purposes it is by far the most practical. The limit corresponding to low neap-tides is probably a more natural one, but it is much more difficult to observe. The largest number of species inhabiting the littoral region is found between the limits of low-water spring and low-water neap-tides. Those species able to endure an exposure to the air every twelve hours are comparatively few in number, whilst every few inches below the limit of low neap-tide adds numbers of species to the list. The vertical distance between low spring and low neap-tides is about two feet in Blacksod Bay, but these limits vary from month to month and are at any time liable to be modified by wind. Beyond the general conclusion that some animals are better able to withstand exposure than others, a classification according to horizontal limits would *a priori* be of little value, and this conclusion is borne out by observation. An exception to this conclusion must be made for the group of species which seem to require periodic exposure, and are consequently found in greatest numbers in the upper littoral region.

Apart from the special types of ground already mentioned, the fauna may be classified under two headings, that of the rocky shores, and that of the sandy beaches. No mud or estuarine deposits occur in the area investigated.

These sub-divisions of the fauna constitute "facies" in the sense of Pruvot, or "formations," as they are termed by some botanists.

Fauna of the Rocky Shore.

This sub-division is here used in a wide sense, to include all those species which live in rock-pools, on or under stones, or in weeds growing on the rocks. The most important factors seem to be (1) the duration of exposure to the air, (2) shelter from dessication, (3) whether the stones are lying loosely, or are embedded in the substratum, (4) the physical and chemical character of the rocks.

The animals living on the rocky shore may be arranged in the following groups according to the positions in which they are found :—

1. Animals exposed to the air on stones, rock faces, or weeds.
2. Animals found under stones.
3. Animals living in crevices of the rocks.
4. Animals living in *Laminaria* roots.

1. Animals exposed to the air on stones, rock faces, or weeds.

Beginning near high-water mark, there are a number of species for which a periodic exposure seems to be beneficial, and they are consequently found in greatest numbers on the exposed

surfaces of rock. Such species are *Littorina rudis*, *L. obtusata*, *L. littorea*, *Lasaea rubra*, *Purpura lapillus*. *Monodonta crassa* (=*Trochus lineatus*), *Gibbula umbilicata*, *Patella vulgata*, and *Balanus balanoides*. Somewhat lower down, but still fully exposed, may be found the anemone *Actinia equina* and the sponges *Hymeniacidon caruncula*, and *Halichondria panicea*. On the overhanging faces of rocks, where they are not so liable to dessication, are found *Sycon compressum*. *Ophlitaspongia seriata* and *Alcyonium digitatum*. Still lower down on the shore, where the tidal exposure is short, are found *Spongelia fragilis*, *Pecten varius*, *Phallusia mentula*, and *Spirorbis borealis*. *Mytilus edulis* comes here, but is scarce in Blacksod Bay. On the exposed fronds of Fucoids may be found the sponges *Oscarella lobularis* and *Halisarca Dujardini*, the molluscs *Helcion pellucida* (young), *Lacuna divaricata*, *L. parva*, and *L. pallidula*, and the Polychaete *Spirorbis borealis*.

2. Animals found under stones.

Stones near high-water mark which rest on sand frequently shelter a number of species which are less commonly found elsewhere. Such are the Amphipods *Orchestia*, *Gammarus*, *Talitrus* and *Ligia oceanica*, with some beetles, mites and spring-tails. A little lower down, in the same kind of habitat, are found the red variety of *Lineus ruber*, the Polychaete *Cirratulus cirratus*, and numerous Oligochaetes such as *Clitellio arenarius*, *Marionina semifusca*, and *Lumbricillus verrucosus*, together with many Nematodes and *Carcinus maenas*. Nearer to low-water mark stones which are resting on or embedded in muddy sand or gravel afford shelter to another group, the majority of which have burrows in the sand. Polychaetes predominate, especially the following species:—*Sthenelais boa*, *Nereis cultrifera*, *Cirratulus cirratus*, *C. tentaculatus*, *Aonides oxycephala*, *Lanice conchilega*, *Stylarioides plumosa*, *Nicomache maculata*, *Arenicola ecaudata*, *A. branchialis*. The Gephyrea *Phascolosoma vulgare*, *P. Johnstoni* and *Physcosoma granulatum* are common here, with the Oligochaete *Tubifex Benedeni*, and the Crustacean *Nebalia bipes*.

The above communities are small compared with that sheltered by the stones near low-water mark, which lie loosely on the substratum, the most densely inhabited being those partly submerged either in depressions or at extreme low-water mark. By far the largest number of species found in Blacksod Bay occurs in this habitat, and the following list contains only the commonest and most characteristic forms. The most favourable localities where this type of fauna is found are Carrigeenmore, Ardelly Point, and the south corner of Barranagh.

Coelenterata.

Cribrina Balli. *Urticina felina.*

Porifera.

Clathrina coriacea.
C. contorta
Leucosolenia variabilis.
Sycon ciliatum.
S. compressum.
S. raphanus.
Leucandra nivea.
L. Johnstoni.
L. cliarensis.
Oscarella lobularis.
Halisarca Dujardini.
Terpios fugax.
Reniera simulans.
R. Peachi.
Halichondria panicea.
Pachychalina limbata.
Aplysilla rosea.
A. sulphurea.
Ophlitaspongia seriata.
Hymeniacidon caruncula.

Turbellaria.

Stylochoplana maculata.
Leptoplana tremellaris.
Prostheceraeus vittatus.
Eurylepta cornuta.
Stylostomum variabile.

Nemertinea.

Cephalothrix rufifrons.
Emplectonema Neesi.
Lineus ruber (green variety).
L. longissimus.
Micrura fasciolata.
M. purpurea.
Nemertopsis flavida.
Amphiporus lactifloreus.
Prostoma coronatum.

Echinodermata.

Cucumaria saxicola.
C. Montagui.
C. lactea.
Asterina gibbosa.
Henricia sanguinolenta.
Asterias rubens.
Ophiothrix fragilis.
Echinus miliaris.
Strongylocentrotus lividus.

Mollusca.

Acanthochites fascicularis.
Lepidopleurus cancellatus.
Tonicella ruber.
Callochiton laevis.
Craspedochilus cinereus.
C. onyx.
Anomia ephippium.
Pecten pusio.
P. varius.
Cardium exiguum.
Acmaea virginea.
Fissurella graeca.
Gibbula cineraria.
G. umbilicata.
Calliostoma zizyphinus.
Nassa reticulata.
N. incrassata.
Trivia europaea.
Lamellaria perspicua.
Bittium reticulatum.
Buccinum undatum (young).
Ocinebra erinacea.
Pleurobranchus plumula.
Archidoris tuberculata.
Jorunna Johnstoni.
Rostanga coccinea.
Cadlina repanda.
Aegires punctilucens.
Triopa clavigera.
Acanthodoris pilosa.
Lamellidoris bilamellata.
L. depressa.
Goniodoris nodosa.
Facelina coronata.
Eolis papillosa.

Crustacea.

Cancer pagurus.
Pilumnus hirtellus.
Xantho incisus.
X. hydrophilus.
Carcinus maenas.
Eurynome aspera.
Hyas araneus (young).
Portunus puber.
Porcellana longicornis.
P. platycheles.
Galathea strigosa (young).
G. squamifera.
Athanas nitescens.

Polychaeta.

Odontosyllis ctenostoma.
Trypanosyllis zebra.
Syllis prolifera.
S. armillaris.
S. gracilis.
Autolytus pictus.
Amblyosyllis lineata.
Castalia fusca.
C. punctata.
Lepidonotus squamatus.
L. clava.
Lagisca floccosa.
Harmothoe imbricata.
Halosydna gelatinosa.
Polynoe scolopendrina (in tubes of Terebellid worms).
Pholoë minuta.
Eulalia bilineata.
E. viridis.
Eumida sanguinea.
Phyllodoce lamelligera.
P. Paretti.
P. maculata.
P. rubiginosa.
Nereis pelagica.
N. Dumerilii.
Staurocephalus rubrovittatus.
Lysidice punctata.
Polydora caeca.
P. ciliata.
Dodecaceria concharum (boring in sponges, shells, etc.)
Amphitrite gracilis.
A. Johnstoni.
Nicolea venustula.
Polymnia nebulosa.
Thelepus setosus.
Flabelligera affinis.
Dasychone bombyx.
Pomatoceros triqueter.
Sabellaria spinulosa.

3. Animals living in crevices of the rocks.

On the north side of Feorinyeeo Bay the schist easily fractures into large flat sheets, which usually have a thin layer of mud between them. Embedded in this mud are to be found large numbers of individuals, chiefly worms belonging to the order Polychaeta, together with many Nemerteans and Gephyrea. The following list comprises the most characteristic species.

Nemertinea.

Emplectonema Neesi.
Lineus ruber (green var.).
Micrura fasciolata.
M. purpurea.

Polychaeta.

Castalia fusca.
Lepidonotus squamatus.
Lagisca floccosa.
Harmothoe imbricata.
Eulalia viridis.
Phyllodoce lamelligera.
P. Paretti.
Nereis cultrifera.
Lumbriconereis Latreillii.
Arabella iricolor.
Lysidice punctata.
Scolecolepis fuliginosa.
Aonides oxycephala.
Polydora flava.
P. caeca.
Cirratulus cirratus.
C. tentaculatus.
Dodecaceria concharum.
Amphitrite gracilis.
Polymnia nebulosa.
Flabelligera affinis.
Arenicola branchialis.

Gephyrea.

Phascolosoma vulgare.
P. Johnstoni.
Physcosoma granulatum.
Thalassema Neptuni.

Mollusca.

Saxicava rugosa.
Kellia suborbicularis.

4. Animals living in *Laminaria* roots.

The belt of Laminaria is well developed throughout the district wherever the rocky shore dips below low-water mark. It is composed chiefly of the three species, *Laminaria digitata*, *L. saccharina*, and *Saccorhiza polyschides* (*Laminaria bulbosa*). The last-named species is much scarcer than the others. The fronds of these Algae are usually uncovered at low water, but it is only at exceptionally low spring tides that many of the fibrous roots are exposed to the air. The examination of *Laminaria* roots is by far the easiest method of obtaining a very large number of small-sized species which would otherwise be overlooked, or only found in very small numbers and with great difficulty. The method adopted was to tear the plants off the rocks, and, after cutting away the stems, completely submerge the roots in dishes of water. Some of the species living in the roots are more intolerant of this treatment than others,* and soon collect in large numbers round the margin of the water whence they can easily be removed. A prolonged soaking is required to make the others quit their retreats, and a continual succession of different species emerges in the course of two or three days. The smaller Crustacea, Turbellaria, Nemertinea, and Polychaeta, collect on the side of the dish nearest the source of light. At the end of three days the contents of the dish begin to putrify, and the tube-dwelling species

* For some interesting observations on the behaviour of various species of Nemertinea under these conditions, see "Quelques observations biologiques et expériences sur 'la Faune des bords de cuvette.'" By M. Oxner in the *Bulletin de l'Institut Océanographique*, No. 108, 1907.

now usually emerge and fall to the bottom of the dish. A few drops of formalin added to the contents of the dish at this stage seem to hasten the process. The roots may now be thrown away and the debris at the bottom of the dish preserved for future examination. It usually contains immense numbers of Nematodes, Polychaetes, and small Crustacea. As many as 66 species of worms have been obtained from half-a-dozen roots in this manner. This method has been used in various localities on the Irish coast and has given very similar results. It would seem to furnish a reliable basis for the comparison of the littoral faunas in different countries, since the external conditions are always more or less similar, and the personal factor in collecting material is largely eliminated. With this end in view it is here treated at some length.

This method was used chiefly for collecting the various groups of worms, for which purpose it is especially favourable. The following species were obtained in this manner :—

Turbellaria.

Proporus venenosus.
Astrotorhynchus bifidus.
Proxenetes tuberculatus.
Promesostoma ovoideum.
Hyporcus venenosus.
Polycystis Naegelii.
Plagiostomum Girardi.
P. elongatum.
P. vittatum.
Vorticeros auriculatum.
Allostoma austriacum.
Monocelis lineata.
Stylochoplana maculata.
Leptoplana tremellaris.
Stylostomum variabile.

Nemertinea.

Tubulanus annulatus.
Cephalothrix rufifrons.
Lineus longissimus.
L. bilineatus.
Micrura fasciolata.
M. purpurea.
Emplectonema Neesi.
Nemertopsis flavida.
Prostoma coronatum.
P. vermiculus.
P. flavidum.
Oerstedia dorsalis.

Polychaeta.

Exogone gemmifera.
Grubea clavata.
G. pusilla.
Sphaerosyllis hystrix.
Pionosyllis lamelligera.
Eusyllis tubifex.
Odontosyllis gibba.
O. ctenostoma.
Eurysyllis paradoxa.
Syllis prolifera.
S. armillaris.
S. ferrugina.
Autolytus longeferiens.
A. punctatus.
A. pictus.
A. ehbiensis.
A. Edwarsi.
Autolytides inermis.
Amblyosyllis lineata.
Castalia punctata.
C. fusca.
Magalia perarmata.
Lepidonotus clava.
Lagisca Elizabethae.

POLYCHAETA—*continued.*

L. floccosa.
Harmothoe imbricata.
H. spinifera.
Pholoë minuta.
Eulalia bilineata.
E. viridis.
E. tripunctata.
E. pusilla.
Eumida sanguinea.
Phyllodoce maculata.
P. rubiginosa.
Nereis Dumerilii.
N. pelagica.
Ophryotrocha puerilis.
Lysidice punctata.
Sphaerodorum minutum.
Nerinides tridentata.
Spio seticornis.
Polydora Giardi.
P. caeca.
Aonides oxycephala.
Scolecolepis vulgaris.
Macrochaeta clavicornis.
Chaetozone viridis.
Dodecaceria concharum.
Nicolea venustula.
Thelepus setosus.
Polycirrus haematodes.
Polyophthalmus pictus.
Arenicola marina } post-
A. ecaudata } larval
A. branchialis. } stages.
Asclerocheilus intermedius.
Stylarioides plumosa.
Flabelligera affinis.
Dasychone bombyx.
Fabricia sabella.
Jasmineira elegans.
Oria Armandi.
Potamilla Torelli.
Pomatoceros triqueter.
Spirorbis spirorbis.
Sabellaria spinulosa.

GEPHYREA.

Phascolosoma Johnstoni.

NUDIBRANCHIATA.

Goniodoris castanea.
Ancula cristata.
Rostanga coccinea.
Eolis olivacea.
Aegires punctilucens.
Runcina Hancocki.

Many species of other groups also occur in *Laminaria* roots, such as Echinoderms, Nematodes, Mollusca, Tunicata, etc., but as they are as easily collected in other situations they call for no comment here.

The massive growths of *Lithothamnium*, which in other places shelter a very rich fauna, are very poorly represented in Blacksod Bay, and they yielded nothing of interest.

THE FAUNA OF THE SANDY BEACHES.

Variations in this fauna seem to depend chiefly on the purity of the sand and the proportion of mud present. The presence of *Zostera* modifies the sand fauna considerably, for, in addition to those animals which live on the blades, a number of other species, chiefly worms, live in large numbers amongst the roots. A number of other factors might be expected, *a priori*,

to modify the sand fauna, such as the slope of the beach and its capacity for retaining moisture, the coarseness of the sand and the amount of shell debris, the presence of streams of fresh water, the exposure of the beach to wave action and the consequent liability to alteration of its configuration. Variations in these conditions either were not present in Blacksod Bay, or were not observed with sufficient accuracy to correlate them with any definite differences in the fauna. Attention was chiefly directed to the differences between the fauna of clean sand and that found in the sand of *Zostera* beds.

The principal stretches of clean sand occur at the heads of Elly Bay and Feorinyeeo Bay, and on the isthmus connecting Barranagh with the mainland.

The north shore of Elly Bay also contains several smaller patches of sand, and small sandy coves occur on Moyrahan and Carrigeenmore.

The following list contains the most characteristic species living in clean fine sand in Blacksod Bay.

Coelenterata.

Cylista undata, on *Cardium edule*.

Nemertinea.

Tubulanus linearis.
Lineus acutifrons.
Amphiporus bioculatus.
A. hastatus.

Echinodermata.

Echinocardium cordatum.
Synapta inhaerens.

Mollusca.

Tellina squalida.
T. fabula.
T. tenuis.
Donax vittatus.
Mactra subtruncata.
Venus gallina.
Tapes aureus.
T. virgineus.
T. pullastra.
T. decussatus.
Cardium edule.
Gari depressa.
Ensis ensis.
Thracia fragilis.
Natica Alderi.
Nassa reticulata.
Philine aperta.

Crustacea.

Corystes cassivelaunus.
Processa canaliculata.
Crangon vulgaris.

Polychaeta.

Harmothoe lunulata.
Sigalion Mathildae.
Phyllodoce greenlandica.
Eteone pusilla.
Nephthys caeca.
N. Hombergi.
N. ciliata.
N. cirrosa.
Glycera alba.
Aricia Latreillii.
Scoloplos armiger.
Scolecolepis fuliginosa.
Nerine foliosa.
N. cirratulus.
Magelona papillicornis.
Owenia fusiformis.
Lanice conchilega.
Pectinaria auricoma.
Lagis Koreni.
Notomastus latericeus.
Ophelia limacina.
Travisia Forbesi.
Caesicirrus neglectus.
Arenicola marina.

Pisces.

Ammodytes sp.

Fields of *Zostera* are widely distributed throughout the area in Blacksod Bay. They sometimes occur in isolated patches amongst the rocks, in other cases passing into more extensive fields below low-water mark. Except on the north-east shore of Barranagh where the substratum is muddy gravel, the *Zostera* is growing on sand. *Zostera* usually grows only on sand with a very slight inclination seawards, and hence a considerable amount of water is retained. The fauna, whilst including a number of species also found in clean sand, has greater affinities with the fauna living in sandy mud and muddy gravel, such as occurs on the north side of Barranagh. The dominant species in the *Zostera* beds of Blacksod Bay are *Nereis cultrifera, Scoloplos armiger, Cirratulus tentaculatus, Notomastus latericeus,* and *Phascolosoma elongatum*, these species often occurring in vast numbers. The following list includes the most characteristic species.

Nemertinea.

Lineus bilineatus.
Cerebratulus fuscus.

Polychaeta.

Sthenelais boa.
Nereis cultrifera.
Nephthys caeca.
N. Hombergi.
N. cirrosa.
Arabella iricolor.
Glycera alba.
Scoloplos armiger.
Cirratulus tentaculatus.
Lanice conchilega.
Polymnia nebulosa.
Thelepus setosus.
Notomastus latericeus.
Polyophthalmus pictus.
Arenicola branchialis.
Scalibregma inflatum.
Stylarioides plumosa.
Sabella pavonina.

Gephyrea.

Phascolosoma vulgare. *P. elongatum.*

Echinodermata.

Synapta inhaerens.

In addition to these species living in the sand, a certain number live on or amongst the blades of *Zostera*, the chief being the anemone *Anemonia sulcata*, the sponge *Leucosolenia variabilis*, the mollusca *Lacuna divaricata* and *Zippora membranacea*, the shrimps *Hippolyte prideauxiana* and *H. varians*, the compound ascidian *Aplidium zostericola* (?), and the fishes *Nerophis ophidion* and *Spinachia vulgaris*.

Sub-littoral.

The greater part of Blacksod Bay is very shallow, the usual depth being from 4-6 fathoms. To the south-east of Carrigeenmore, near the entrance of the Bay, soundings of 10 fathoms are obtained. The composition of the sea-bottom is very uniform over the greater part, consisting of fine sand, sometimes with a slight admixture of mud. Elly Bay and Feorinyeeo Bay are very shallow, 1-3 fathoms in depth, and for the most part occupied by extensive fields of *Zostera*, with an upper fringe, on the rocky parts of the shore, of *Laminaria* and other Algae. With the *Zostera* is associated a fairly well-defined fauna of which the following species are the most characteristic :—

Anemonia sulcata.
Plagiostomum Girardi.
Cephalothrix rufifrons.
Prostoma coronatum.
Oerstedia dorsalis.
Sphaerosyllis hystrix.
Odontosyllis gibba.
Harmothoe imbricata.
Nereis Dumerilii.
Macrochaeta clavicornis.
Polyophthalmus pictus.
Pandalus Montagui.
Hippolyte prideauxiana.
H. varians.
H. Cranchi.
Gibbula magus.
Lacuna divaricata.
Rissoa violacea.
R. parva.
Zippora membranacea.
Bittium reticulatum.
Nerophis ophidion.
Siphonostoma typhle.
Crenilabrus melops.
Ctenolabrus rupestris.

Below the *Zostera*, in depths of 3-5 fathoms, the sea-floor in the middle and mouths of the bays and the deeper waters adjoining, is modified and characterised by immense numbers of *Turritella communis*, both living and dead shells. This ground, though more open than the *Zostera* area, does not appear to be exposed to the full force of the tidal current. A number of species characteristic of this ground are dependent on the *Turritella* shells, either for a firm basis of attachment, or for

shelter. To the first category belong *Sabellaria spinulosa*, *Pomatoceros triqueter*, *Hydroides norvegica*, *Styela sp.*; to the second *Phascolion strombi*, *Eupagurus cuanensis* and *Anapagurus Hyndmanni*, the two latter being very abundant, with *Eupagurus bernhardus* in much smaller numbers. Other organisms, not directly dependent on the *Turritella*, but frequenting the same kind of ground, are *Ficulina ficus*, *Dicoryne conferta*, *Portunus depurator*, *P. arcuatus*, *P. pusillus*, *Tellina fabula*, *Buccinum undatum*, *Bela turricula*, *Nereilepas fucata* (in *Buccinum* shells), and *Ampharete Grubei*.

In depths of 5–10 fathoms the character of the fauna alters, the change consisting either in the addition of some new species, such as *Aphrodita aculeata*, *Ephesia gracilis*, *Pectinaria auricoma*, *Chaetopterus variopedatus*, and *Eupagurus Prideauxi*, or in the changed proportion of species already occurring in the *Turritella* association. There is an increase in those Polychaetes which form tubes embedded in the sand, such as *Lanice conchilega*, and *Owenia fusiformis*. *Turritella* decreases with the increase of depth, whilst *Ophiura albida* is more frequently met with. The determining factors seem to be the greater depth, with its accompanying changes in the vegetation, and the increased exposure to the tidal current, rather than any change in the nature of the sea-bottom.

iii. Record of Species.

With very few exceptions, all the following species have been recorded in the published results of the Clare Island Survey,[1] and reference may be made to those results for further information on matters of distribution, nomenclature, and synonymy.

The following lists of species are naturally very unequal in value, some groups having been carefully collected and examined, whilst others received only the most cursory treatment. The total number of species recorded is 1,133, of which 128 are plants, and 1,005 animals. The following groups were worked with sufficient thoroughness to give a fairly accurate representation of their occurrence in Blacksod Bay :—Lichenes, Porifera, Echinodermata, Nemertinea, Polychaeta, Gephyrea, Decapoda, and Nudibranchiata. Next come those groups in which the more easily observed species were collected, but which are certainly incomplete as regards the smaller and more obscure species. Such are the Turbellaria, Lamellibranchiata, Gasteropoda, Amphineura, Tunicata, and Fishes. Finally, there are those groups to the collecting of which little attention was paid, and which are obviously incomplete, such as the Algae, Foraminifera, Nematoda, Polyzoa, Entomostraca, Cumacea, Mysidacea, Amphipoda, Isopoda, Acarina, and Oligochaeta.

In some of these groups specimens were collected and sub-

[1] *Proc. Royal Irish Academy*, Vol. XXXI.

mitted for identification to the specialists whose names are prefixed to each group, the account of the distribution being based on their reports. The remaining groups were worked out by the naturalists of the Fisheries Branch, the initials of those mainly responsible for the identification being prefixed. The reports of Miss M. C. Knowles on the Lichens, and of Dr. Hartmeyer, of Berlin, on the Tunicata are given in full.

The letters A, B, C, etc., which follow the name of each species indicate the section of the shore on which it was found (see above, p. 5, and map, Pl. I).

ALGAE.

Over the whole district, except where sandy bays intervene, the succession of algae from high-water to low-water marks is very uniform, though the varied slope of the shore gives an advantage locally to one or another species. Along the extreme H.W.M., just below the zone of the Lichen *Lichina confinis*, *Pelvetia canaliculata* forms a sparse band except on Carrigeenmore, where the rocks are almost submerged at high water. Next in succession is *Fucus spiralis* which, lower down, blends with *Fucus vesiculosus* and *Ascophyllum nodsoum*. The two latter densely cover the shore, sometimes one, sometimes the other predominating, to about the level of L.W. neaps, below which *Fucus serratus* gradually take their place. *Ascophyllum nodosum* is, as noted above, quite absent from Carrigeenmore, probably owing to the increased salinity of the surrounding water. *Fucus serratus* is the most valued of the inter-tidal algae for manurial purposes, and consequently those parts of the shore in which the slope is least near L.W.M., such as the east and south sides of Barranagh and Ardelly Point, yield the most valuable crop of weed. The zone of *Fucus serratus* stops almost abruptly at L.W.M., and is succeeded by a varied band consisting of *Chondrus crispus*, *Laurencia pinnatifida*, *Furcellaria fastigiata* and *Halydrys siliquosa*, only exposed at exceptionally low spring tides and passing gradually into the Laminarian zone.

The drainage of fresh water on to the beach was usually marked by the presence of *Enteromorpha*, but the occurrence of the three commonest species on Carrigeenmore, which is almost submerged at high tide, shows that this condition is not essential.

The presence of a dense band of *Ulva lactuca* at L.W.M. under the newly-constructed whaling station, completely covering all the other algae at the same level, may reasonably be ascribed to the unavoidable discharge of water containing nitrogenous material in solution, as on the first two visits to the locality, before work had been started at the station, the Ulva was present in much smaller quantity.

"Sand binding" algae, the constituent species of which, except *Rhodochorton floridulum*, were not identified, occur all

through the area, forming velvety patches on the rocks and firm stones. Their presence was specially noted, near L.W.M., on the Moyrahan shore and on the north side of Feorinyeeo Bay.

For a detailed account of the conditions of growth of Algae on the west coast of Ireland, dealing, *inter alia*, with the south side of Blacksod Bay and other areas similar to the one here treated, reference should be made to the paper on "Marine Algae," by Dr. A. D. Cotton, in the *Proceedings of the Royal Irish Academy*, Vol. XXXI (Clare Island Survey).

The list which follows contains only the larger and more conspicuous forms which occur in the district, and the absence or rarity of a species cannot be inferred from the absence of its name from the list.

Species of which specimens have kindly been examined and identified by Dr. A. D. Cotton, are indicated in the list by an asterisk. The notes on distribution were made by the observers on the spot, mainly by L. B. Smyth.

CHLOROPHYCEAE.

Enteromorpha clathrata, S. Ag.—A, B, D, E, F. Fairly plentiful.
Enteromorpha compressa, Grev.—A, B, D, E, F. Plentiful.
Enteromorpha intestinalis, Link.—A, B, C, D, E, F. Plentiful.
Ulva lactuca, L.—A, B, C, D, E, F. Plentiful. Dense at L.W.M. under the whaling station.
***Codium tomentosum,** Stackh.—A, B, C, D, E, F. Plentiful on Carrigeenmore, scarce elsewhere. *Codium mucronatum* has probably been included in the records of this species.
***Codium mucronatum** var **atlanticum,** Cotton. A. F. Specimens identified by Dr. A. D. Cotton, Sept. '11.

CYANOPHYCEAE.

The algae in this group were not recorded except *Rivularia atra* which was noted on B, C, and E.

FUCOIDEAE.

Desmarestia ligulata, Lam.—Off Carrigeenmore, 7–8 fms.
***Scytosiphon lomentarius,** J. Ag.—B. Fairly plentiful, March, '11.
Asperococcus fistulosus, Hook.—A, B, C, D, F. Plentiful.
Asperococcus bullosus, Lamour.—Dredged in Feorinyeeo Bay, 2 fms., August, '09.
Pylaiella littoralis, Kjellm.—A, B, C, D, E. F. Abundant in August, very scarce in May. Feorinyeeo Bay, 2 fms.
Elachista fucicola, Fries.—A, B, C, E, F. Abundant.
***Sphacelaria cirrhosa,** Ag.—A, B, C, D, E, F. Abundant.
Cladostephus verticillatus, Ag.—D, E, F. Plentiful in August, '09.
***Cladostephus spongiosus,** Ag.—A, B, C, D, E, F. Plentiful.
***Chordaria flagelliformis,** Ag.—A, C, D, E, F. Fairly plentiful in August.

Mesogloia vermiculata, le Jol.—A, B, D, E. Scarce.
Leathesia tuberiformis, Aresch.—A, B, C, D, E, F. Plentiful in August.
Chorda filum, Stackh.—A, B, C, D, E, F. Plentiful in August.
Laminaria saccharina, Lamour.—A, B, C, D, E, F. Abundant.
Laminaria digitata, Lamour.—A, B, C, D, E, F. Abundant.
Saccorhiza polyschides, Batt.—A, B, D, F. Plentiful.
Fucus spiralis, L.—A, B, C, D, E, F. Abundant.
Fucus vesiculosus, L.—A, B, C, D, E, F. Abundant.
Fucus serratus, L.—A, B, C, D, E, F. Abundant.
Ascophyllum nodosum, le Jol.—A, B, C, D, E. Abundant. Its absence from Carrigeenmore is to be noted.
Pelvetia canaliculata, Decne & Thur.—A, B, C, D, E. Abundant. Absent from Carrigeenmore.
Himanthalia lorea, Lyngb.—F. Abundant.
Dictyopteris membranacea, Batters.—Off Carrigeenmore, 7–8 fms.
Halidrys siliquosa, Lyngb.—A, B, C, D, E, F. Abundant, especially in rock-pools. Often dredged.
Cystoseira ericoides, Ag.—A, E, F. Scarce, except in rock-pools on Carrigeenmore.
***Dictyota dichotoma**, Lamx.—A, C, D, E, F. Fairly plentiful.

FLORIDEAE.

Porphyra umbilicalis, Kütz.—A, B, C, D. Fairly plentiful.
***Pterocladia capillacea**, Born.—B. Rare.
Gelidium corneum, Lamour.—A, B, C, D, E, F. Fairly plentiful.
***Chondrus crispus**, Stackh.—A, B, C, D, E, F. Abundant.
***Phyllophora membranifolia**, J.Ag.—B. Fairly plentiful, Mar. '11.
Gigartina mamillosa, J. Ag.—B, C. Rare.
Callophyllis laciniata Kütz.—D. March '11, scarce.
***Cystoclonium purpurascens**, Kütz.—A, B, C, D, E, F. Plentiful.
Rhodophyllis bifida, Kütz.—Elly Bay, 4 fms.
Calliblepharis ciliata, Kütz.—Occasionally dredged, 5–9 fms.
***Ahnfeltia plicata**, Fr.—F. Probably often overlooked.
***Rhodymenia palmetta**, Grev.—A, B, C, D, E, F. Plentiful.
***Lomentaria articulata**, J. Ag.—A, B, C, D, E, F. Plentiful.
***Lomentaria clavellosa**, Gaill.—B. Fairly plentiful, Mar. '11.
***Chylocladia kaliformis**, Hook.—A, B, D, E, F. Fairly plentiful in August.
***Chylocladia ovalis**, Hook.—A, B, C, D, E, F. Fairly plentiful.
***Plocamium coccineum**, Lyngb.—A, B, D, E, F. Plentiful. Dredged, 5–9 fms.
Nitophyllum Bonnemaisoni, Grev.—D, F. Plentiful, August, '10.
Nitophyllum laceratum, Grev.—F. Plentiful, March, '10.
***Delesseria sanguinea**, Lamour.—A, B, C, D, E, F. Plentiful in March.
Delesseria alata, Lamour.—B, D, F. Fairly plentiful.

*Rhodomela subfusca, Ag.—D. Fairly plentiful, Sept., '10 Mar., '11.
*Laurencia hybrida, Lenorm.—B. Fairly plentiful, March, '11.
*Laurencia pinnatifida, Lamour.—A, B, C, D, E, F. Very plentiful.
*Chondria dasyphylla, Ag.—A, B, D, F. August, '10–'11, plentiful.
*Polysiphonia elongata, Grev.—B, D. Scarce.
Polysiphonia fastigiata, Grev.—A, B, C, D, E, F. Plentiful.
Polysiphonia subulifera, Han.—A, C, E. Plentiful. Frequently dredged, 2–9 fms.
*Polysiphonia fruticulosa, Spreng.—A, B, D, E, F. August, '10–'11, plentiful.
*Polysiphonia nigrescens, Grev.—C. Once recorded.
Dasya arbuscula, Ag.—A, B, D. Scarce.
Spondylothamnion multifidum, Näg.—A. August, '09, scarce.
*Griffithsia corallina, Ag.—A. Scarce.
*Griffithsia setacea, Ag.—E. Scarce.
Rhodochorton Rothi, Näg.—D. Scarce.
Rhodochorton floridulum, Näg.—A, B, C, D, E, F. Very plentiful.
Ceramium diaphanum, Roth.—A, B, D, E, F. Plentiful in August.
*Ceramium rubrum, Ag.—A, B, C, D, E, F. Plentiful.
Ceramium echionotum, J. Ag.—A, D. August, '10, plentiful.
Gloiosiphonia capillaris, Carm.—A. August, '09, scarce.
Dilsea edulis, Stackh.—A, B, D, E, F. Fairly plentiful.
*Furcellaria fastigiata, Lam.—A, B, C, D, E, F. Plentiful.
Lithophyllum sp.; Lithothamnium sp.—Incrusting algae are common in the exposed parts of the shore, especially in rock-pools on Carrigeenmore, but rarely form more than a thin layer.
Corallina officinalis, L.—A, B, C, D, E, F. Plentiful.
*Corallina rubens, Ellis & Sol.—A, B, C, D, E, F. Plentiful.

LICHENES.

The following notes and list of species have been kindly contributed by Miss M. C. Knowles :—

Speaking generally for the rocky areas of the western coast of Blacksod Bay the lichens are disposed in the following more or less distinct zones or belts in descending order from just above high-water mark of spring tide towards low-water.

1. A white belt of *Lecanora atra* and *L. parella*.
2. *Ramalina scopulorum*.
3. Orange lichens (*Physcia parietina*, *Lecanora murorum* and *L. lobulatum*).
4. *Lichina confinis*.
5. *Verrucaria maura*.
6. *Lichina pygmaea*.
7. Marine Verrucarias.

The lichens of the first three belts grow mainly above high-water mark of spring tides; 4 and 5 normally occupy the area between high neap and high spring tide-levels; while the main growths of 6 and 7 are found just below high-water mark of neap-tide, but sometimes extend nearly to low-water. The white belt and the *Lichina pygmaea* growth are the most characteristic lichen vegetation of the area under consideration.

The White Belt.

The White Belt has not been described previously as a constituent element of the maritime vegetation. It is best developed on the comparatively sheltered south shores of the bays where, owing to the absence of high rocks, the *Ramalina* growths are thin. On the exposed sides of the rocky points where the *Ramalina* growths are strongest the lichens forming the white belt grow chiefly under the shelter of the *Ramalina* fronds.

The white belt is a conspicuous feature on the shores of Elly Bay. From the landing-place below Bingham Castle southwards as far as Ardelly Point the rocks and boulders, embedded in the low earth-banks, or lying on the beach just above high-water mark, when seen from the sea, have the appearance of having been whitewashed, and the effect is similar on the north side of Doobeg Point. The main constituents of the belt are *Lecanora parella* and *Lecanora atra*, the latter being much more abundant and growing in shadier aspects and nearer the sea than *L. parella*. During unusually high spring tides the lower part of the white belt is splashed by the waves, and, in stormy weather, the whole belt must be often saturated with spray. In addition to *Lecanora parella* and *Lecanora atra* the following species were occasionally noted: *Lecanora ferruginea* var. *festiva*, *L. caesiorufa*, *L. subfusca* var. *campestris*, *L. atrynea*, *L. coilocarpa*, *Lecidea albocoerulescens*, *L. contigua*, *L. contigua* var. *limitata*, *Biatorina chalybeia* subsp. *chloroscotina*, *B. lenticularis*, *Bilimbia aromatica*, etc.

Ramalina scopulorum Belt.

The strongest growths of *Ramalina scopulorum* occur on the windy sides of the promontories. The belt is poorly represented in the bays. Along the south shore of Elly Bay the belt is thin and narrow, but can be clearly made out on the rocks below the well-developed white belt. On the exposed east and south-east coasts of Barranagh Island and on Ardelly Point *Ramalina scopulorum* covers an extensive area with strong tufts, forming a belt several yards wide, and harbouring a sub-vegetation, of which *Physcia aquila*, *Ph. parietina*, *Buellia canescens*, *Lecanora parella*, *L. atra*, *Lecidea protrusa*, and *Opegrapha calcarea* are the commonest species. *Ramalina scopulorum* var. *incrassata* is common where there is much wind and spray. Only where the *Ramalinas* were well-sheltered and protected from the sea-water was the barren and much-branched form encountered.

The Orange Belt.

The greater part of the west coast of Blacksod Bay seems to be too exposed for the lichens which constitute the Orange Belt. The three characteristic species: *Physcia parietina*, *Lecanora murorum* and *Lecanora lobulatum*, are widespread, but the growth is mostly thin and scattered, and nowhere forms such a close-grown, well-defined belt as that described for the Howth shores.[1] These three lichens seem to prefer a west or south-west aspect, and the belt is most easily made out when looking along the beach in an easterly direction. *Physcia parietina* grows furthest from the sea, and is the most frequent species; the variety *virescens* is found in shady situations. At a lower level *Lecanora murorum* and *Lecanora lobulatum* are usually associated, but on exposed rocks *L. lobulatum* occurs alone. As on the Howth coasts the grey crustaceous lichen, *Lecanora prosechoides*, is sometimes associated with *L. lobulatum*, but is more usually found, forming pure growths, on exposed rocks with an easterly aspect. The parasitic lichen, *Arthonia varians* occurs commonly on the apothecia of *Lecanora prosechoides* throughout the whole area. *Physcia stellaris* subsp. *tenella*, *Lecanora vitellina* and *Opegrapha calcarea* are frequently associated with *Physcia parietina*. *Rhizocarpon albcatrum* also occurs in the belt associated with *Lecanora prosechoides* and *Lecanora lobulatum*.

The Verrucaria maura Belt.

Verrucaria maura forms a broad blue-black band on the east and south shores of Barranagh Island just above the seaweed *Pelvetia canaliculata* and it also covers the tops of the bare rocks amongst the *Pelvetia* plants. It is poorly represented in Elly Harbour, but is conspicuous on the shores of Elly Bay, between Bingham Castle and Ardelly Point. On the north shores of Ardelly Point *Bilimbia sabulosa* occurs frequently in chinks of the rocks inside the *Verrucaria maura* belt, and *Verrucaria memnonia* is common on rocks at a lower level on the shore than *V. maura*. On the north shore of Feorinyeeo Bay, near the whaling station, the *Verrucaria maura* growth is almost smothered by a covering of *Gleocapsa*, *Rivularia*, and other minute algae. Near Moyrahan Point the *V. maura* belt is again conspicuous and also on Doobeg Point.

Lichina confinis and L. pygmaea Belts.

The Lichina Vegetation is very similar to that described by Mr. Cotton for Clare Island[2] and for several other areas on the west coast of Ireland. Both species are present and occupy

[1] "The Maritime and Marine Lichens of Howth," *Sci. Proc. Roy. Dublin Soc.*, Vol. XIV. (N.S.), No. 6, 1913.

[2] "Marine Algae, Clare Island Survey," Part 15, *Proc. Roy. Irish Acad.*, Vol. XXXI., 1912.

the same relative position on the shore. *Lichina confinis* grows at a higher level than *L. pygmaea* and is found chiefly along the upper limit of *Verrucaria maura*, but it sometimes overlaps and spots the entire *V. maura* belt. The growth of *Lichina confinis* is, however, always densest in the upper part of its range. *Lichina pygmaea* grows below *Verrucaria maura* on rocks that are submerged at every tide.

Both species flourish best on the most exposed parts of the coast. The growths of *Lichina pygmaea* on the south and south-east coasts of Barranagh Island, on Ardelly Point, on Doobeg Point, and on the smooth granites of Carrigeenmore are remarkably fine and are a conspicuous feature on the rocks exposed at low water.

The Marine Verrucaria Belt.

The Marine Verrucarias are chiefly represented by *Verrucaria mucosa* which is widely distributed. The best growths of this species were those seen on the smooth granites of Carrigeenmore where it is associated with *Lichina pygmaea*, and those on Ardelly Point. In this last locality *Verrucaria mucosa* extends down the shore nearly as far as low-water of neap-tides. *Verrucaria microspora* is general for the whole coast, but is not common. *Verrucaria striatula* is frequent on quartz pebbles on the east coast of Barranagh Island, and grows amongst barnacles and on steep rocks covered with *Lichina pygmaea* at Doobeg Point. *Arthopyrenia foveolata* is abundant everywhere on barnacles. *Arthopyrenia halodytes* covers wide tracts of rock at Doobeg Point and on Ardelly Point below *Verrucaria maura* and between it and *Verrucaria mucosa*. *Arthopyrenia halodytes* is also frequent at other parts of the coast, but it was not seen anywhere in such abundance as at the two localities mentioned above.

List of Lichens noted on the west coast of Blacksod Bay.

COLLEMACEI.

Lichina pygmaea, Ag.—A, C, D, E, F. Common.
L. confinis, Ag.—A, B, C, D, E, F. Common.

LICHENACEI.

Ramalina scopulorum, Ach.—A, C, D, E, F. Common.
R. scopulorum var. **incrassata,** Nyl.—A, C, F. Frequent.
R. pollinaria, Ach.—C. Walls of Boat House.
Usnea hirta, Hoffm.—C. Scarce, Ramalina belt.
Parmelia perlata, Ach. var. **ciliata.** } Occasionally seen on rocks above high-water mark.
P. saxatilis, Ach.
P. fuliginosa, Nyl.
Physcia parietina, de Not.—A, B, C, D, E, F. Common.
Ph. parietina f. **virescens,** Nyl.—C, D. Frequent on shady rocks.
Ph. aquila, Nyl.—A. Scarce, Ramalina belt.

Ph. stellaris subsp. **tenella**, Nyl.—C, D. Frequent.
Lecanora murorum, Ach.—A, B, C, D, E, F. Frequent.
L. lobulata, Somm.—A, B, C, D, E, F. Common.
L. vitellina, Ach.—B, C, D, E. Frequent, Ramalina belt.
L. citrina, Ach.—C. Plentiful on the walls of the Boat House.
L. ferruginea var. **festiva**, Nyl. } C, D. Scarce.
L. caesiorufa, Nyl. }
L. galactina, Ach.—C. Common on the Boat House.
L. subfusca, Nyl. var. **campestris**, Nyl.—D. Rare.
L. atrynea, Nyl.—A, C, E. Rare.
L. coilocarpa, Nyl.—A, E. Occasionally.
L. gangaleoides, Nyl.—A, C. Scarce, Ramalina belt.
L. prosechoides, Nyl.—A, C, E, F. Common in exposed areas.
L. polytropa, Schaer.—A, C. Scarce.
L. atra, Ach.—A, B, C, D, E, F. Abundant.
L. parella, Ach.—B, C, D, E, F. Frequent.
L. smaragdula, Nyl.—A, D. Scarce.
Cladonia pyxidata, Fr.—C. Frequent, on the ground above H.W.M.
Cl. cervicornis, Schaer.—C, D. On the ground above H.W.M.
Cl. furcata, Hoffm. subsp. **racemosa** f. **recurva**.—E. Very rare, above H.W.M.
Lecidea granulosa, Schaer.—C, D. Rare.
L. protrusa, Fr.—A, C, D. Frequent, Ramalina belt.
L. contigua, Fr.—A, C. Scarce.
L. contigua f. **limitata**, Leight.—C. Frequent.
L. albocoerulescens, Ach.—C. Rare.
L. rivulosa, Ach.—D. Scarce.
Biatorina lenticularis, Koerb.—C, D. Rare, Ramalina belt.
B. chalybeia, Mudd. subsp. **chloroscotina**, A. L. Sm.—D. Rare, Ramalina belt.
Bilimbia aromatica, Jatta.—D. Occasional, White belt.
B. sabulosa, Massal.—C. Frequent, associated with *Verrucaria maura*.
Buellia canescens, de Not.—C, D. Scarce, chiefly in shade, Ramalina belt.
Rhizocarpon alboatrum, Th. Fr.—B, C, D. Frequent, Orange belt.
Arthonia varians, Nyl.—A, C, D, E, F. Common on *Lecanora prosechoides*.
Opegrapha calcarea, Turn.—C, D. Not common, Ramalina belt.
Verrucaria maura, Wahlenb.—A, B, C, D, E, F. Common.
V. maura var. **memnonia**, Koerb.—D, E. Plentiful.
V. mucosa, Wahlenb.—A, C, D, E, F. Common.
V. microspora, Nyl.—A, C, E, F. Frequent.
V. striatula, Wahlenb.—A, D. Rare.
V. striatula f. **continua**, Knowles.—A, C, E, F. Frequent.
Arthopyrenia foveolata, A. L. Sm.—A, C, D, E. Abundant on barnacles.
A. leptotera, A. L. Sm.—D. Rare.
A. halodytes, Oliv.—A, D, E. Plentiful.
Porina chlorotica, Wainio.—C. Rare, White belt.

PROTOZOA.

FORAMINIFERA.

A dredging from Feorinyeeo Bay, off the whaling station, in 3 fathoms, made in March, 1911, was examined by Messrs. E. Heron-Allen and A. Earland, and the result published in *Proc. Royal Irish Acad.*, Vol. XXXI (Clare Island Survey, pt. 64). The dredging consisted of a fine grey-fawn muddy sand with coarse shell fragments and contained the following species. Common and very common species are indicated by c. and v.c.

Nubecularia depressa.
N. lucifuga.
Biloculina depressa.
Spiroloculina planulata.
S. limbata.
Miliolina oblonga.
M. rotunda (c.)
M. circularis.
M. subrotunda (c.)
M. seminuda.
M. seminulum (c.)
M. candeiana.
M. contorta.
M. sclerotica.
M. agglutinans.
M. fusca.
M. stelligera.
M. laevigata.
M. bicornis.
M. Brongniartii.
M. pulchella.
Massilina secans (v.c.)
M. secans var. *tenuistriata.*
Ophthalmidium carinatum.
Cornuspira involvens.
C. selseyensis.
Psammosphaera Bowmani.
P. fusca.
Hyperammina ramulosa.
Reophax moniliforme.
Haplophragmium canariense.
H. globigeriniforme.
H. anceps.
Thurammina papillata.
Hippocrepina indivisa.
Ammodiscus gordialis.
A. shoneanus.
Trochammina squamata.
T. ochracea.
T. plicata.
T. rotaliformis.
Textularia agglutinans.
T. conica.
Verneuilina polystropha.
Spiroplecta Wrighti.
Gaudryina filiformis.
Clavulina obscura.
Bulimina pupoides.
B. elegans.
B. squamigera.
B. fusiformis (c.)
B. elegantissima.
B. minutissima.
B. marginata.
B. convoluta.
Virgulina schreibersiana.
Bolivina textilarioides.
B. laevigata.
B. difformis (c.)
B. dilatata.
B. plicata (c.)
B. variabilis (c.)
B. inflata.
Cassidulina laevigata (c.)
C. crassa.
C. subglobosa (c.)
C. nitidula.
Lagena globosa.
L. apiculata.
L. hispida.
L. protea.
L. lineata.
L. costata.
L. hexagona.
L. reticulata.
L. squamosa (c.)
L. squamosa var. *Montagui.*
L. laevis.

L. semistriata.
L. striata.
L. sulcata.
L. Lyelli.
L. Williamsoni (c.)
L. clavata (c.)
L. gracillima.
L. laevigata (c.)
L. Milletti.
L. lucida.
L. fasciata (c.)
L. quadrata.
L. Malcomsoni.
L. marginata.
L. unguis.
L. marginato-perforata.
L. lagenoides var. *tenuistriata.*
L. bicarinata.
L. fimbriata.
L. orbignyana (c.)
L. clathrata.
Nodosaria pyrula.
N. scalaris.
Lingulina carinata.
L. biloculi.
Cristellaria crepidula.
T. cultrata.
Polymorphina lactea.
P. gibba.
P. oblonga.
P. compressa.
P. sororia.
P. myristiformis.
Uvigerina angulosa.
Globigerina bulloides (c.)
G. inflata.
G. rubra (c.)
Orbulina universa.
Spirillina vivipara.
S. Groomi.
S. obconica var. *carinata.*
Patellina corrugata.
Discorbina mediterranensis (c.)
D. nitida.
D. Milletti.
D. Praegeri.
D. peruviana (c.)
D. rosacea (c.)
D. planorbis (c.)
D. baccata.
D. globularis.
D. obtusa.
D. polyrraphes.
D. Chasteri.
D. Bertheloti.
Planorbulina mediterranensis.
Truncatulina refulgens.
T. lobatula (c.)
T. variabilis.
T. ungeriana.
Pulvinulina punctulata.
P. auricula.
P. haliotidea.
P. crassa.
P. truncatulinoides.
P. Karsteni.
Rotalia Beccarii (v.c.)
Gypsina inhaerens.
Nonionina depressula (c.)
N. umbilicatula.
N. asterizans.
N. stelligera.
N. pauperata.
N. scapha.
N. turgida.
Polystomella striato-punctata.
P. crispa (v.c.)
P. macella.
Operculina ammonoides.

PORIFERA.

(Identified by Miss J. Stephens).

CALCAREA.

Clathrina coriacea (Montagu).—A, B, C, D, F. Moderately common under large stones between tidemarks, chiefly in September. On Laminaria roots dredged in 1 fm. off Ardelly Pt.

Clathrina contorta (Bowerbank).—B, E, F. Under large stones between tidemarks, scarce. Dredged in 8–9 fms. off Blacksod Lt. Only found in September.

Leucosolenia botryoides (Ellis and Sol.).—F. Found twice, fairly plentifully, on Carrigeenmore.

Leucosolenia variabilis (Haeck.).—A, B, C, D, F. Moderately common.

Leucosolenia complicata (Montagu).—B. Scarce.

Sycon coronatum (Ellis and Sol.).—B, C, D. Scarce.

Sycon ciliatum (Fabr.).—A, B, C, D, E, F. Not plentiful. Dredged three times, 1–6 fms.

Sycon raphanus, Schmidt.—A, B, C, D, F. Scarce. Dredged in 1 fm., off Ardelly Pt.

Sycon setosum, Schmidt.—F. Scarce.

Sycon compressum (Fabr.).—A, B, C, D, E, F. Common between tidemarks, and frequently found high up on the shore under overhanging rocks.

Leucandra nivea (Grant).—A, B, C, D, E, F. Common on undersides of stones between tidemarks.

Leucandra Johnstoni (Carter).—A, B, D, F. Scarce.

Leucandra cliarensis, Stephens.—A, B, C, D, E, F. Under stones at low water, frequent.

NON-CALCAREA.

Halisarca Dujardini, Johnston.—A, B, C, D, E, F. Very common under stones and on *Fucus* stems, between tidemarks. Dredged in 2 fms., Elly Bay.

Oscarella lobularis (Schmidt.)—A, B, C, D, E, F. Common.

Cliona celata, Grant.—A, B, C, D, E, F. Frequent, boring in shells and limestone. Dredged in 4–8 fms.

Ficulina ficus (Linn.).—C, E. Scarce between tidemarks. Frequently dredged 2–8 fms, Occurred both on *Pecten* and Gastropod shells.

Suberites carnosus (Johnston).—C. Once between tidemarks. Dredged twice off Ardelly Pt., 2–5 fms.

Terpios fugax, Duch. and Mich.—A, B, C, D, E, F. Frequent under stones in small quantities.

Reniera simulans (Johnston).—A, B, C, D, E, F. Common between tidemarks. Dredged off Ardelly Pt., 3–4 fms.

Reniera Peachi (Bowerbank).—B, C, D, F. Frequent between tidemarks. Dredged off Ardelly Pt., 1–8 fms.

Reniera cinerea (Grant).—B, C. Scarce between tidemarks. Dredged off Ardelly Pt., 1–5 fms.

Reniera fistulosa (Bowerbank).—D, E. Found twice.

Reniera indistincta (Bowerbank).—A, B, C. Scarce.

Halichondria panicea (Pallas).—A, B, C, D, E, F. Common everywhere between tidemarks.

Pachychalina limbata (Montagu).—A, B, C, D, E, F. Frequent between tidemarks. Dredged three times, 1–5 fms.

Stylostichon plumosum (Montagu).—A, B, C, D, E, F. Common between tidemarks.

Pocillon Hyndmani (Bowerbank).—D, F. Found twice, on shells.

Ophlitaspongia seriata (Grant).—A, B, C, D, E, F. Very common between tidemarks, often high up on the shore.

Raspalia (?) Howsei (Bowerbank).—D. Found twice.

Myxilla incrustans (Johnston).—C. Fou

Myxilla rosacea (Lieberkühn).—F. Once at L.W. on Carrigeen-more.

Mycale aegagropila (Johnston).—B, C, D. Scarce.

Mycale macilenta (Bowerbank).—A, B. Found twice.

Mycale rotalis (Bowerbank).—A, B. Found three times at extreme L.W.M.

Esperiopsis fucorum (Johnston).—A, B, C. Scarce between tidemarks. Dredged twice, 3–8 fms.

Hymeniacidon caruncula, Bowerbank.—A, B, C, D, E, F. Very common on rocks between tidemarks, often near H.W.M.

Aplysilla rosea, Schultze.—A, B, C, D, E, F. Common under stones at L.W.M. On *Laminaria* roots from 4–6 fms., off Feorinyeeo Bay.

Aplysilla sulphurea, Schultze.—A, B, C, D, F. Frequent under stones at L.W.M.

Spongelia fragilis (Montagu).—A, B, C, D, E, F. Common.

COELENTERATA.

(Identified by Miss J. Stephens).

GYMNOBLASTEA.

Coryne pusilla, Gaert.—C, D, F. Between tide-marks, scarce.

Coryne vaginata, Hincks.—C, E, F. Between tide-marks, scarce.

Tubiclava cornucopiae, Norman.—On *Dentalium*, dredged off Blacksod Lt., 8–9 fms.

Hydractinia echinata (Fleming).—On hermit-crab shells, 5–9 fms., frequent.

Dicoryne conferta (Alder).—On *Turritella* shells inhabited by hermit-crabs, 6–8 fms., common.

Tubularia larynx, Ellis and Sol.—A. One colony.

CALYPTOBLASTEA.

Halecium halecinum (Linn.).—Off Ardelly Pt. and Carrigeen-more, 5–9 fms., scarce.

Clytia Johnstoni (Alder).—D. Three times between tide-marks. Dredged in 1–9 fms., Elly Bay, Feorinyeeo Bay, and off Blacksod Lt.

Obelia geniculata (Linn.).—F. Once between tide-marks; probably often overlooked. Feorinyeeo Bay, 3–5 fms.

Obelia dichotoma (Linn.)—D, F. Twice found; probably often overlooked.

Lovenella clausa (Loven).—C. Once found, on *Dentalium* shells.

Campanulina turrita, Hincks.—C. Once found.

Sertularella polyzonias (Linn).—Dredged 1–8 fms., Elly Bay and off Ardelly.

Sertularia pumila, Linn.—A, C, D, F. Probably overlooked on other sections; common.

Sertularia operculata, Linn.—A. Probably washed up.

Antennularia antennina (Linn.).—Dredged off Ardelly Pt., Blacksod Lt., and Carrigeenmore, 5–9 fms.

Antennularia ramosa (Lmck.).—Off Blacksod Lt., 8–9 fms.

Aglaophenia pluma (Linn.).—Off Feorinyeeo Bay, 4–6 fms.

Plumularia setacea (Ellis).—Off Feorinyeeo Bay, 4–6 fms.

STAUROMEDUSAE.

Lucernaria campanulata, Lam.—E. One specimen at L.W.M. Feorinyeeo Bay, 3–5 fms., two.

DISCOMEDUSAE.

Pelagia perla (Slabber).—Washed ashore, Sept. '11.

ALCYONARIA.

Alcyonium digitatum, Linn.—A, B, D, E. Very small colonies not uncommon. Dredged in 4–9 fms., orange form only.

ZOANTHARIA.

Halcampa chrysanthellum (Peach)?—B. One specimen in sand.

Actinia equina, Linn.—A, B, C, D, E, F. Common everywhere between tide-marks, usually high above L.W.M.

Anemonia sulcata (Pennant).—A, B, C, D, E, F. Common between tide-marks attached to *Zostera* or weed. Feorinyeeo Bay, 2–5 fms., common. Off Carrigeenmore, 3 fms.

Metridium dianthus (Ellis).—Off Ardelly Pt., 5½ fms., small specimens on *Laminaria* roots.

Sagartia miniata, Gosse.—Off Ardelly Pt., 6–8 fms., a few large specimens.

Cylista viduata (Müller).—D. One specimen in sand.

Cylista undata (Müller).—A, C. Abundant on live cockle shells in the strand N.E. of Barranagh, about 20 per cent. of the cockles carrying the anemone. Off Ardelly Pt., 1 fm. Off Carrigeenmore, 9 fms.

Adamsia palliata (Bod.).—Off Ardelly Pt., 6–8 fms., on shell with *Eupagurus Prideauxi,* one.

Cribrina Balli (Cocks).—A, B, C, D, E, F. Under large stones between tide-marks, frequent in small numbers.

Corynactis viridis, Allman.—Feorinyeeo Bay, 4–6 fms., few on *Laminaria* roots.

Urticina felina (Linn.).—A, B, C, D, E, F. Under large stones between tide-marks, frequent in small numbers.

CTENOPHORA.

Pleurobrachia pileus, Fabr.—Common in townettings.

ECHINODERMATA.

(Identified by G. P. F. and S. W. K.).

HOLOTHUROIDEA.

Synapta inhaerens (O. F. M.).—A, B, C, D, E, F. Frequent in sand and muddy gravel. Dredged off Ardelly Pt., 4¾ fms.

Cucumaria Montagui (Fleming).—A, B, C, D, E, F. Frequent under stones but not plentiful. Distinguished from *C. saxicola*, with which it is associated, by its brown colour and stiffer and more wrinkled skin.

Cucumaria lactea (Forbes and Goodsir) ?—A, B, C, D, F. Frequent but scarcer than *C. Montagui*, from which its spicules are indistinguishable. In external characters it differs in its small size and its very stiff slightly rugose creamy white glistening skin.

Cucumaria saxicola, Brady and Rob.—A, B, C, D, E, F. Common under stones. On *Laminaria* roots off Ardelly Pt., 1 fm. Usually of a milky white colour but sometimes suffused with smoky black.

Thyone fusus (O. F. M.).—Feorinyeeo Bay, 2–3 fms., one.

CRINOIDEA.

Antedon bifida (Pennant).—E. Two specimens. Dredged off Blacksod Lt., 8–9 fms., and Ardelly Pt., 5–8 fms., few.

ASTEROIDEA.

Astropecten irregularis (Pennant).—Off Ardelly Pt., 5–8 fms., few.

Asterina gibbosa (Pennant).—F. Fairly common on Carrigeenmore, probably on account of its exposed position, not found elsewhere.

Henricia sanguinolenta (O. F. M.).—A, B, C, D, E, F. Moderately common. Scarce in dredgings; off Ardelly Pt. 2–8 fms., Feorinyeeo Bay 4–6 fms.

Asterias rubens, Linn.—A, B, C, D, E, F, Common between tide-marks and in dredgings, 2–9 fms.

OPHIUROIDEA.

Ophiura ciliaris (Linn.).—C. One specimen. Abundant off Ardelly Pt., 5–8 fms., scarce in other dredgings.

Ophiura albida, Forbes.—Moderately common in dredgings; off Ardelly Pt. 4–8 fms., off Carrigeenmore 3–9 fms., off Blacksod Lt. 7–9 fms.

Amphiura Chiajii, Forbes.—Off Blacksod Lt. and Carrigeenmore, 3–8 fms., scarce.

Amphiura elegans (Leach).—A, B, C, D, E, F. Shore to 9 fms., common.

Ophiopholis aculeatus (Linn.).—Off Ardelly Pt., 5½ fms., one.

Ophiothrix fragilis (Abild.).—A, B, C, D, E, F. Shore to 9 fms., very common.

ECHINOIDEA.

Echinus miliaris, Gmel.—A, B, C, D, E, F. Very common under stones. Elly Bay, 2–5½ fms., moderately common.

Echinus esculentus, Linn.—A, B, C, D, E, F. Frequent but not plentiful.

Strongylocentrotus lividus (Lmk.).—A, D, E, F. Frequent but not plentiful on Ardelly Pt. and Carrigeenmore, under stones. Scarce elsewhere.

Echinocardium cordatum (Pennant).—B, C. On sandy shores, dead tests common, living specimens scarce. Off Blacksod Lt., 8–9 fms., one.

TURBELLARIA.

(Identified by R. S.)

ACOELA.

Proporus venenosus (O. Schmidt). Gamble 1893, p. 440.—B, C, D. In weeds from rock-pools, and in *Laminaria* roots, common. Dredged in Feorinyeeo Bay, 2–3 fms., in Elly Bay 1 fm.

Aphanostoma rhomboides (Jensen). Gamble (as *A. elegans*) 1893, p. 443. B. In weeds from rock-pools, rare. Dredged in Elly Bay, 1 fm.

Convoluta flavibacillum, Jensen. Gamble 1893, p. 448.—B. In weeds from rock-pools, rare. Dredged in Elly Bay, 2 fms.

RHABDOCOELIDA.

Microstomum groenlandicum (Levinsen). Gamble 1893, p. 449.—D. In weeds from rocks. Dredged in Elly Bay, 2 fms.

Macrostomum appendiculatum (Fabr.). Graff 1905, p. 80.—C. In weeds from rock-pools, rare. Dredged in Elly Bay, 2 fms.

Provortex balticus (Schultze). Gamble 1893, p. 468.—C. Single specimen in weeds from shore. Mature in September.

Provortex rubrobacillus, Gamble. Gamble 1893, p. 469.—Rare. Dredged off Ardelly Pt., 6–8 fms. Mature in September.

Maerenthalia intermedia (Graff). Gamble (as *Byrsophlebs intermedia*) 1893, p. 456.—A, C. In weeds from rock-pools. Mature in September.

Astrotorhynchus bifidus (McIntosh). Gamble (as *Pseudorhynchus bifidus*) 1893, p. 459.—B. Rare. In *Laminaria* roots. Mature in March.

Proxenetes flabellifer, Jensen. Gamble 1893, p. 456.—E. Rare. In weeds from shore. Mature in September.

Proxenetes cochlear, Graff. Gamble 1893, p. 457.—A. Rare. In weeds from rock-pools. Mature in September.

Proxenetes gracilis, Graff. Graff 1882, p. 280.—A. In weeds from rock-pools. Dredged in Elly Bay, 1 fm., and 2 fms.

Proxenetes tuberculatus, Graff. Graff 1882, p. 281.—B. Rare. In *Laminaria* roots. Mature in March.

Promesostoma marmoratum (M. Schultze). Gamble 1893, p. 450.—B, C, F. In weeds from rock-pools. Dredged in Feorinyeeo Bay, 2–3 fms. Mature in September.

Promesostoma ovoideum (O. Schmidt). Gamble 1893, p. 451.—A, B, F. Common. In weeds from rock-pools, and in *Laminaria* roots. Dredged in Elly Bay, 2 fms. Mature in March and September.

Hyporcus venenosus (Ulj.). Graff 1905, p. 110.—B, D. In weeds from rock-pools, and in *Laminaria* roots. Mature in March.

Trigonostomum setigerum, O. Schmidt. Graff 1882, p. 338.—Dredged in Elly Bay, 2 fms. Mature in September.

Trigonostomum armatum (Jensen). Gamble (as *Hyporhynchus armatus*) 1893, p. 466.—C. In weeds from rock-pools. Mature in September.

Trigonostomum penicillatum (O. Schmidt). Graff 1882, p. 341.—A, D. In weeds from rock-pools. Mature in September.

Acrorhynchus caledonicus (Clap.). Gamble 1893, p. 460.—C, D, F. In weeds from rock-pools. Mature in September.

Polycystis Naegelii, Kölliker. Gamble (as *Macrorhynchus Naegelii*) 1893, p. 462.—B, F. In *Laminaria* roots. Dredged in Feorinyeeo Bay, 2–3 fms. Mature in March and September.

Phonorhynchus helgolandicus (Metschn.) Gamble (as *Macrorhynchus helgolandicus*) 1893, p. 464.—A, B. In weeds from rock-pools. Dredged in Elly Bay, 2 fms. Mature in September.

Gyratrix hermaphroditus, Ehrbg. Gamble 1893, p. 465.—C. In weeds from rock-pools. Dredged in $4\frac{3}{4}$ fms., E. of Ardelly Pt. Mature in March and September.

Fecampia erythrocephala, Giard. Caullery and Mesnil 1903, p. 131.—F. Cocoons under stones.

Plagiostomum Girardi (O. Schmidt). Gamble 1893, p. 477.—A, C, F. Very common in *Laminaria* roots, and in weeds from rock-pools. Dredged in large numbers, Feorinyeeo Bay 2–5 fms., Elly Bay 2 fms. Mature in March and September.

Plagiostomum elongatum, Gamble. Gamble 1893, p. 473.—D. Single specimen, in *Laminaria* root.

Plagiostomum vittatum (Leuckart). Gamble 1893, p. 475. B, C, D, F. Common in *Laminaria* roots and weeds from rock-pools.

Plagiostomum Koreni, Jensen. Gamble 1893, p. 476.—C. In weeds from rock-pools.

Vorticeros auriculatum (Müller). Gamble 1893, p. 478.—A, B. In *Laminaria* roots. Mature in March.

Pseudostomum quadrioculatum (Leuckart). Gamble (as *Cylindrostoma quadrioculatum*) 1893, p. 483.—Dredged in Elly Bay, 1–2 fms. Mature in September.

Allostoma austriacum (Graff). Gamble (as *Enterostoma austriacum*) 1893, p. 480.—A, B, F. In *Laminaria* roots, and weeds from rock-pools. Dredged in 4¾ fms., E. of Ardelly Pt.; in Elly Bay, 2 fms. Mature in March and September.

Monocelis lineata (Müller). Gamble (as *Monotus lineatus*) 1893, p. 487.—B, C, D. In *Laminaria* roots, and weeds from rock-pools. Mature in March and September.

POLYCLADIDA.

Stylochoplana maculata (Quatrf.). Gamble 1893, p. 497.—B, C, D, E, F. Common under stones, in *Laminaria* roots, and in weeds from rock-pools. Not found on East Barranagh. Dredged in Feorinyeeo Bay, 2–5 fms.

Leptoplana tremellaris (Müller). Gamble 1893, p. 498.—A, B, C, D, E, F. Common under stones, and in *Laminaria* roots. Dredged in Elly Bay, 3–4 fms. Mature in September.

Leptoplana fallax (Quatrf.). Quatrefages 1845, p. 135.—D. Under stones on shore. Dredged in Elly Bay, 1 fm. Mature in September.

Leptoplana droebachensis, Oersted. Jensen 1878, p. 76.—C. Under stones on shore. Mature in September. This species and the one preceding were at first confused with L. *tremellaris*, and are probably more abundant than the records would show.

Prostheceraeus vittatus (Montagu). Gamble 1893, p. 504.—A, B, D. Under stones on shore. Dredged in Elly Bay, 2 fms., Rare.

Cycloporus papillosus, Lang. Gamble 1893, p. 506.—A, B, D, F. Under stones on shore. Dredged in Feorinyeeo Bay, 2–3 fms. Mature in September. The var. *laevigatus*, Lang, was also found on the shore.

Eurylepta cornuta (Müller). Gamble 1893, p. 507.—A, B, C, D, F. Fairly common under stones on shore. Dredged off Feorinyeeo Bay, 4–6 fms.

Stylostomum variable, Lang. Gamble 1893, p. 511.—A, B, D, F. Common under stones and in *Laminaria* roots. Dredged in Elly Bay, 2–4 fms.; Feorinyeeo Bay, 3–5 fms.; off Elly Bay, 4–5 fms.; off Ardelly Pt., $3\frac{1}{2}$–8 fms. Small and immature specimens were found in March and September.

NEMERTINEA.

(Identified by R. S. For Nomenclature and a fuller account of the following species, see Southern, R., "Nemertinea." Clare Island Survey, No. 55. *Proc. Roy. Irish Academy*, Vol. XXXI.)

ANOPLA.

Tubulanus banyulensis (Joubin).—Rare, only 2 specimens obtained, one in Elly Bay in 2 fms., and one off Ardelly Pt., in 6–8 fms.

Tubulanus superbus (Kölliker).—A single specimen dredged off Carrigeenmore in 7–8 fms.

Tubulanus annulatus (Montagu).—D. Rare. A single specimen in *Laminaria* roots from north side of Feorinyeeo Bay. A single specimen dredged in Feorinyeeo Bay in 3–5 fms.

Tubulanus linearis (McIntosh).—A, C, D, E. Not uncommon in clean sand, and in sand-binding seaweeds on the shore.

Cephalothrix rufifrons (Johnston).—A, B, C, D, E, F. Very abundant on shore, under stones, in corallines and in *Laminaria* roots. Dredged in Feorinyeeo Bay, 2–3 fms.; in Elly Bay, 1–2 fms.; off Carrigeenmore, 3 fms.

Lineus longissimus (Gunnerus).—A, B, C, D, E, F. Very common on shore under stones, and occasionally in *Laminaria* roots.

Lineus bilineatus (Renier).—A. One large specimen in muddy gravel, and another smaller one in *Laminaria* roots, from Barranagh. Dredged in Elly Bay, 2 fms., and frequently in the deeper parts of the Bay in 4–9 fms.

Lineus acutifrons, Southern.—B, E. Found only on three occasions, in sand near low-water mark.

Lineus ruber (Müller).—A, B, C, D, E, F. Very abundant under stones on shore.

Micrura fasciolata, Ehrbg.—A, B, D, E, F. Widely distributed but not abundant, under stones or in *Laminaria* roots. Dredged off Ardelly Pt. in $4\frac{3}{4}$ fms.

Micrura purpurea (Dalyell).—A, B, D, F. Associated with the last species, under stones and in *Laminaria* roots.

Cerebratulus fuscus (McIntosh).—A, B, F. Usually found in sand, gravel, or Zostera beds. Most abundant on north side of Elly Bay. Dredged in Elly Bay in ½–3½ fms.

ENOPLA.

Emplectonema Neesii (Oersted).—A, B, C, D, E, F. Extremely abundant on shore, under stones, in crevices of the schist, and in *Laminaria* roots.

Emplectonema echinoderma (Marion).—A, D. Rare; only three specimens obtained, under stones.

Nemertopsis flavida (McIntosh), Beaumont.—A, B, C, D, E, F. Under stones on shore, in weeds and *Laminaria* roots. Dredged in Elly Bay, 1 fm.; off Ardelly Pt., 4¾ fms.

Amphiporus lactifloreus (Johnston).—B, C, D, F. Not common. Under stones on shore. Dredged off Ardelly Pt., 5½ fms.

Amphiporus bioculatus, McIntosh.—B. Rare. Two specimens in sand on the north shore of Elly Bay. Dredged off Carrigeenmore in 7–8 fms.; Feorinyeeo Bay in 2–3 fms; Elly Bay in 2 fms.

Amphiporus hastatus, McIntosh.—B. C. Very rare. Two specimens found in clean sand in Elly Bay just above low-water mark.

Prostoma melanocephalum (Johnston).—F. In weeds from rock-pools on Carrigeenmore.

Prostoma coronatum (Quatrefages).—A, B, C, D, F. Common on shore, in weeds, under stones, and especially in *Laminaria* roots. Dredged in Elly Bay, 4 fms.; in Feorinyeeo Bay, 4–5 fms.; off Carrigeenmore, 3 fms.

Prostoma vermiculus (Quatrefages).—A, B, C, D, E, F. Very common in *Laminaria* roots. Dredged in all parts of the Bay, in 2–9 fms.

Prostoma flavidum (Ehrenberg).—B. Few specimens living in sand and in *Laminaria* roots.

Prostoma candidum (Müller).—Dredged off Ardelly Pt., in 5½ fms.

Prostoma Beaumonti, Southern.—Dredged in Elly Bay, 1 fm.

Oerstedia dorsalis (Abildg.).—A, B, C, D, F. Common on shore in weeds, especially in *Laminaria* roots. Dredged frequently in all parts of the Bay, in 1–9 fms.

NEMATODA.

(Identified by R. S. For Nomenclature and a fuller account see Southern R., Clare Island Survey, Part 54, Nemathelmia, Kinorhyncha, and Chaetognatha. *Proc. Roy. Irish Academy,* Vol. XXXI.)

Family *ANGUILLULIDAE.*

Monohystera acris, Bastian.—D. Amongst tubes of *Spirorbis.*

Enchelidium tenuicolle, Eberth.—C. Dredged in Elly B., ½–3½ fms.

Dipeltis typicus, Cobb, *var.*—B. D. Rare, only two specimens found, one in sand, the other amongst tubes of *Spirorbis medius.*

Cricolaimus elongatus, Southern.—A. One specimen, living in sand.

Anticoma pellucida, Bastian.—A, C, D. Common in weeds, rarely in sand.

Halichoanolaimus robustus (Bastian).—D. Rare.

Thalassironus britannicus, de Man.—B, C, F. Fairly common in weeds, *Zostera* sand, etc.

Spira parasitifera, Bastian.—A, D. In the sand of a *Zostera* bed.

Spira Schneideri, Villot.—B, F. Fairly common.

Spira laevis, Bastian.—B, D. In *Zostera* sand.

Spilophora gracilicauda, de Man.—D. Rare, under stones on the shore.

Euchromadora vulgaris (Bastian).—A, B, D. Fairly common in weeds and in sand.

Chromadora nudicapitata, de Man.—D. Rare.

Cyatholaimus ocellatus, Bastian.—D. Dredged off Feorinyeeo Bay, 4–6 fms.

Cyatholaimus dubiosus, Bütschli.—B, C, D. Common in *Zostera* sand.

Dagda bipapillata, Southern.—C. Rare, in clean sand.

Diodontolaimus sabulosus, Southern.—C. Rare, in clean sand.

Thoracostoma figuratum (Bastian).—C, D, E, F. Very common on the shore. Dredged off Feorinyeeo Bay, 4–6 fms.

Thoracostoma denticaudatum (Schneider).—D. Rare, only a single specimen found.

Cylicolaimus magnus (Villot).—C. A single specimen found on the shore.

Symplocostoma longicolle, Bastian.—C, D. Dredged in Feorinyeeo Bay, 2 fms.; in Elly Bay, $\frac{1}{2}$–$3\frac{1}{2}$ fms.; off Feorinyeeo Bay, 4–6 fms. Abundant in dredged weeds.

Eurystoma acuminatum, de Man.—B. Single specimen found in *Zostera* sand.

Oncholaimus vulgaris, Bastian.—A, B, C, D, F. Common under stones. Dredged in Elly Bay, 2 fms.

Oncholaimus similis, Southern.—A, B, C, D, F. Common under stones.

Enoplus communis, Bastian.—B, C, D. Common in sand, weeds, etc.

KINORHYNCHA.

Echinoderes Dujardini Claparède.—B. Living amongst weeds on the shore.

Echinoderes Worthingi, Zelinka.—Dredged amongst weeds in Elly Bay, 2 fms.

ANNELIDA.

(Identified by R. S.).

ARCHIANNELIDA.

Nerilla antennata, O. Schmidt.—C, D, E, F. In weeds from shore, and in sand of *Zostera* beds. Frequent. Dredged in 2 fms., Elly Bay.

POLYCHAETA.

(For Nomenclature and a fuller account see Southern : Clare Island Survey, Part 47. Polychaeta and Archiannelida. *Proc. Royal Irish Academy,* Vol. XXXI.)

Family *SYLLIDAE.*

Exogone gemmifera, Pagenstecher.—D, F. In *Laminaria* roots. Dredged in Elly Bay, in 1 fm.

Exogone hebes (Webster & Benedict) var. **Hibernica,** Southern.—C. A single specimen living in the sand of a *Zostera* bed.

Grubea pusilla (Dujardin).—B, D, F. In weeds from shore. Dredged in Elly Bay in 1 fm., in *Laminaria* roots. Comparatively rare.

Grubea clavata (Claparède).—A, B, C, D, F. Common in weeds from shore, in sand of *Zostera* beds, and in *Laminaria* roots. Dredged in Feorinyeeo Bay in 2–5 fms.; in Elly Bay in 1–2 fms.; and off Ardelly Pt. in 5 fms.

Sphaerosyllis hystrix, Claparède.—A, C, D. In weeds from shore, and in *Laminaria* roots. Dredged in Elly Bay in 1–2 fms.; off Ardelly Pt. in $4\frac{3}{4}$ fms.

Pionosyllis lamelligera, de St. Joseph.—A, B, D, E, F. Taken on nine occasions, always in *Laminaria* roots. Dredged in Elly Bay in 1 fm.

Pionosyllis serrata, Southern.—B. A single specimen was found on the shore.

Eusyllis tubifex (Gosse).—A, B, D, E, F. Extremely abundant in rock-pools, and in roots of *Laminaria.* Occurs high up on the littoral zone. Dredged in Feorinyeeo Bay on three occasions in 3–6 fms.; off Ardelly Pt. on two occasions in $4\frac{3}{4}$ fms.

Odontosyllis gibba, Claparède.—A, B, D, F. Common on shore, in weeds, and in *Laminaria* roots. Dredged on 6 occasions in all parts of the Bay.

Odontosyllis ctenostoma, Claparède.—A, B, C, D, E, F. Abundant on shore, under stones and in *Laminaria* roots. Found on 20 occasions. Dredged in Elly Bay in 1 fm.

Trypanosyllis zebra (Grube).—A, B, E, F. This species is most abundant on Barranagh. It was taken on the shore on 9 occasions, usually under stones.

Eurysyllis paradoxa (Claparède).—A, B, D, F. Taken on 4 occasions, in *Laminaria* roots.

Syllis (Typosyllis) prolifera, Krohn.—A, B, C, D, F. Common on shore, under stones and in *Laminaria* roots. Taken on 10 occasions. Dredged on 5 occasions, in Feorinyeeo Bay in 4–5 fms.; in Elly Bay in 1–2 fms.; off Ardelly Pt. in $4\frac{3}{4}$–8 fms.

Syllis (Typosyllis) hyalina, Grube.—Dredged off Ardelly Pt., in $5\frac{1}{2}$ fms. Rare.

Syllis (Typosyllis) armillaris (Müller).—A, B, C, D, E, F. Very abundant under stones on shore, and in *Laminaria* roots. Dredged in all parts of the Bay, on 6 occasions, in 1–6 fms.

Syllis (Typosyllis) Krohnii, Ehlers.—F. A single specimen only in weeds from Carrigeenmore.

Syllis (Haplosyllis) spongicola, Grube.—A, B, E, F. Common on shore in sponges, especially *Spongelia fragilis.*

Syllis (Syllis) gracilis, Grube.—A, B, C, D, F. Common on shore under stones.

Syllis (Ehlersia) ferrugina (Langerhans).—D. Single specimen in *Laminaria* roots from the north side of Feorinyeeo Bay.

Autolytus longeferiens, de Saint-Joseph.—D. Found on two occasions, in *Laminaria* roots.

Autolytus punctatus, de Saint-Joseph.—D. Found on one occasion, in *Laminaria* roots.

Autolytus pictus (Ehlers).—A, C, D. Common in *Laminaria* roots; occasionally under stones. Dredged in Elly Bay, 2 fms.; off Ardelly Pt., 6–8 fms.

Autolytus ehbiensis, de Saint-Joseph.—A, D. Common in *Laminaria* roots. Very abundant in dredged material from all parts of the Bay.

Autolytus Edwarsi, de Saint-Joseph.—B, D, E, F. Common under stones and in *Laminaria* roots. Dredged in Feorinyeeo Bay, 3–5 fms; in Elly Bay, 1–5 fms.

Autolytus brachycephala (Marenzeller).—Dredged once off Ardelly Pt., 6–8 fms.

Autolytides inermis (de Saint-Joseph).—D. In *Laminaria* roots from shore of Feorinyeeo Bay. Dredged off Feorinyeeo Bay, 4–6 fms.

Amblyosyllis lineata, Grube.—A, B, C, D, E, F. Common on shore under stones and in *Laminaria* roots. Dredged in Elly Bay, 1 fm.

Family *HESIONIDAE.*

Castalia punctata (Müller).—B, D, F, Under stones and in *Laminaria* roots. Dredged off Ardelly Pt., in $4\frac{3}{4}$–$5\frac{1}{2}$ fms.

Castalia fusca (Johnston).—A, B, C, D, E, F. Very common under stones on shore, and in *Laminaria* roots. Dredged off Feorinyeeo Bay, 4–6 fms.; off Ardelly Pt., $3\frac{1}{2}$–$4\frac{1}{2}$ fms.; Elly Bay, 1 fm.

Magalia perarmata, Marion and Bobretzky.—D. In *Laminaria* roots from north of Feorinyeeo Bay. Dredged in Elly Bay, 2 fms.; off Ardelly Pt., 5½ fms.

Ophiodromus flexuosus (D. Chiaje).—A single specimen dredged in 6–8 fms.

Microphthalmus Schzelkowi, Mecznikow.—D. Three specimens under a stone on the shore.

Family *APHRODITIDAE.*

Aphrodita aculeata, L.—Dredged on eight occasions in the deeper parts of the Bay, in 4–9 fms., usually on sand.

Lepidonotus squamatus (L.).—A, B, C, D, E, F. Very abundant on the shore under stones. Dredged in all parts of the Bay in 3½–8 fathoms.

Lepidonotus clava (Montagu).—A, B, C, D, E, F. Common under stones, in *Lithothamnion,* and in *Laminaria* roots. Not taken in the dredge.

Gattyana cirrosa (Pallas).—B, C. Two specimens found on the shore, one of them accompanying *Chaetopterus variopedatus* in its tube. Dredged off Ardelly Pt., in 4¾ fms.

Lagisca floccosa (Savigny).—A, B, C, D, E, F.—The commonest Polynoid in the Bay. Very abundunt under stones. Not taken in the dredge.

Lagisca Elizabethae, McIntosh.—A, B, C, D, E, F. Common under stones and in *Laminaria* roots. Dredged in Elly Bay, ½–3½ fms.; off Ardelly Pt., 3½–5½ fms.

Harmothoe imbricata (L.).—A, B, C, D, E, F. Very common under stones and in *Laminaria* roots. Frequently dredged in all parts of the Bay.

Harmothoe spinifera (Ehlers).—A, C, D, F. Fairly common under stones and in *Laminaria* roots.

Harmothoe lunulata (Delle Chiaje).—A, B, C, D. Lives in the clean sand, probably commensally with *Synapta inhaerens.*

Evarne impar (Johnston).—A, C. Rare between tide-marks, where it lives under stones. Frequently dredged in the deeper parts of the Bay, in 3–6 fms.

Scalisetosus communis (Delle Chiaje).—B. One specimen was found between tide-marks on the north side of Elly Bay, and a second was dredged off Ardelly Pt., in 4¾ fms.

Halosydna gelatinosa (M. Sars).—A, B, C, D, E, F. Widely spread but not common, under stones between tide-marks.

Polynoe scolopendrina, Savigny.—A, B, C, D. Usually found sharing the tubes of Terebellid worms. Dredged frequently in the deeper parts of the Bay, in 4–8 fms.

Sthenelais boa (Johnston).—A, B, C, D, E, F. Common on shore, in gravel and under stones, and in *Zostera* beds. Dredged in Feorinyeeo Bay, 3 fms.; off Ardelly Pt., 4¾ fms.

Sigalion Mathildae, Aud. and Edw.—A, B, C, D. Common in clean sand near low-water mark.

Pholoë minuta (Fabricius).—A, B, C, D, E, F. Common under stones and in *Laminaria* roots. Frequently dredged in all parts of the Bay, in 1–8 fms.

Pholoë tuberculata, Southern.—A, B, D, F. Rare, on the shore under stones.

Family *PHYLLODOCIDAE.*

Eulalia bilineata (Johnston).—A, B, D, E, F. Common under stones and in *Laminaria* roots. Dredged in all parts of the Bay in 1–8 fms.

Eulalia punctifera (Grube).—D. A single specimen was found under a stone on the north side of Feorinyeeo Bay.

Eulalia viridis (Müller).—A, B, C, D, E, F. Very abundant on shore, under stones and in *Laminaria* roots. Dredged in Elly Bay in 1 fm.

Eulalia tripunctata, McIntosh.—A. Very rare. Single specimen in *Laminaria* roots from Barranagh. Single specimen dredged in Elly Bay in 1 fm.

Eulalia pusilla, Oersted.—F. In *Laminaria* roots from Carrigeenmore. Dredged in Elly Bay in 1 fm.

Eumida sanguinea (Oersted).—A, B, C, D, E, F. Very abundant on shore, under stones, in *Lithothamnion*, and especially in *Laminaria* roots. Dredged very frequently in all parts of the Bay, in 1–8 fms.

Paranaitis Jeffreysi, McIntosh.—Three specimens dredged in Feorinyeeo Bay, in 2–3 fms. Rare.

Phyllodoce lamelligera (Gmelin).—A, B, C, D, E, F. Common under stones on the shore.

Phyllodoce Paretti (Blainville).—A, B, C, D, E, F. Common under stones on the shore.

Phyllodoce greenlandica, Oersted.—B. Single specimen in sand on the north side of Elly Bay.

Phyllodoce maculata (L.).—A, B, C, D, E, F. Very common on shore under stones, in sand, and in *Laminaria* roots. Dredged in all parts of the Bay, in 1–8 fms.

Phyllodoce rubiginosa, de St. Joseph.—A, B, D. Fairly common under stones on the shore. Dredged in Elly Bay in 1 fm.; off Ardelly Pt., 6–8 fms.

Eteone picta, Quatr.—A, D. Not common. Under stones and in weeds. Dredged in Elly Bay in 1 fm; off Ardelly Pt., 6–8 fms.

Eteone arctica, Malmgren.—Dredged off Carrigeenmore in 3 fms.

Eteone pusilla, Oersted.—A, C, D. Occasionally obtained by digging in clean sand. Dredged off Carrigeenmore in 3 and 8 fms.

Eteone depressa, Malmgren.—D. A single specimen found in sand on the north side of Feorinyeeo Bay.

Mysta barbata, Malmgren.—Dredged in Feorinyeeo Bay, 3 fms. Only a single specimen obtained.

Family *NEREIDAE.*

Nereis pelagica, L.—A, B, C, D, E, F. Very abundant on the shore, in weeds, under stones, and in the sand of *Zostera* beds. Dredged in Elly Bay in 1 fm.

Nereis cultrifera, Grube.—A, B, C, D, E, F. Very common on the shore, under stones. It is one of the most characteristic inhabitants of the sand of *Zostera* beds. Dredged in Elly Bay, in $\frac{1}{2}$–$3\frac{1}{2}$ fms.

Nereis Dumerilii, Aud. and Edw.—A, B, C, D, E. Common on shore, in weeds, under stones, and especially in *Laminaria* roots. One of the most abundant species taken in the dredge, in all parts of the Bay, in 1–9 fms.

Nereis diversicolor, Müller.—D. Very rare. Only two specimens taken, on the north shore of Feorinyeeo Bay.

Nereis longissima, Johnston.—B. A single specimen living in sand on the north shore of Elly Bay.

Nereis fucata (Savigny).—Accompanies *Eupagurus bernhardus* in the shells of *Buccinum,* in 3–9 fms.

Family *NEPHTHYDIDAE.*

Nephthys caeca (Müller).—A, B, C, D, E, F. Widespread but not abundant, under stones, in sand, and in the sand of *Zostera* beds. Dredged in Elly Bay, 2 fms. The variety *ciliata* was also found in sand.

Nephthys Hombergi, Lamarck.—A, B, C, D, E. Common under stones, in sand, and in the sand of *Zostera* beds. Dredged in all parts of the Bay in 2–9 fms.

Nephthys ciliata (Müller).—B, D, E. Always found in sand. Not common. Dredged in Elly Bay, 4 fms.

Nephthys hystricis, McIntosh.—D. A single specimen in sand between tide-marks on the north side of Feorinyeeo Bay.

Nephthys cirrosa, Ehlers.—A, B, C, D, F. Common under stones, in sand, and in the sand of *Zostera* beds.

Family *EUNICIDAE.*

Staurocephalus rubrovittatus, Grube.—A, B, D, E, F. Common under stones on shore. Dredged in Elly Bay, 1 fm.

Staurocephalus Kefersteini, McIntosh.—D, F. Very rare, only two specimens being obtained, under stones and in weeds on the shore.

Ophryotrocha puerilis, Clap. and Meczn.—A, F. Usually found in *Laminaria* roots. Dredged in Elly Bay, 1–2 fms; off Ardelly Pt., 6–8 fms.

Lumbriconereis Latreillii, Aud. and Edw.—A, B, D, F. Not uncommmon under stones on the shore.

Arabella iricolor (Montagu).—A, B, D, E, F. Frequent under stones, in crevices of the schist, and in the sand of *Zostera* beds.

Marphysa fallax, Marion and Bobretzky.—A. Very rare. This, the only British specimen, was found under a stone on Barranagh shore.

Lysidice punctata (Risso).—A, B, C, D, E. Common under stones on the shore, from mid tide-mark downwards. Frequent in crevices of the schist, and in *Laminaria* roots. Occasionally in the sand of *Zostera* beds.

Family *GLYCERIDAE.*

Glycera siphonostoma (Delle Chiaje).—F. Only a few specimens in sand on the shore of Carrigeenmore.

Glycera alba, Blainville.—A, B, C, D, E, F. Common in sand, under stones, and in the sand of *Zostera* beds.

Family *SPHAERODORIDAE.*

Ephesia gracilis, Rathke.—A. Rare on the shore. Dredged frequently in all parts of the Bay, in 1–9 fms.

Ephesia peripatus (Claparède).—F. Found twice on the shore. Dredged in Elly Bay, 2 fms.

Sphaerodorum minutum (Webster & Benedict).—A. A single specimen found in *Laminaria* roots from Barranagh.

Sphaerodorum Claparedii, Greeff.—A. Found once on the shore of Barranagh. Dredged in Feorinyeeo Bay, 3 fms; in Elly Bay, 1 fm.

Family *ARICIIDAE.*

Aricia Latreillii, Aud. and Edw.—B, C, D. Occasionally found by digging in clean sand in Elly Bay and Feorinyeeo Bay.

Scoloplos armiger (Müller).—A, B, C, D, E, F. Common in clean sand, and in the sand of *Zostera* beds. Dredged in Elly Bay, in 2 fms.

Family *TOMOPTERIDAE.*

Tomopteris helgolandica, Greeff.—Small specimens taken in the townet.

Family *SPIONIDAE.*

Scolecolepis vulgaris (Johnston).—B, C, D, E, F. Not abundant, but sparingly distributed over the whole area. In sand between tide-marks.

Scolecolepis fuliginosa (Claparède).—D, F. In Feorinyeeo Bay and on Carrigeenmore, this species occurs in vast numbers in clean sand.

Spio martinensis, Mesnil.—A, F. Rare, two specimens under stones.

Spio seticornis, Fabricius.—A, B, F. Rare, in *Laminaria* roots. Dredged in Elly Bay 1 fm.; in Feorinyeeo Bay 2–3 fms.; off Feorinyeeo Bay 4–6 fms.

Nerine foliosa (Aud. and Edw.).—A, B, C. Not uncommon in clean sand from mid-tide mark down to low-water mark.

Nerine cirratulus (Delle Chiaje).—B, D. In clean sand, and in sand of exposed *Zostera* bed. Occurs in vast numbers in Feorinyeeo Bay in a narrow belt just below high-water mark.

Nerinides longirostris (de St. Joseph).—C, D, F. Rare, in sand.

Nerinides tridentata, Southern.—A, D, F. Found on five occasions, always in *Laminaria* roots.

Aonides oxycephala (Sars.).—A, B, C, D, E, F. Common and widely distributed. Lives in muddy sand under stones, occasionally in *Laminaria* roots.

Polydora ciliata (Johnston).—B, D, E, F. This species was found boring into shells, in sponges, in *Lithothamnion*, and in the roots of corallines. Dredged in Elly Bay, 2–4 fms.; off Ardelly Pt., $3\frac{1}{2}$–$4\frac{1}{2}$ fms.

Polydora hoplura, Claparède.—C. Found on one occasion, living in *Halichondria panicea* in large numbers.

Polydora quadrilobata, Jacobi.—C. A single specimen in the sand of a *Zostera* bed on the south shore of Elly Bay.

Polydora flava, Claparède.—D, F. In *Lithothmnion*, and between the layers of schist. Dredged off Ardelly Pt., $3\frac{1}{2}$–$5\frac{1}{2}$ fms.

Polydora caeca (Oersted).—A, B, C, D, E, F. Common in *Laminaria* roots. Tunnelling between Ascidians and the stones to which they are attached. Dredged in Elly Bay, 1 fm.; off Ardelly Pt., $4\frac{3}{4}$–8 fms.

Polydora Giardi, Mesnil.—B, D, F. Under stones and in *Laminaria* roots. Rare.

Spiophanes bombyx (Claparède).—A, D. Two specimens in sand near low-water mark.

Prionospio Steenstrupi, Malmgren.—Dredged in Feorinyeeo Bay in 3 fms.; Elly Bay, 2 fms. Rare.

Magelona papillicornis, Fr. Müller.—B, D. Not uncommon in clean sand near low-water mark.

Family *DISOMIDAE.*

Poecilochaetus serpens, Allen.—Two specimens of the larval form were taken in the bottom townet, in 9 fms.

Family *CHAETOPTERIDAE.*

Chaetopterus variopedatus (Renier).—A, B, C. Three specimens found in sand and muddy gravel near low-water mark. Empty tubes dredged in all parts of the Bay, in 1–9 fms.

Family *AMMOCHARIDAE.*

Owenia fusiformis (Delle Chiaje).—B, C, D. Frequent in clean sand near low-water mark. Tubes dredged in 9 fms.

Family *CIRRATULIDAE.*

Macrochaeta clavicornis (Sars).—A, B. In *Laminaria* roots, and in weeds from mid-tide mark. Taken in surface townet in Elly Bay. Dredged in Feorinyeeo Bay, in 3–5 fms.; in Elly Bay, in 1–2 fms.

Dodecaceria concharum, Oersted.—A, B, C, D, E, F. Common in the roots of corallines, in *Lithothamnion*, in certain sponges, and between the layers of schist. Dredged off Ardelly Pt., in $3\frac{1}{2}$–$4\frac{1}{2}$ fms.

Chaetozone viridis (Langerhans).—A, B, D, F. Common in *Laminaria* roots. Dredged in Elly Bay, in 1 fm.

Chaetozone zetlandica, McIntosh.—B, D. Rare. Two specimens found in clean sand.

Chaetozone setosa, Malmgren.—Single specimen taken in the surface townet at night, in Elly Bay.

Chaetozone alata, Southern.—A single specimen found in *Laminaria* roots on Carrigeenmore.

Cirratulus tentaculatus (Montagu).—A, B, C, D, F. Common in sand under stones. Frequently occurs in vast numbers in the sand of *Zostera* beds, where it is one of the dominant species.

Cirratulus cirratus (Müller).—B, D, F. Under stones on shore, in rather muddy places. Young specimen dredged in $4\frac{3}{4}$ fms.

Family *TEREBELLIDAE.*

Amphitrite Johnstoni, Malmgren.—B, C. Not common. Forms tubes under stones, and in the sand of *Zostera* beds.

Amphitrite gracilis (Grube).—A, B, C, D, E, F. This is one of the most abundant species in the Bay. The tubes are attached to the under-side of stones, and in crevices of the schist.

Lanice conchilega (Pallas).—A, B, C, D, E. This species lives with its tube deeply buried in sand, only the upper end projecting. It is found in clean sand, in mud, gravel, and in the sand of *Zostera* beds. The empty tubes were dredged in all parts of the Bay, in 1–9 fms.

Nicolea venustula (Montagu).—A, B, D. Under stones on the shore, and in *Laminaria* roots. Dredged off Carrigeenmore in 3 fms; off Ardelly Pt., 4–6 fms.

Polymnia nebulosa (Montagu).—A, B, C, D, E. Very common under stones, especially those lying in rock-pools. Common in gravel, and in the sand of *Zostera* beds. Dredged in Feorinyeeo Bay, 3 fms.; off Ardelly Pt., 2–6 fms.

Polymnia nesidensis (Delle Chiaje).—B, C, D. Common under stones and in the sand of *Zostera* beds. Dredged in all parts of the Bay in 1–8 fms.

Thelepus cincinnatus (Fabricius).—B, D. Rare. Only two specimens found, under stones.

Thelepus setosus (Quatrefages).—A, B, C, D, F. Common on the shore, under stones, in *Laminaria* roots, and in the sand of *Zostera* beds.

Scione maculata (Dalyell).—E. Rare. One specimen under stone on shore. Dredged off Ardelly Pt. in $4\frac{3}{4}$–$5\frac{1}{2}$ fms. Tubes attached to Zoophytes.

Polycirrus Smitti (Malmgren).—B, D. In clean sand and sandy gravel. Not common.

Polycirrus caliendrum, Claparède.—B, D. In sand of a *Zostera* bed and in *Laminaria* roots.

Polycirrus haematodes (Claparède).—A, F. Rare. In roots of *Laminaria.*

Polycirrus denticulatus, de Saint-Joseph.—D. Found on one occasion in *Laminaria* roots.

Terebellides Stroemi, Sars.—C. Rare on shore. One specimen in sand of *Zostera* bed. Dredged in Feorinyeeo Bay, 3 fms.; in Elly Bay, $\frac{1}{2}$–$4\frac{1}{2}$ fms.

Family *AMPHARETIDAE.*

Ampharete Grubei, Malmgren.—Dredged in Feorinyeeo Bay, 3–5 fms.; Elly Bay, 2 fms.; off Ardelly Pt., $4\frac{1}{2}$–$5\frac{1}{2}$ fms.; off Carrigeenmore, 3 fms. Generally taken on sand.

Family *AMPHICTENIDAE.*

Pectinaria auricoma (Müller).—B, C. Common in sandy gravel, and rarely in the sand of *Zostera* beds. Empty tube dredged in 7–8 fms.

Lagis Koreni, Malmgren.—A, B, C, D, F. Common in sand, more rarely under stones. Dredged off Ardelly Pt., in 6–8 fms.

Family *CAPITELLIDAE.*

Capitella capitata (Fabricius).—D. Rare. Found on one occasion in muddy sand. Dredged in Elly Bay, 1 fm.

Notomastus latericeus, Sars.—A, B, C, D, F. Very common in sand and under stones. One of the dominant species in the sand of *Zostera* beds.

Family *OPHELIIDAE.*

Ophelia limacina (Rathke).—A, B, C. Rare. Lives in clean sand near low-water mark.

Travisia Forbesi, Johnston.—A, B, C. Very abundant in the patches of clean sand in Elly Bay and Feorinyeeo Bay.

Polyophthalmus pictus (Dujardin).—A, B, D, E, F. Common in weeds from rock-pools, from mid-tide mark downwards; in *Laminaria* roots, and in *Zostera*. Dredged in all parts of the Bay where weeds occur, in 1–8 fms.

Family *MALDANIDAE.*

Nicomache maculata, Arwidsson.—D. Rare. Eleven individuals were found in muddy sand between stones on the north side of Feorinyeeo Bay.

Caesicirrus neglectus, Arwidsson.—A, B, C. This species is extremely abundant in the clean sandy patches of Elly Bay and Barranagh. The fine sandy tubes project in vast numbers from the sand near low-water mark. It was not found in Feorinyeeo Bay. Dredged in Elly Bay, 4 fms.; off Ardelly Pt., 5½ fms., on sand.

Petaloproctus terricola, Quatrefages.—A, C. Very rare. Two specimens were obtained under stones.

Family *ARENICOLIDAE.*

Arenicola marina (L.).—A, B, C, D, E, F. Universally distributed in clean sand. A post-larval specimen was taken at night in the surface townet, in March. More advanced stages were found in September, in *Laminaria* roots.

Arenicola ecaudata, Johnston.—C, D, F. In gravel and sand under stones. Post-larval stages common in *Laminaria* roots in September, young specimens in March.

Arenicola branchialis, Aud. and Edw.—A, B, C, D, F. Common in gravel, and coarse sand under stones. Not found in clean sand, but common in the sand of *Zostera* beds. Post-larval stages rare, in *Laminaria* roots in September. Young specimens with gills found in March and September.

Family *SCALIBREGMIDAE.*

Scalibregma inflatum, Rathke.—A, D. Rare on the shore, in coarse shelly sand, between flakes of schist, and in the sand of *Zostera* beds.

Sclerocheilus minutus, Grube.—A, C, D, F. Rare, under stones on the shore. Dredged in 1 fm., Elly Bay.

Asclerocheilus intermedius (de Saint-Joseph).—F. Rare, in *Laminaria* roots from Carrigeenmore. Dredged in 1 fm., Elly Bay, in *Laminaria* roots.

Family *CHLORHAEMIDAE.*

Stylarioides plumosa (Müller).—A, B, C, D, E, F. Common on the shore, in muddy sand, between layers of schist, in sand of *Zostera* beds, etc. Dredged in Elly Bay, 1–3½ fms.; off Ardelly Pt., 3½–5 fms.

Flabelligera affinis, Sars.—A, B, C, D, E, F. Very common under stones on the shore, and occasionally in *Laminaria* roots. Dredged in 1 fm., Elly Bay; off the mouth of Feorinyeeo Bay, 4–6 fms.

Family *SABELLIDAE.*

Sabella pavonina (Savigny).—A, B, C. In muddy gravel and in the sand of *Zostera* beds. Empty tubes dredged in 9 fms.

Branchiomma vesiculosum (Montagu).—In muddy gravel and in the sand of *Zostera* beds.

Dasychone bombyx (Dalyell).—A, B, C. Under stones on the shore, in *Laminaria* roots, in sand of *Zostera* beds. Dredged in Feorinyeeo Bay, 2–3 fms.; off Ardelly Pt., 4–8 fms.; Elly Bay, 1 fm.

Potamilla reniformis (Müller).—Rare. Dredged off Ardelly Pt., in $4\frac{3}{4}$ fms.

Potamilla Torelli, Malmgren.—A, B, F. Under stones on the shore, in *Laminaria* roots, and in *Lithothamnion.* Dredged in Elly Bay, 1 fm.; off Ardelly Pt., $4\frac{1}{2}$–$5\frac{1}{2}$ fms.

Jasmineira elegans, de Saint-Joseph.—D, F. In *Laminaria* roots. Dredged in Elly Bay, 1 fm.; off Ardelly Pt., $4\frac{1}{2}$–6 fms.

Oria Armandi (Claparède).—F. In *Laminaria* roots. Dredged in Elly Bay, 1 fm.

Fabricia sabella (Ehrenberg).—A, B, C, D, E, F. Common in weeds from the rocks, and in *Laminaria* roots.

Family *SERPULIDAE.*

Serpula vermicularis, L.—B, D, F. Under stones on the shore.

Pomatoceros triqueter (L.)—A, B, C, D, E, F. Extremely common on the rocks, and on shells. Dredged on stones and shells in all parts of the Bay.

Hydroides norvegica (Gunn.).—Dredged on stones and shells, off Ardelly Pt., $3\frac{1}{2}$–$5\frac{1}{2}$ fms.

Spirorbis Spirorbis (L).—A, B, C, D, E, F. Very abundant on the shore on stones, shells, and weeds. Dredged in Elly Bay, 2 fms.

Spirorbis pusilloides, Bush.—D. Under stones on the shore.

Spirorbis medius, Pixell.—D. In large masses under stones on the shore.

Family *HERMELLIDAE.*

Sabellaria spinulosa, Leuckart.—A, B, C, D, E, F. Common on the shore, under stones, and boring into sponges. Dredged in Elly Bay, 2 fms.; off Ardelly Pt., $3\frac{1}{2}$–6 fms.

OLIGOCHAETA.

(For a more complete account of the following species see Southern, R., Clare Island Survey, Part 48, *Proc. Roy. Irish Acad.*, XXXI.).

Clitellio arenarius (Müller).—C. D. Common under stones between tide-marks.

Tubifex Benedeni (Udekem).—A, B, C, F. Very common between tide-marks, especially in muddy places.

Marionina semifusca (Claparède).—F. Probably common throughout the area.

Lumbricillus verrucosus (Claparède).—D. Probably common throughout the area.

Grania maricola, Southern.—C. A single immature specimen in the sand of a *Zostera* bed.

HIRUDINEA.

(For a more complete account see Southern, R., Clare Island Survey, Part 50, *Proc. Roy. Irish Acad.*, XXXI.).

Branchellion torpedinis, Savigny.—A single specimen of this rare leech was found by E. W. L. Holt, attached to the upper surface of the pelvic fin of a Thorn-back (*Raia clavata*, L.).

? **Platybdella sexoculata,** Malm.—D. One large specimen attached to the tail of *Cottus bubalis*, two smaller ones to stones.

GEPHYREA.

(For a more complete account see Southern, R., Clare Island Survey, Part 49, *Proc. Roy. Irish Acad.*, XXXI.).

Physcosoma granulatum (Leuckart).—A, B, C, D, E, F. Very common between tide-marks, living under stones and in crevices of the schist.

Phascolosoma vulgare, Blainville.—A, B, C, D. Common under stones, between flakes of schist, in the sand of *Zostera* beds, and in coarse gravel.

Phascolosoma elongatum, Keferstein.—A, B, D, F. One of the most characteristic species living in the sand of *Zostera* beds. Also in sand under stones, and in gravel.

Phascolosoma Johnstoni (Forbes).=*Petalostoma minutum*, Kef. —A, B, C, D, F. Common under stones and in *Laminaria* roots. Dredged in Elly Bay, 1 fm.

Phascolion strombi (Montagu). Dredged commonly in all parts of the Bay, in 2–9 fms.

Thalassema Neptuni, Gaertner.—A, B. Rare, only two specimens found, between flakes of schist.

CHAETOGNATHA.

Spadella cephaloptera (Busch).—Taken in the surface townet, Elly Bay.

POLYZOA.

(Identified by A. R. Nicholls).

Pedicellina cernua, Pallas.—A, C, D.
Loxosoma phascolosomatum, Vogt.—A. On *Phascolosoma vulgare*.
Loxosoma singulare, Kefers.—Off Ardelly Pt., 4¾ fms., on *Trophonia plumosa*.
Crisia eburnea, L.—D, E, F.
Diastopora patina, Link.—Off Ardelly Pt., 4¾ fms.
Eucratea chelata, L.—C.
Scrupocellaria reptans, L.—C, D, E, F.
Membranipora membranacea, L.—F. Plentiful everywhere on *Laminaria* fronds.
Electra pilosa, L. (*Membranipora*).—A, C, D, F. Plentiful everywhere on *Laminaria*.
Callopora lineata, L. (*Membranipora*).—B.
Callopora Dumerilii, Aud. (*Membranipora*).—Off Ardelly Pt., 4¾ fms., on Pecten.
Hippothoa hyalina, L. (*Schizoporella*).—D.
Escharella immersa, Flem.—D.
Escharoides coccinea, Abild. (*Mucronella*).—D, E, F.
Schizoporella unicornis, Johns.—A, C, D.
Escharina spinifera, Johns. (*Schizoporella*).—B. On *Anomia*.
Fenestrulina Malusii, Aud. (*Microporella*).—Off Ardelly Pt., 4¾ fms., on *Pecten*.
Smittina linearis, Hass. (*Schizoporella*).—B, E.
Smittina pallasiana, Moll.—A.
Cellepora pumicosa, L.—D.
Cellepora Costazii, Aud.—D.
Alcyonidium hirsutum, Flem.—C.
Alcyonidium mytili, Dal.—C.
Flustrella hispida, Fabr.—A, C, D. Common.
Bowerbankia imbricata, Adams.—Off Feorinyeeo Bay, 4–6 fms.

ARTHROPODA.

BRANCHIOPODA.

(Identified by G. P. F.)

Evadne Nordmanni, Loven.—In townettings, moderately common.
Podon intermedius, Lillj.—In townettings, scarce.

COPEPODA.

(Identified by G. P. F.).

Calanus helgolandicus (Cls.).—In townettings, frequent.
Paracalanus parvus (Cls.).—In townettings, moderately common.
Pseudocalanus elongatus (Boeck).—In townettings, common.

Centropages typicus, Kröyer.—In townettings, frequent but not plentiful.
Centropages hamatus (Lillj.).—In townettings, abundant.
Isias clavipes, Boeck.—In townettings, common.
Temora longicornis (Müll).—In townettings, common.
Parapontella brevicornis (Lubb.)—In townettings, common.
Acartia Clausi, Giesbr.—In townettings, abundant.
Lichomolgus forficula, Thorell.—In *Phallusia mentula.*
Longipedia Scotti, G. O. Sars.—Feorinyeeo Bay, 2–4 fms., few.
Longipedia minor, Scott.—C, E. Few between tide-marks. Common in 2–4 fms.
Sunaristes paguri, Hesse.—A. From weeds between tide-marks, one.
Canuella perplexa, Scott.—Feorinyeeo Bay, 2–4 fms., one.
Ectinosoma melaniceps, Boeck.—A, C, E, F. Frequent. Elly Bay, 2 fms., one.
Harpacticus littoralis, G. O. Sars.—A. Common. Common in L. Leam.
Harpacticus uniremis, Kröyer.—C. Few.
Harpacticus gracilis (Claus).—E. Common.
Harpacticus flexus, Br. and Rob.—Feorinyeeo Bay, 2–4 fms., one.
Zaus spinatus, Goodsir.—A, D, F. Common.
Zaus abbreviatus, G. O. Sars.—F. One.
Parategastes sphericus (Claus).—C. Few. Several dredged in 2 fms.
Tegastes nanus, G. O. Sars.—Feorinyeeo Bay, 2–4 fms., one.
Porcellidium fimbriatum, Claus.—C, D. Few.
Porcellidium lecanoides, Claus.—E, F. Few, between tide-marks.
Aspidiscus fasciatus, Norman.—A, C, D. Common.
Psamathe longicauda, Philippi.—D. One.
Idya furcata (Baird).—A, D, F. Common.
Idya angusta, G. O. Sars.—Elly Bay, 2–3 fms., few.
Idya tenera, G. O. Sars.—E. Few.
Thalestris longimana, Claus.—A, D. Scarce between tide-marks, frequent in townettings at night.
Parathalestris harpactoides (Claus).—A, D, E. Common.
P. hibernica (Br. & Rob.).—Elly Bay. Surface townet.
Phyllothalestris mysis (Claus).—C. Common. Frequent in townettings and dredgings, 2–3 fms.
Rhynchothalestris rufocincta (Norman).—A, B, C, E. Common. Frequent in dredgings and townettings, 2–4 fms.
Rhynchothalestris helgolandica (Claus).—C. Few. Elly Bay, 2 fms., several.
Microthalestris littoralis, G. O. Sars.—A, E, F. Frequent. Elly Bay. 2 fms., common.
Dactylopusia thisboides (Claus).—C, E. Few. L. Leam, few.
D. vulgaris, G. O. Sars.—Elly Bay, 2 fms., one.
Dactylopodella flava (Claus).—C. Few. Elly Bay, 2 fms., one. L. Leam, two.

Westwoodia nobilis (Baird).—E. Few. Common in dredgings, 2–3 fms.
W. minuta, Claus. —C. Several. Elly Bay, 2 fms., common.
W. pygmaea (Scott).—C. Two. Elly Bay, 2 fms., common.
W. Andrewi (Scott).—E. One.
Diosaccus tenuicornis (Claus).—C. Several. Elly Bay, in townets, common
Amphiascus varicolor, Farran.—D. Common. Common in townettings, 0–3 fms.
A. cinctus (Claus).—A, B, C, E. Common. Common in townettings, 2–3 fms.
A. obscurus, G. O. Sars.—A, E. Few.
A. similis, Claus.—B. Common. In dredgings and townettings, 0–3 fms.
A. phyllopus, G. O. Sars.—Feorinyeeo Bay, 2–3 fms., one.
A. propinquus, G. O. Sars.—E. One.
Mesochra pygmaea, Claus.—C. One.
Ameira minuta, Boeck.—F. Two.
Ameiropsis longicornis, G. O. Sars.—Elly Bay, 2 fms., one.
Laophonte cornuta, Phil.—B, C, E, F. Common. Feorinyeeo Bay, 2–3 fms., common.
L. similis (Claus).—F. Common.
L. Strömi (Baird).—A, E. Few.
L. serrata (Claus).—E, F. Few.
L. brevirostris (Claus).—C. Common.
L. bulligera, Farran.—C. One. Elly Bay, 2 fms., several.
L. bulbifera, Norman.—Feorinyeeo Bay, 2–3 fms., one.
Laophontodes bicornis (A. Scott).—C. One. Frequent in dredgings, 2–3 fms.
Eurycletodes similis (Scott).—Elly Bay, 2 fms., one.
Enhydrosoma propinquum (B. & Rob.).—Feorinyeeo Bay, 2–4 fms., one.
Tachidius brevicornis, Lillj.—L. Leam, one.
Metis ignea, Phil.—B, D, E. Several.
Cyclopina longicornis, Boeck.—Elly Bay, 3 fms., in townet, few.
Oithona similis, Giesbr.—Common in townettings.
Ascidicola rosea, Thorell.—Elly Bay, 2 fms., one in *Pyura sp.*
Notodelphys Allmanni, Thorell.—A. In *Phallusia mentula*, one.
Notopterophorus elongatus, Buchholz.—A, E. In *Phallusia mentula*, several.

CIRRIPEDIA.

(Identified by G. P. F.).

Verruca stromia, Müll.—All round the shores, on rocks and stones at extreme L.W.M.
Balanus balanoides, Linn.—Covering rocks and stones from high- to low-water mark.
Balanus porcatus, da Costa.—Off Ardelly Pt., 4¾ fms., several on *Mytilus modiolus.*
Peltogaster sp.—Off Ardelly Pt., 4¾ fms., on *Eupagurus cuanensis.*

NEBALIACEA.

Nebalia bipes (Fabr.)—A, C, D, F. Under stones on muddy ground, scarce.

CUMACEA.

(Identified by W. M. Tattersall.)

Bodotria pulchella (G. O. Sars).—Twice taken.
Cumopsis Goodsiri (Van Ben.).—Feorinyeeo Bay, four.
Iphinoe trispinosa (Goodsir).—2–9 fms., common.
Vauntompsonia cristata, Bate.—Elly Bay, 1–4 fms., three.
Eudorella truncata (Bate).—5 fms., two.
Nannastacus unguiculatus (Bate).—One specimen.
Pseudocuma longicornis (Bate).—Common.
Diastylis rugosa, G. O. Sars.—One specimen.
Dyastilis rostrata (Goodsir).—3–9 fms., common.
Dyastilis spinosa, Norman.—9 fms., two.

MYSIDACEA.

(Identified by W. M. Tattersall.)

Siriella armata (M. Ed.).—E, F. Few. Common in dredgings amongst weeds, 1–7 fms.
Siriella Clausi, G. O. Sars.—E. One in rock pool. Dredged in 7 fms.
Siriella jaltensis, Czer.—A, B, E, F. Few.
Mysidopsis gibbosa, G. O. Sars.—Elly Bay, 4 fms., one.
Hemimysis lamornae (Couch).—Off Blacksod Lt., 7 fms., two.
Macromysis flexuosa (Müll).—A, B, F. Very common. Dredged in 1–5 fms., Common in L. Leam.
Macromysis inermis (Rathke).—F. Abundant in weeds just below L.W.M.
Schistomysis ornata (G. O. Sars).—Feorinyeeo Bay, 5 fms., one. Common off Blacksod Lt., 7 fms.
Schistomysis arenosa (G. O. Sars).—F. Common on sand just below L.W.M.
Neomysis integer (Leach).—L. Leam, abundant.

TANAIDACEA.

(Identified by W. M. Tattersall.)

Tanais Cavolini, M. Ed.—B, D. Three. Off Ardelly Pt., 2 fms., two.
Paratanais Batei, G. O. Sars.—F. Two.

ISOPODA.

(Identified by W. M. Tattersall.)

Gnathia oxyuraea (Lilj.).—Off Ardelly Pt., 1 fm., two. Elly Bay, 4 fms., one.

Eurydice pulchra, Leach.—C. One from sand at L.W.M. Surface townet, Elly Bay, two.

Sphaeroma serratum (Fabr.).—B. Two.

Dynamene bidentata (Mont.).—A, B, C, D, E, F. Common under stones near L.W.M.

Idotea baltica (Pallas).—B, C, D, F. Common on *Laminaria.* Dredged in 2–3 fms., two. L. Leam, one.

Idotea granulosa, Rathke.—B, F. Four.

Idotea neglecta, G. O. Sars.—F. One.

Idotea linearis (Penn.).—Off Blacksod Lt., 8–9 fms., few.

Janira maculosa, Leach.—F. Numerous.

Jaera marina (Fabr.).—B, C, D, E. Common between tide-marks.

Jaera Nordmanni (Rathke).—C, D. Not so common as *J. marina.* Probably often overlooked.

Pleurocrypta galatheae, Hesse.—D. Two on *Galathea squamifera.*

Pseudione sp.—Two on *Porcellana longicornis* from off Ardelly Pt., 4–6 fms.

AMPHIPODA.

(Identified by W. M. Tattersall.)

Nannonyx Goesii (Boeck).—B. One. Elly Bay, 2 fms., one.

Lysianassa ceratinus (Walker).—B, C, D, E, F. In small numbers. Commoner in dredged material, Elly Bay, 2–5 fms.

Ferrierella audouiniana (Bate).—Off Ardelly Pt., $4\frac{3}{4}$ fms., two.

Orchomene Batei, G. O. Sars.—C. One between tide-marks. Off Ardelly Pt., 5–8 fms., plentiful.

Tryphosa Sarsi (Bonnier).—Off Ardelly Pt., 2–5 fms., two.

Tmetonyx cicada (Fabricius).—Feorinyeeo Bay, 3–5 fms., one.

Ampelisca brevicornis (A. Costa).—A, B, C, D. Common in sand at L.W.M. Dredged off Ardelly Pt., $4\frac{3}{4}$ fms.

Ampelisca spinipes (Boeck.).—Off Blacksod Lt., 7–9 fms., many.

Ampelisca diadema (A. Costa).—Feorinyeeo Bay, 3–5 fms., two. Off Carrigeenmore, 8–9 fms., one.

Ampelisca typica (Bate).—Dredged three times, 3–8 fms.

Ampelisca tenuicornis Liljeborg.—C. Two at L.W.M. Dredged a few times, 3–9 fms.

Bathyporeia guilliamsoniana (Bate).—A, B, C, D, E. Common in sand at low water.

Urothoe marina (Bate).—C, D. In sand at L.W.M., few. Off Ardelly Pt., 5 fms., one.
Urothoe brevicornis, Bate.—A, C. Common in sand at L.W.M. in Elly Bay.
Urothoe elegans, Bate.—Two in surface townet, Elly Bay.
Stenothoe monoculoides (Montagu).—Feorinyeeo Bay, 1 fm., one. Off Carrigeenmore, 1 fm., one.
Perioculodes longimanus (Bate and Westwood).—E. Six. Twice in townets, surface and 1 fm.
Pontocrates arenarius (Bate).—One in fine sand, 6–7 fms.
Calliopius Rathkei (Zaddach).—D. One.
Apherusa cirrus (Bate).—A, B, C, F. Common in March, '11.
Apherusa bispinosa (Bate).—A, B, C. Common.
Apherusa Jurinei (M. Ed.).—A, D, F. Taken four times.
Neopleustes monocuspis (G. O. Sars).—B. One.
Nototropis Swammerdamei (M. Ed.).—B,C. Twice on shore, twice dredged, 3–5 fms.
Gammarellus homari (Fabr.).—A, B, C, D, F. Frequent.
Cheirocratus Sundevalli (Rathke).—C, D. Seven. Off Ardelly Pt., 4¾ fms., eight.
Melita palmata (Mont.).—C, E, F. Ten. L. Leam, one.
Melita obtusata (Mont.).—3–8 fms., six.
Maera tenuimana (Bate).—Feorinyeeo Bay, 3–5 fms., two.
Gammarus marinus, Leach.—B, C, D, E. Common.
Gammarus Duebeni, Liljeb.—C. Several.
Gammarus locusta, Linn.—B, C, D, F. Common. Abundant in L. Leam.
Dexamine spinosa (Mont.).—A, B, C, D, E, F. Common. One in L. Leam. Three times dredged, 2–3 fms.
Dexamine thea (Boeck).—B. Four.
Tritaeta gibbosa (Bate).—B. Two.
Guernea coalita (Norman).—Surface townet, Elly Bay, three.
Orchestia gammarellus (Pallas).—C. One record. Probably overlooked elsewhere.
Hyale Prevosti (M. Ed.).—B, E, F. Seven.
Microdeutopus anomalus (Rathke).—B, C, E. Eleven. Twice dredged in 2 fms.
Microdeutopus damnoniensis (Bate).—B, C. Twenty. Elly Bay, 2 fms., six.
Coremapus versiculatus (Bate).—1–5 fms., fifteen.
Lembos Websteri (Bate).—C, D, E, F. Eleven. Off Carrigeenmore, 3 fms., two.
Microprotopus maculatus, Norman.—Surface townet, Elly Bay, one.
Photis longicaudata (Bate and Westwood).—Off Blacksod Lt., 7–9 fms., six.
Eurystheus maculatus (Johnston).—F. Six.
Amphithoe rubricata (Mont.).—A, B, C, D, E, F. Abundant. Common in dredgings, 2–9 fms.
Pleonexes gammaroides, Bate.—B, C, D, E, F. Frequent. Elly Bay, 1 fm., one.

Sunamphithoe pelagica, M. Ed.—D, F. Two.
Jassa falcata (Mont.).—B, C, D, F. Common.
Erichthonius brasiliensis (Dana).—A, B, C, D, F. Common. Common in dredgings, 2–5 fms.
Siphonoecetes Colleti, Boeck.—Off Blacksod Lt., 8–9 fms., one.
Corophium Bonellii (M. Ed.).—A, B, C, D, E. In small numbers. Common in dredgings, 1–8 fms. L. Leam, two.
Proto ventricosa, O. F. Müll.—B, C. Two. Elly Bay, 2 fms., one.
Pseudoprotella phasma (Mont.).—C. One.
Podalirius typicus, Kröyer.—Feorinyeeo Bay, 3–5 fms., one.
Caprella linearis, Linn.—D. Twenty-seven.
Caprella acanthifera, Leach.—B, C, F. Three. Feorinyeeo Bay, 3–5 fms., one.

DECAPODA.

(Identified by G. P. F., S. W. K., and W. M. T.)

Cancer pagurus, Linn.—A, B, C, D, E, F. Common under stones between tide-marks, small or half grown. Twice dredged, off Ardelly Pt., 5 fms.; Feorinyeeo Bay, 5 fms.
Pilumnus hirtellus (Linn.).—A, B, C, D, E, F. Common amongst stones and seaweed, March, '10, '11, and Sept., '10. Not observed, Sept., '09 or '11.
Xantho incisus (Leach).—A, B, C, D, E, F. Very common amongst stones and seaweed.
Xantho hydrophilus (Herbst).—A, B, C, D, F. Frequent in March but not plentiful. Only twice seen in September.
Carcinus maenas (Pennant).—A, B, C, D, E, F. Common everywhere. Ovigerous in March.
Pinnotheres pisum (Linn.).—In *Mytilus modiolus* dredged off Ardelly Pt., 4¾ fms., common.
Maia squinado (Herbst).—Trawled off Feorinyeeo Bay, 5 fms., three specimens.
Pirimela denticulata (Montagu).—B, D, E, F. Amongst seaweed, scarce. Dredged off Carrigeenmore, 3 fms., one. Ovigerous in March.
Eurynome aspera (Pennant).—B, D, E. Small specimens under stones, very scarce.
Hyas araneus (Linn.).—A, B, C, D, E, F. Small specimens under stones and amongst seaweed. Common in March, scarce in September. Dredged N. of Ardelly Pt., 3–4 fms.
Pisa tetraodon (Pennant).—B, D, E, F. Found five times in March, once in September.
Inachus dorynchus, Leach.—A, B, C, D, F. Scarce. Dredged in Elly Bay, 2–5 fms.

Stenorhynchus rostratus, Linn.—A, B, C, D, E, F. Common in March between tide marks, scarce in September. Very common in dredgings all over the area, 1–9 fms.

Portunus puber (Linn.).—A, B, C, D, E, F. Common under stones and seaweed.

Portunus depurator (Linn.).—Not found between tide marks. Frequently dredged, 2–9 fms.

Portunus pusillus, Leach.—Not found between tide marks. Frequently dredged, 4–9 fms. Ovigerous in March.

Portunus holsatus (Fabr.).—Dredged off Ardelly Pt., 6–8 fms., one.

Portunus corrugatus (Pennant).—Dredged in Elly Bay, 2 fms., one.

Portunus arcuatus, Leach.—Not found between tide marks. Frequently dredged in 1–5 fms.

Corystes cassivelaunus, Pennant.—B. One specimen on a sandy beach. Dredged in 8 fms., off Blacksod Point.

Porcellana longicornis (Linn.)—A, B, C, D, E, F. Abundant all over the area, both between tide marks and in dredgings in 1–8 fms.

Porcellana platycheles (Pennant).—A, B, C, D, E, F. Abundant between tide marks, not found below L.W.M.

Galathea strigosa (Linn.).—A, B, C, D. Scarce, only small specimens seen.

Galathea squamifera, Leach.—A, B, C, D, E, F. Very common in March, scarce in September. Scarce in dredged material, Elly Bay, 2 fms.; Feorinyeeo Bay, 3–5 fms.; off Blacksod Pt., 8 fms.

Galathea nexa.—B, D, F. Very scarce.

Galathea intermedia, Liljeberg.—E. One specimen. Twice dredged, Feorinyeeo Bay, 3 fms.; off Blacksod Pt., 8–9 fms.

Eupagurus bernhardus (Linn.).—A, B, C, D, E, F. Very small specimens common at extreme L.W.M. Larger specimens dredged all over the area, 1–9 fms.

Eupagurus Prideauxi (Leach).—Dredged twice off Elly Bay, 4–8 fms.

Eupagurus cuanensis (Thomp.).—A, B, C, D. Occasionally found between tide marks. Common in dredgings all over the area, 1–8 fms.

Anapagurus laevis (Thomp.).—Off Blacksod Pt., 8 fms., one.

Anapagurus Hyndmanni (Thomp.).—A, B, C, D, E, F. Very small specimens common at extreme L.W.M. in March. Common in dredgings all over the area, 2–8 fms.

Homarus gammarus (Linn.).—A, B. Found twice.

Pandalus Montagui, Leach.—In small numbers in dredged material, Elly Bay, 2–4 fms.; Feorinyeeo Bay, 2–5 fms. Abundant in centre of Elly Bay, 3 fms., Sept., '09.

Pandalina brevirostris (Rathke).—A. One, ovigerous, March, '10. Dredged in Elly Bay, 1–3 fms., twice; Feorinyeeo Bay, 5 fms., once.

Hippolyte varians, Leach.—A, B, C, D, E, F. Common. Frequent in dredged material throughout the area, 2–8 fms. Ovigerous, March, Sept.

Hippolyte prideauxiana, Leach.—A, B, C, F. Frequent in *Zostera* beds on the shore and in shallow water, but not plentiful. Elly Bay, 2–3 fms.; Feorinyeeo Bay, 2–5 fms.

Spirontocaris Cranchi (Leach).—A, B, C, D, E, F. Not so common as *Hippolyte varians*, scarce in dredged material. Elly Bay, 2–4 fms.; Feorinyeeo Bay, 3–5 fms. Ovigerous, Sept.

Athanas nitescens (Montagu).—A, B, C, D, E, F. Frequent under stones near L.W.M., always in small numbers.

Processa canaliculata, Leach.—A, B. On sandy shore, three specimens. Two dredged in Elly Bay, 2 fms.

Leander serratus (Pennant).—A, B, C, D, E, F. Common in rock-pools. Ovigerous, March.

Leander adspersus (Rathke).—C. In a rock pool near H.W.M., few.

Leander squilla (Linn.).—A, B, C, D, E, F. Common in rock-pools; found in Lough Leam.

Palaemonetes varians (Leach).—B. Common in Lough Leam and in the adjoining ditches which are flooded at H.W.

Crangon vulgaris Linn.—A, B, C, E, F. Scarce between tide marks; common in Lough Leam. Common in shallow water, 1–5 fms. Ovigerous, March.

Philocheras trispinosus (Hailstone).—Dredged off Blacksod Pt., 3 fms., several; off Carrigeenmore, 3 fms., one. Ovigerous March and September.

Philocheras fasciatus (Risso).—A, B, F. Scarce. Dredged in Elly Bay, 2–3 fms.; Feorinyeeo Bay, 2–3 fms.; off Carrigeenmore, 3 fms.

Philocheras bispinosus (Hailstone and Westwood).—Dredged off Blacksod Point, 8 fms., several.

MYRIAPODA.

(Identified by C. M. Selbie.)

Scolioplanes maritimus (Leach).—Under stones below H.W.M. Scarce.

INSECTA.

(Identified by S. W. K.)

COLEOPTERA.

Aëpus Robinii, Lab.—C. Under stones between tide marks. Several.

HEMIPTERA.

Aëpophilus Bonnairei, Sig.—D. Under stones at L.W.M., on Ardelly Pt.

PYCNOGONIDA.

(Indentified by G. H. Carpenter.)

Nymphon gracile (Leach).—D. One.
Phoxichilidium femoratum (Rathke).—C. One.
Anaphia pygmaea (Hodge).—C, D. Two.
Ammothea echinata, Hodge.—D. One.
Endeis laevis (Grube).—B, E. Three.
Pycnogonum littorale, Stroem.—B, C, E. Frequent.

ACARINIDA (HALACARIDAE).

(Identified by J. N. Halbert.)

[1] **Rhombognathus pascens** (Lohm.).—F. March, '11.
Halacarus actenus, Trt.—A. In weeds from shore, Sept., '11, (Nymphs only). March, '10, no particulars of locality.
H. Basteri (Johnst.) (*H. spinifer*, Lohm).—F. In weeds, Sept., '11. Sept., '09 (nymph). March, '11 (with eggs), no particulars of locality.
Halacarus areolatus, Halbert.—A. In weeds from shore, Sept., '11.
H. gracilipes, Trt.—B. In weeds from shore, Sept., '11 (nymph and adult). Elly Bay, 2 fms., dredge, Sept., '11 (nymph and adult).
H. Seahami, Hodge.—D. In *Lithothamnion.*
H. oculatus, Hodge.—Elly Bay, 2 fms., dredge.
H. Fabricii, Lohm.—A. In weeds from shore, Sept., '11. In Sept., '10 (nymphs), no particulars of locality.
H. rhodostigma, Gosse.—Feerinyeeo Bay, dredge, 3 fms
Trouessartella falcata, Hodge.—Sept., '09 (adult and nymphs) no particulars of locality.

MOLLUSCA.

(Small species identified by Anne L. Massy, others by G. P. F., S. W. K., and W. M. T.)

CEPHALOPODA.

Loligo Forbesi, Steenstrup.—One trawled off Feerinyeeo Bay, 4–6 fms.
Sepiola atlantica, d'Orb.—Feerinyeeo Bay, 2 fms., one. Off Blacksod Lt., 8–9 fms., one.

[1] *R. setosus* Lohm. and *R. notops* Gosse are found in corallines on the shore of Clew Bay and no doubt occur also at Blacksod.—J. N. H.

AMPHINEURA.

Acanthochites fascicularis (L.) (*Chiton*).—A, B, C, D, F. Frequent in small numbers near L.W.M. Elly Bay, and off Ardelly Pt., 1–5 fms.; Feorinyeeo Bay, 4–6 fms.

Lepidopleurus cancellatus (G. B. Sowerby) (*Chiton*).—A, B, D, F. Scarce, seven records from between tide-marks. Feorinyeeo Bay, 3–5 fms.

Tonicella ruber (L.) (*Chiton*).—A, B, C, D, E. Scarce, six records.

Callochiton laevis (Mont.) (*Chiton*).—A, B, C, D, F. Frequent, eleven records from between tide-marks. Off Ardelly Pt., 2–8 fms.

Craspedochilus onyx (Speng.) (*Chiton cinereus*).—A, B, C, D. Scarce, six records from between tide-marks. Feorinyeeo Bay, 4–6 fms., one.

Craspedochilus cinereus (L.) (*Chiton marginatus*).—A, B, C, D, E, F. Common under stones at L.W.M. Elly Bay, $3\frac{1}{2}$–$4\frac{1}{2}$ fms., one.

PELECYPODA.

Nucula nitida, G. B. Sow.—Feorinyeeo Bay, 3–5 fms.; off Ardelly Pt., $4\frac{3}{4}$ fms., frequent. Other Nuculas, not identified, dredged off Blacksod P., 7–9 fms.

Anomia ephippium, L.—A, B, C, D, E, F. Common everywhere between tide-marks. Elly Bay, and off Ardelly Pt., 1–5 fms.

Glycymeris glycymeris (L.) (*Pectunculus glycymeris*).—Feorinyeeo Bay, 3–5 fms. Off Carrigeenmore, 9 fms.

Arca tetragona, Poli.—A, B, F. In crevices of stones, six records.

Mytilus edulis (L.).—A, B, C, D, E, F. There is a small mussel bed on the sand flats to the N.E. of Barranagh, and young specimens are common on all parts of the shore.

Volsella modiolus (L.) (*Mytilus modiolus*).—A, B. Young specimens between tide-marks, a few large ones in *Zostera* bed at L.W.M., N.E. of Barranagh. Frequently dredged. Elly Bay, Feorinyeeo Bay, and off Ardelly Pt., 1–8 fms,

Volsella barbata (L.) (*Mytilus barbatus*).—C, D. Scarce.

Volsella phaseolina (Phil.) (*Mytilus phaseolinus*).—F. One valve.

Modiolaria marmorata (Forbes).—A, B, C, D, E, F. Frequent between tide-marks, 10 records, and sometimes common. Off Ardelly Pt., 5 fms.

Modiolaria discors (L.).—C, D, E, F. Scarce between tide-marks, six records. Feorinyeeo Bay, 3 fms., two.

Ostrea edulis (L.).—A, B, C, D. Occasionally found at L.W.M., eleven records. Dredged, Feorinyeeo Bay, 3–5 fms., two; Elly Bay and off Ardelly Pt., 4–8 fms., six.

Pecten pusio (L.).—A, B, C, D, F. Frequent, attached to stones at L.W.M., 12 records. Off Ardelly Pt., $4\frac{3}{4}$ fms., one.

Pecten varius (L.).—A, B, C, D, E, F. Moderately common between tide-marks, 26 records. Dredged, Feorinyeeo Bay, Elly Bay, and off Ardelly Pt., 2–5 fms.

Pecten opercularis (L.).—Dredged nine times in small numbers in all localities, 3–8 fms.

Cyprina islandica (L.).—One valve, off Blacksod Pt., 7–8 fms.

Lucina borealis (L.).—E, F. Two records of living shells from between tide-marks. Feorinyeeo Bay, Elly Bay, off Blacksod Lt., and Carrigeenmore, 3–8 fms., scarce.

Thyasira flexuosa (Mont.) (*Axinus flexuosus*).—D. One, living, between tide-marks. Dredged thirteen times, usually dead shells, in all localities, 1–9 fms.

Montacuta bidentata (Mont.).—E. One specimen.

Diplodonta rotundata (Mont.).—Dead shells dredged four times, Elly Bay, off Ardelly Pt., and Carrigeenmore, 3–9 fms.

Kellia suborbicularis (Mont.).—A, B, C, D, E, F. Usually in mud-filled crevices or inside dead Lamellibranch shells, 12 records.

Lasaea rubra (Mont.).—C, D. Twice recorded, probably often overlooked.

Syndosmya alba (Wood).—Dead shells dredged eight times in all localities, 3–9 fms.

Gastrana fragilis (L.).—One valve, Feorinyeeo Bay, 2–3 fms.

Tellina squalida, Pult.—B, C. One, living, in sand at L.W.M., Elly Bay. Valves dredged five times, Feorinyeeo Bay, Elly Bay, off Ardelly Pt., and Blacksod Lt., 1–8 fms.

Tellina donacina (L.).—Feorinyeeo Bay, 2½ fms., 1 valve.

Tellina tenuis (C.).—A, B, C, D, E. Common, living in sandy beaches at L.W.M., 13 records. Dredged off Ardelly Pt., 4¾ fms.

Tellina fabula, Gron.—B, D. Twice, in sand, at L.W.M. Dredged ten times in all localities, usually dead shells, 3–8 fms.

Donax vittatus (da C.).—D. Several, live and dead.

Mactra stultorum, L.—One valve, off Ardelly Pt., 6–8 fms.

Spisula subtruncata (da C.) (*Mactra subtruncata*).—A, B, C, D, F. Living specimens common, especially in sandy patches, 14 records. Absent from Moyrahan and scarce, one specimen, on Carrigeenmore. Dredged 16 times in all localities, 1–8 fms.

Lucinopsis undata (Penn.).—Off Blacksod Lt., 7–8 fms., one valve.

Dosinia exoleta (L.) (*Venus exoleta*).—C, D, F. Valves only, 3 records. Dredged, valves, in Feorinyeeo Bay, 2½ fm.

Venus gallina (L.).—A, B, C, D, F. Frequent between tide-marks, especially in sandy bays, 16 records. Dredged in all localities, 8 records, 1–9 fms.

Tapes aureus (Gm.).—A, B, C, D, E, F. Common, between tide-marks, 16 records. Dredged in Feorinyeeo Bay and Elly Bay, 1–3 fms.

Tapes virgineus (L.).—A, B, C, D, F. Not very common; five records from between tide-marks. Valves dredged in Feorinyeeo Bay, $2\frac{1}{2}$ fms., and off Ardelly Pt., $4\frac{3}{4}$ fms.

Tapes pullastra (Montagu).—A, B, C, D, E, F. Frequent between tide-marks, 19 records. Valves dredged in Feorinyeeo Bay, 3–5 fms., and off Ardelly Pt., $4\frac{3}{4}$ fms.

Tapes decussatus (L.). –A, B, C, F. Nine records, valves only, except once on Carrigeenmore.

Cardium echinatum (L.).—Valves dredged twice off Blacksod Lt., 7–9 fms.

Cardium exiguum, Gmel.—A, B, C, D, E. Frequent between tidemarks, 15 records. Frequent in dredged material from all localities, 1–9 fms., nine records.

Cardium nodosum, Turton.—D, F. Scarce between tidemarks, 3 records. Dredged three times in Feorinyeeo Bay, 3–5 fms., and once off Ardelly Pt., $4\frac{3}{4}$ fms.

Cardium edule (L.).—A, B, D, F. Common, living in the strand to N.E. of Barranagh, and under Bingham's Castle; valves elsewhere.

Cardium norvegicum Spengler.—C, D. Valves only. One valve dredged off Carrigeenmore, 7–8 fms.

Gari ferroensis (Chemnitz) (*Psammobia ferroensis*).—A, B, D. Valves only. Valves dredged in all localities, 3–9 fms. 10 records.

Gari depressa, Pennant (*Psammobia vespertina*).—B, C, F. Living in sand on Carrigeenmore, valves elsewhere, 5 records. Valves dredged off Carrigeenmore, 8–9 fms.

Mya arenaria (L.).—Two young specimens dredged in Feorinyeeo Bay, 3 fms.

Mya truncata (L.).—A, C, D. Valves only, four records. Valves dredged in Feorinyeeo Bay, with one living specimen. Elly Bay, and off Ardelly Pt., 1–8 fms., nine records.

Cultellus pellucidus (Penn.) (*Solen pellucidus*).—Off Carrigeenmore, 7–8 fms., two valves.

Ensis ensis (L.).—A, B, C, D. Frequent, living in sand in B. and D., dead elswehere. Dredged, living off Carrigeenmore, 7–9 fms. Valves in Feorinyeeo Bay, and off Ardelly Pt.

Saxicava rugosa, L. A, B, C, D, E, F. Frequent between tidemarks, 13 records, but probably often overlooked.

Saxicava arctica (L.).—A, D, F. Three records, but may have been mistaken for *S. rugosa*.

Barnea candida (L.). (*Pholas candidus*).—B. Frequent in a small patch of submerged peat bog at extreme L.W.M. on N.E. shore of Elly Bay.

Cochlodesma praetenue (Pult.) (*Thracia prætenuis*).—B, C. Two records, living in C. Valves dredged off Carrigeenmore, 3–8 fms.

Thracia fragilis Penn. (*Thracia papyracea*).—A, B, C. Eight records, five of living specimens from sand. Valves dredged in all localities, 11 records.

SCAPHOPODA.

Dentalium entalis (L.).—Off Carrigeenmore, 3 fms., four.

Dentalium vulgare, da C. (*D. tarentinum*).—A, B, D. Four records from between tide-marks. Dredged in all localities, 1–9 fms., eight records.

GASTROPODA.

Patella vulgata (L.)—A, B, C, D, E, F. Abundant everywhere between tide-marks.

Helcion pellucida (L.).—A, B, C, D, F. Frequent between tide-marks, 16 records. Young individuals occasionally abundant on *Laminaria* fronds at L.W.M. Dredged off Ardelly Pt., 4¾ fms.

Acmaea virginea (Müll.).—A, B, C, D, E, F. Frequent between tide-marks, 15 records. Feorinyeeo Bay, 3–5 fms.; off Ardelly Pt., 1 fm.

Emarginula fissura (L.).—B, E. Two specimens. Off Ardelly Pt., 1 fm., two.

Fissurella graeca (L.).—A, B, C, D, E, F. Frequent between tide-marks, 18 records; most numerous on Ardelly Pt.

Gibbula magus (L.) (*Trochus*).—A, B, C, D, F. Scarce between tide-marks except on B; eight records. Off Ardelly Pt., Elly Bay, and Feorinyeeo Bay, 2–5 fms., moderately common, eleven records.

Gibbula cineraria (L.) (*Trochus*).—A, B, C, D, E, F. Abundant between tidemarks. Frequent in dredgings from all localities, 2–9 fms.

Gibbula umbilicata (Mont.) (*Trochus*).—A, B, C, D, E, F. Abundant between tide-marks, usually higher on the shore than *G. cineraria*. Once dredged, Elly Bay, ½–3½ fms., few.

Monodonta crassa (Montfort) (*Trochus lineatus*).—A, B, C, D, E, F. Abundant on all bare rocks above half tide-mark.

Calliostoma zizyphinus (L.) (*Trochus*).—A, B, C, D, E, F. Common at L.W.M., 24 records. Feorinyeeo Bay, 3 fms., few.

Phasianella pullus (L.)—A, C, D, F. Six records from L.W.M. Elly Bay and off Ardelly Pt., 2–4¾ fms., two records.

Aclis minor Brown.—Off Blacksod Lt., 8–9 fms., one.

Lacuna divaricata (Fabr.).—A, B, C, D, E, F. Common on seaweeds and *Zostera* between tide-marks, 13 records. Elly Bay, Feorinyeeo Bay, and off Ardelly Pt., 1–6 fms., 11 records.

Lacuna parva (da C.) (*Lacuna puteolus*).—A, B, C, D, E, F. Frequent in small numbers on Fucoids at L.W.M., 16 records.

Lacuna pallidula (da C.).—A, B, C, D, E, F. Scarce at L.W.M., 12 records.

Littorina obtusata (L.).—A, B, C, D, E, F. Abundant between tide-marks.

Littorina rudis (Maton).—B, C, D, F. Locally common, 8 records, but may have been overlooked.

Littorina littorea (L.)—A, B, C, D, E, F. Abundant everywhere between tide-marks. Elly Bay, $\frac{1}{2}$–$3\frac{1}{2}$ fms. Gathered on E. of Barranagh and Carrigeenmore for the English market.

Rissoa parva (da C.).—A, B, C, D, E, F. Abundant amongst weeds and in rock-pools between tide-marks, 23 records. Frequent in dredgings from all localities, 1–6 fms., nine records.

Rissoa violacea, Desmarest.—A, B, C, D, E, F. Common between tide-marks with *R. parva*, 16 records. Frequent in Elly Bay and Feorinyeeo Bay, 1–6 fms., nine records.

Zippora membranacea (Adams) (*Rissoa*).—A, B, C, D, E. Abundant in *Zostera* at L.W.M., 11 records. Dredged in all localities, 1–9 fms., 11 records.

Onoba striata (Adams) (*Rissoa*).—A, B, C, D, E, F. Very common amongst weeds between tide-marks, 15 records. Feorinyeeo Bay 3–5 fms., 2 records.

Cingula semistriata (Mont.) (*Rissoa*).—A, C, E, F. Not uncommon locally, 5 records.

Cingula trifasciata (Adams) (*Rissoa cingillus*).—C, D. Scarce, 4 records.

Trivia europea (Mont.) (*Cypraea*).—A, B, C, D, E, F. Frequent at L.W.M., 23 records. Commoner in March than September. Dredged in all localities, 1–5 fms., 11 records.

Natica catena, da C.—D. One shell.

Natica Alderi Forbes.—A. One living on sand. Dredged in small numbers in all localities, 2–9 fms., 8 records.

Lamellaria perspicua (L.).—A, B, C, D, E, F. Frequent under stones between tide-marks, 19 records.

Velutina laevigata (Penn.).—Off Ardelly Pt., 6–8 fms., 7 specimens.

Bittium reticulatum (da C.) (*Cerithium*).—A, B, C, D, E, F. Common between tide-marks, 26 records. Frequent in dredgings from all localities, 1–5 fms., 6 records.

Cerithiopsis tubercularis (Mont.).—B, D. Rare, 2 records.

Brachystomia albella (Lovén) (*Odostomia*).—F. Two specimens.

Eulima polita (L.).—Off Carrigeenmore, 8–9 fms., several.

Turritella communis (Lmk.) (*T. terebra.*).—A, B, C, D, E. Dead shells not uncommon between tide-marks. Dredged in great abundance over most of the area between 5 and 8 fms., frequent in lesser depths, 21 records.

Aporrhais pes-pelecani (L.).—D. One shell. Dredged twice off Carrigeenmore, 7–9 fms.

Buccinum undatum (L.)—A, B, C, D, E, F. Young and half-grown specimens frequent at L.W.M., 17 records. Dredged in all localities, 2–9 fms., 15 records.

Ocinebra erinacea (L.) (*Murex*).—A, B, C, D, E, F. Frequent between tide-marks, 15 records. Feorinyeeo Bay, and off Ardelly Pt., 4–6 fms., 3 specimens.

Purpura lapillus (L.).—A, B, C, D, E, F. Abundant on rocks between tide-marks.

Nassa reticulata (L.).—A, B, C, D, E, F. Frequent between tide-marks both under stones, and more plentifully on sandy beaches, 24 records. Dredged in all localities, 1–9 fms., 11 records.

Nassa incrassata (Ström).—A, B, C, D, E, F. Abundant under stones at L.W.M. Dredged in all localities, 1–9 fms., 7 records.

Bela turricula (Mont.) (*Pleurotoma*).—B. Twice between tide-marks. Frequent in dredgings from all localities, 2–5 fms.

Bela rufa (Mont.) (*Pleurotoma*).—C. One specimen. Dredged once off Ardelly Pt., 4¾ f.

Haedropleura costata (Costa) (*Pleurotoma septangularis*).—E. One specimen.

? **Mangilia attenuata** (Mont.) (*Pleurotoma*).—Feorinyeeo Bay, 3–5 fms., one, juv.

Mangilia costata (Donov.) (*Pleurotoma*).—Feorinyeeo Bay, 2–3 fms., 3 records; Elly Bay, 2 fms., 1 record.

Mangilia brachystoma (Phil.) (*Pleurotoma*).—F. Two specimens. Feorinyeeo Bay, 2½ fms., two. Off Blacksod Lt., 8–9 fms., two.

Mangilia nebula (Mont.) (*Pleurotoma*).—Elly Bay, 3 fms., two specimens.

Clathurella linearis (Mont.).—B, C, E. Scarce, 4 records.

Clathurella purpurea (Mont.).—B, D, E, F. Scarce, 4 records.

TECTIBRANCHIA.

Actaeon tornatilis (L.).—Off Ardelly Pt., 6–8 fms., one shell.

Bullinella cylindracea (Penn.) (*Cylichna*).—Off Carrigeenmore, 7–8 fms., one broken shell.

Philine aperta (L.).—A, B, C, D. Frequent in sand between tide-marks, 6 records. Scarce in dredgings from all localities, 1–9 fms., 7 records.

Aplysia punctata, Cuv.—C, D. Numerous large specimens taken on Ardelly Pt., in March, 1911; not seen between tide-marks at any other time. Dredged in Elly Bay and off Ardelly Pt., 2–8 fms., in Sept., '11, two young specimens.

Pleurobranchus plumula (Mont.).—A, B, C, D, E, F. Frequent and often common under stones between tidemarks, 25 records.

Runcina coronata (Quatref.) (*R. Hancocki*).—E, F. Occasionally on *Codium* or amongst *Zostera*.

NUDIBRANCHIA.

Archidoris tuberculata (Cuv.).—A, B, C, D, E, F. Frequent. Occasionally dredged, 1–8 fms.

Archidoris testudinaria (Risso).—E. Two specimens near L.W.M. This is the first Irish record, but the species has probably been confounded with *A. tuberculata*.

Geitodoris planata (A. & H.).—E. One specimen under a stone near L.W.M.

Jorunna Johnstoni (A. & H.).—A, B, C, E, F. Scarce.

Rostanga coccinea (Forbes).—A, B, C, D, E, F. Taken several times on the sponge *Ophlitaspongia seriata*. Spawning in September.

Cadlina repanda (A. & H.).—A, C, D, E, F. Frequent.

Aegires punctilucens (d'Orb.).—A, B, C, F. Scarce, small specimens only. Elly Bay, 2 fms.

Triopa clavigera (O. F. M.).—A, C, D, E, F. Frequent. Commonest in March. Feorinyeeo Bay, 4–5 fms.

Polycera quadrilineata (O. F. M.).—C, F. Scarce.

Lamellidoris sparsa (A. & H.).—D. One specimen.

Lamellidoris diaphana (A. & H.).—F. Two specimens.

Acanthodoris pilosa (O. F. M.).—A, B, C, D. Only found in March, 1910.

Lamellidoris bilamellata (L.).—B, C, D, E. Only found in Sept., '10 (one young), and March, '11 (fragment, spawning).

Lamellidoris depressa (A. & H.).—B, C, D. Scarce.

Goniodoris nodosa Montagu.—A, B, C, D, E, F. Scarce in September; common, spawning, in March, especially on Carrigeenmore; associated with the Tunicate *Dendrodoa grossularia*. Off Ardelly Pt., 4–6 fms.

Goniodoris castanea (A. & H).—A, B. Scarce. Dredged, Elly Bay and Feorinyeeo Bay.

Ancula cristata, Alder.—A, F. Two specimens.

Doto pinnatifida (Montagu).—Dredged once off Ardelly Pt., $4\frac{3}{4}$ fms.

Coryphella gracilis (A. & H.).—E. Scarce.

Galvina Farrani, A. & H.—Feorinyeeo Bay, 2 fms., one.

Facelina coronata (Forbes).—A, C, D, E, F. Frequent. Spawning in March.

Amphorina coerulea (Montagu).—September only, Elly Bay and off Ardelly Pt., 4–8 fms.

Amphorina olivacea (A. & H.).—C, E. Scarce. Off Ardelly Pt., 1 fm.

Cuthona Peachi (A. & H.).—Off Ardelly Pt., $4\frac{3}{4}$ fms., one.

Eolis papillosa (L.).—B, D, F. Scarce. Spawning in March.

Hermaea bifida (Montagu).—Feorinyeeo Bay, 3 fms., one.

Hermaea dendritica, A. & H.—A, C, F. Common on *Codium* in March, '10. Dredged in Feorinyeeo Bay, 2–3 fms., Sept., '10.

Elysia viridis, Montagu.—A, B, C, D, E, F. Common, usually on *Codium*. Feorinyeeo Bay, 2–3 fms., Elly Bay, 2 fms.

Limapontia capitata, Müll.—D. Two very small specimens in a rock-pool near H.W.M.

TUNICATA.

By Dr. R. Hartmeyer, Berlin.

Molgula citrina, Ald. Hanc. (*Molgula nana*, Kupff.; *M. littoralis*, Verr.).—A. One specimen.

Pyura squamulosa (Ald.) (*Cynthia sigillata*, Lacaze Delage; *C. ovata*, Ald. Hanc.)—B, C, D, F. Not plentiful; seven records, usually of single specimens.

Pyura Savignyi (Phil.) (*Cynthia morus* Forbes; *C. scutellata* Hell.).—A, B, C, D, F. Twenty-three records. Very plentiful in all stages of growth.

Styela Loveni (Kor. Dan.) (*Cynthia coriacea*, Ald. Hanc.; *C. granulata*, Ald.; *C. placenta*, Pack; *Styela armata*, Lacaze Delage; *S. northumbrica*, Ald. Hanc.).—C. One specimen.

Polycarpa singularis (Gunn.) (? *Distomus mamillaris*, C. F. Gaertn.; *Cynthia pomaria*, Sav.; *C. tuberosa*, Macq.; *C. informis*, Forbes; *C. sulcatula*, Ald.; *Polycarpa varians* + *Mayeri*, Traust.).—A, B, C, D, E, F. Plentiful, but only small specimens.

Dendrodoa grossularia (Bened.) (*Thylacium syloani*, Carus).—A, D, F. Abundant on Carrigeenmore where it forms sheets of aggregated specimens covering the sides of large boulders at L.W.M.; rare elsewhere on the shore. Frequently dredged in 3–8 fms. attached to shells of *Turritella communis*.

Botryllus Schlosseri (Pall.).—A, B, C, D, E, F. The collection contains, in large numbers, a species of *Botryllus* which I can only identify as *Botryllus Schlosseri*. The colonies display the most varied types of growth. Either they spread in a thin crust over the surface of algae and shells or they encrust stalks of weed and in this way form "Pseudoknollen," or finally they grow out into true "Knollen." The last-named type of colony might be casually taken for a *Polycyclus*. A specific separation of all these types cannot, as it appears to me, be rightly maintained since the anatomy of the individuals furnishes no differentiating characters. The systems are always circular and consist of from six to ten individuals.

Botrylloides rubrum, M-E.—A, B, C, D, E. Plentiful, but not so common as the preceding species.

Phallusia mentula (Müll.) (*Ascidia venosa*, Müll., non Traustedt et alii; *Ascidia robusta* + *rubicunda* + *rubro coincta* + *plana* + *Alderi*, Hanc.)—A, B, C, D, E. Moderately plentiful, but only in small and medium-sized examples. Occasional records also exist of larger examples.

Phallusia virginea (Müll.) (*Phallusia venosa*, Traustedt et alii, non O. F. Müller 1776).—A, B, C, D. Moderately plentiful.

Phallusia conchilega (Müll.) (*Ascidia depressa*, Ald. Hanc.; ? *A. rudis*, Ald.; *A. plebeia*, Ald.; ? *A. producta*, Hanc.; *A. inornata*, Hanc.).—A, B, C, D, E, F.—Very plentiful.

Ascidiella aspersa (Müll.) (*Ascidia scabra*, Müll.; *A. pustulosa*, Ald.).—A, B, C, D, E, F.—Very plentiful, but only small specimens.

Ciona sociabilis (Gunn.) (*Ascidia intestinalis*, L.).—A, B, C, D, F. Not very plentiful; usually single and almost always small individuals. Records also exist of larger dredged specimens, attached to shells.

Clavelina lepadiformis (Müll.).—B, C, D, E, F. Only a few specimens.

Trididemnum cereum (Giard).—B. Taken twice, one colony on each occasion.

Didemnum aff. **durum** (M.-E.).—A, B, C, D, F. A few small thin snow-white encrusting colonies of a species of *Didemnum* which appears to belong to the *D. durum* group.

Leptoclinum listerianum var. **gelatinosum**, M.-E.—B, D, F. A few colonies.

Leptoclinum spongiforme (Giard).—D. Two small colonies, probably referable to this species.

Diplosomoides perforatum (Giard). (*Diplosoma pseudoleptoclinum*, Drasche).—B, E. One colony from each section. *Leptoclinum griseum*, Ald. Hanc. (1912) may correspond to this species. The *Leptoclinum griseum* which Lahille (1890) placed as a sub-variety of *Leptoclinum asperum-maculatum* has, naturally, nothing to do with *D. perforatum*.

Glossoforum sabulosum (Giard).—A, B, C, D, E, F. Very plentiful. Most of the colonies are without a sandy covering. The hemispherical type is prevalent. The colonies reach a length of 30 mm, a height of 16 mm and a breadth of 21 mm. Often several colonies are aggregated.

Amaroucium proliferum, M.-E. (*Amaroucium aureum*, M.-E.; *A. roseum*, d. Valle; *A. commune*, Drasche).—A, B, C, D, E, F. Not very plentiful. The prevailing type is the flattened pillow-like one.

Amaroucium punctum (Giard) (*Morchelliopsis pleyberianus*, Lah. —B, C, D, F. Not plentiful.

Aplidium zostericola (Giard) (*Aplidium melleum*, Ald. Hanc.).—A, B, E, F. Not plentiful.

Morchellium argus (M.-E.).—A, B, C, D, E, F. Plentiful.

There is only one published reference to the occurrence of Ascidians in Blacksod Bay, by Holt (*Proc. R. Dub. Soc.*, N.S. Vol. VII.) in which he records the genera *Botryllus* and *Botryl-*

loides and also *Ciona sociabilis*. All the remaining species in the foregoing list are, accordingly, new for Blacksod Bay. The list further contains nine species not previously recorded from the West coast of Ireland, or at any rate not, until now, identified with certainty, namely *Molgula citrina*, *Pyura Savignyi* *Styela Loveni*, *Trididemnum cereum*, *Leptoclinum listerianum* var. *gelatinosum*, *Leptoclinum spongiforme*, *Diplosomoides perforatum*, *Glossoforum sabulosum*, and *Amaroucium punctum*. On the other hand, of the common species which occur on all the coasts of Great Britain and Ireland, one misses especially, in the collection, *Eugyra arenosa*, *Molgula oculata* and other species of *Molgula*, *Polycarpa comata*, *Corella paralellogramma* and *Perophora Listeri*. The almost complete absence of the *Molgulidae* and other species which inhabit muddy ground, e.g., *Pelonaia corrugata*, is probably explained by the nature of the bottom. The small size of the individuals of many species is remarkable, particularly, for instance, of *Polycarpa singularis*, *Phallusia mentula* and *Ciona sociabilis*.

The Ascidian fauna of Blacksod Bay is characteristically sub-Arctic. It differs in no way from the fauna of the Irish Sea or even of the English Channel, except that some few Mediterranean species, which extend as far as the Channel, e.g., *Microcosmus claudicans*, do not, apparently, push so far to the northward. There is no indication of an admixture of Arctic forms.

PISCES.

(Identified by G. P. F., S. W. K., W. M. T.)

This list consists mainly of fishes obtained between tidemarks with the addition of a few which were obtained by dredging or trawling in shallow water. It cannot be regarded as a complete list even of the common fishes of Blacksod Bay.

ELASMOBRANCHII.

Scyllium canicula (L.).—F. One between tidemarks; trawled a few times in 4–8 fms.

Acanthias vulgaris, Risso.—Trawled in immense numbers in Sept., '09, 4–6 fms.

Raia maculata, Montagu.—Trawled, 4–6 fms., Sept., '09.

Raia blanda, Holt & Calderwood.—Trawled in May, 1905, 6–8 fms.

Raia clavata, (L.)—Trawled, 4–6 fms., Sept., '09.

TELEOSTEI.

Anguilla vulgaris, Turton.—C. Sept., '09, few; March, '11. (glassy elvers), few.

Conger vulgaris, Cuv.—A, B, C, D, E, F. Small specimens frequent under stones.

Gasterosteus aculeatus.—Few in L. Leam.

Gasterosteus spinachia (L.).—A, F. Scarce. Dredged in *Zostera*, Elly Bay.

Siphonostoma typhle (L.).—Several amongst *Zostera*, Elly Bay.

Syngnathus acus (L.).—Two amongst *Zostera*, Elly Bay.

Nerophis aequoreus (L.).—One in *Zostera*, Elly Bay.

Nerophis lumbriciformis (Yarrell).—A, B, C, D, E, F. Common under stones and amongst weed. Dredged off Carrigeenmore, 6–8 fms.

Nerophis ophidion (L.).—A few in *Zostera* beds, ½–3½ fms., Elly Bay and Feorinyeeo Bay.

Ammodytes sp.—D, F. In sand, scarce.

Motella mustela (L.).—A, B, C, D, E, F. Common under stones.

Motella tricirrata, Bloch.—A, B, C, D, E, F. Common under stones.

Ctenolabrus rupestris (L.).—B. One. A few in *Zostera*, Elly Bay.

Crenilabrus melops (L.).—A, B, C, D, F. Frequent amongst weeds.

Pleuronectes platessa (L.).—Trawled, 4–8 fms., common.

Pleuronectes limanda (L.).—C. One. Trawled, 4–8 fms., common.

Rhombus laevis, Rondel.—Trawled, 4–6 fms., one.

Zeugopterus punctatus (Bloch).—D. One.

Arnoglossus laterna (Walb.).—Trawled, 6–8 fms., one.

Solea vulgaris, Quesn.—Trawled, 4–6 fms., few.

Solea lutea (Risso).—Trawled, 5–9 fms., few.

Gobius Ruthensparri, Euphras.—A, B, C, D, E, F. Common between tidemarks, spawning in March.

Gobius pictus, Malm.—A, F. Scarce. Feorinyeeo Bay, 3 fms., one.

Gobius minutus (L.).—A, B, C, E, F. Moderately common. Dredged, ½–9 fms.

Gobius paganellus, Gm.—A, B, C, D, E. Common in March, scarce in September.

Gobius niger (L.).—C, D, E. Common on C. in March, '10 ; only one seen subsequently.

Crystallogobius Nilssoni (Dub. & Kor.).—In fine net on trawl, Feorinyeeo Bay, 4–6 fms.

Cottus bubalis, Euph.—A, B, C, D, E, F. Frequent between tide-marks. Dredged, ½–4 fms.

Cottus scorpius (L.).—Dredged, Elly Bay, 2 fms.

Liparis Montagui (Donovan).—A, B, C, D, F. Found a few times in March.

Cyclopterus lumpus (L.).—B. One, spawning, March, '10.

Trigla cuculus (L.).—Trawled, 4–6 fms., one.

Trigla gurnardus (L.).—Trawled, 4–8 fms., few.

Callionymus lyra (L.).—Dredged, 6–8 fms., one.

Lepadogaster bimaculatus (Donovan).—Dredged, 2–9 fms., several.

Lepadogaster Decandollii, Risso.—B, E. Three between tide-marks.

Blennius pholis (L.).—A, B, C, D, E, F. Frequent amongst rocks and stones between tide-marks.

Blennius ocellaris, (L.).—Twice dredged, 5–8 fms.

Blennius gattorugine (Bloch.)—A. One.

Blennius galerita, L. (*Blennius Montagui*, Flem.).—D. Two.

Carelophus Ascanii Walb.—A. One.

Centronotus gunnellus (L.).—A, B, C, D, E, F. Common under stones between tide-marks.

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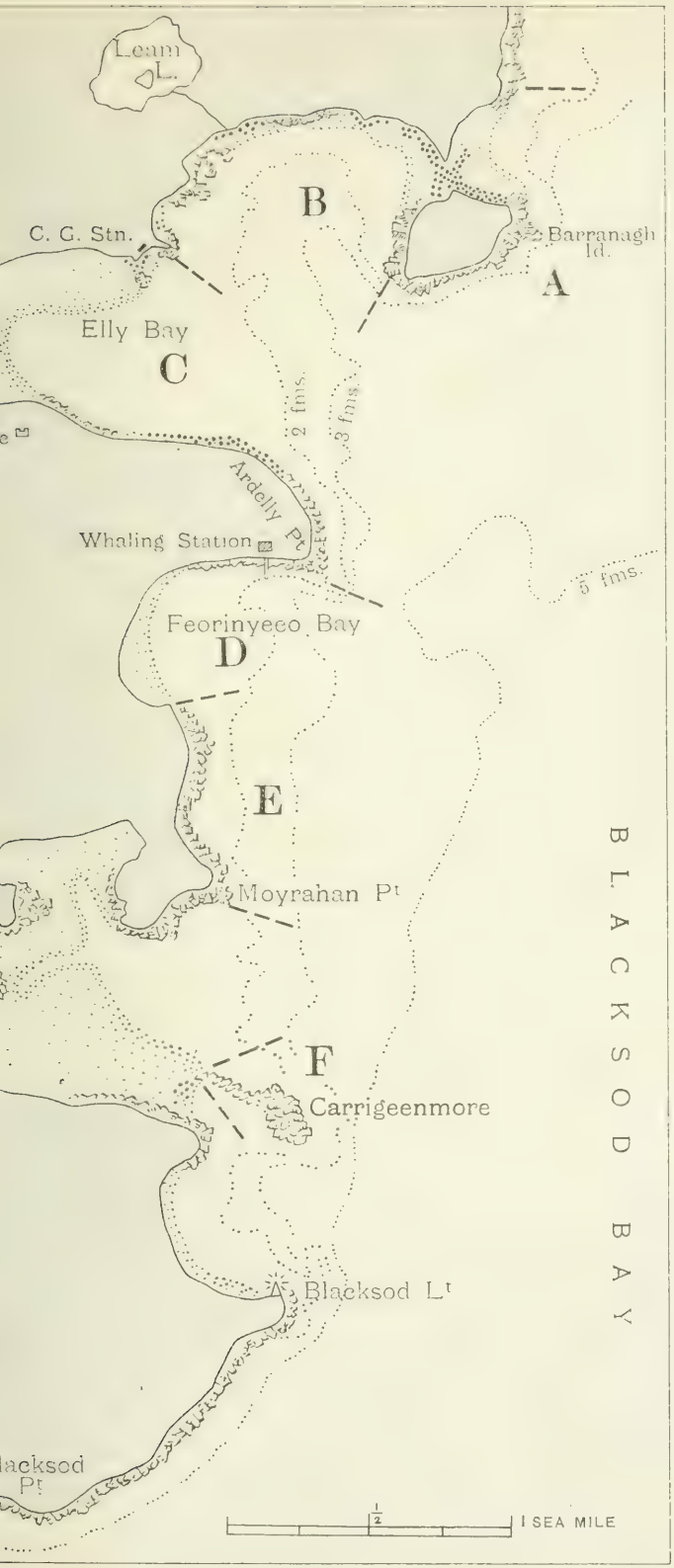
Leam L.
B
C. G. Stn.
Barranagh Id.
A
Elly Bay
C
2 fms.
3 fms.
Ardelly Pt
Whaling Station
5 fms.
Feorinyeeo Bay
D
E
Moyrahan Pt
BLACKSOD BAY
F
Carrigeenmore
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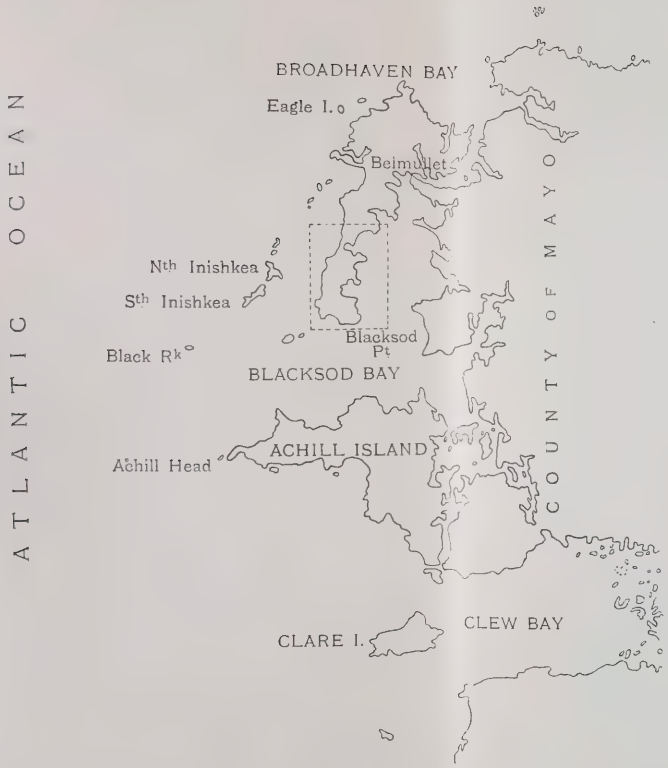
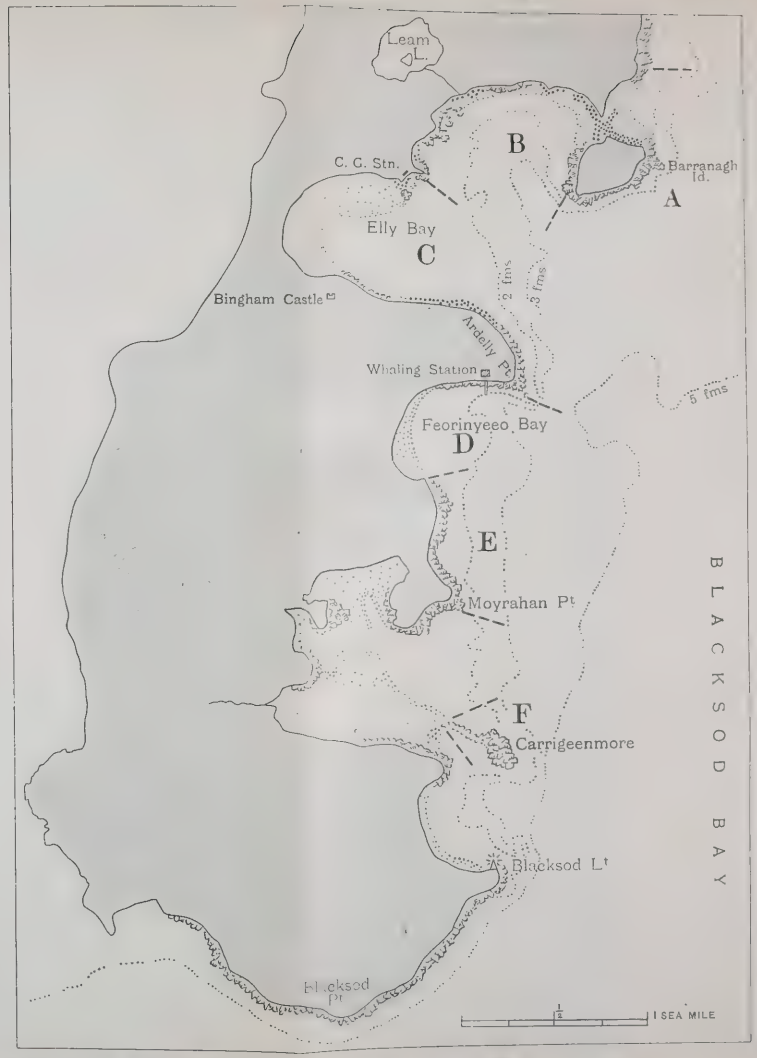


The area investigated is indicated above by dotted lines, and is shown on an enlarged scale in the adjoining map.



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SPONGES OF THE COASTS OF IRELAND.

I.—THE TRIAXONIDA AND PART OF THE TETRAXONIDA

BY

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Plates I–V.

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i. INTRODUCTION.

Large numbers of sponges belonging to the chief subdivisions of the phylum have been obtained off the coast of Ireland, in the course of the dredging operations carried on by the Fisheries Branch of the Irish Department of Agriculture.

Of these, the Triaxonida and part of the Tetraxonida are dealt with in this paper. The term Tetraxonida is here taken in the wide sense in which it is understood by Professor Dendy (4) and includes the grades Tetractinellida, Lithistida, Monaxonellida and Pseudoceratosa. The first section of the paper contains a description of the Triaxonida and the Tetractinellida; the second deals with part of the Monaxonellida, namely, with those sponges belonging to the sub-order Astromonaxonellida. No Lithistid sponge has as yet been obtained off the coast of Ireland.

I am indebted to Miss Eileen E. Barnes for the care with which she has made the drawings for this paper.

ii. TRIAXONIDA AND TETRACTINELLIDA.

All the sponges belonging to these two groups were obtained off the west and south-west coasts of Ireland, and, with the exception of one species, *Pachymatisma johnstonia*, they were all taken in deep water. The classification of the Tetractinellida is taken from Professor Dendy's important work on the sponges of Ceylon (4).

The following is a list of the species obtained :—

Order TRIAXONIDA.

Leucopsacus scoliodocus, Ijima.
Mellonympha velata (Wyville Thomson).
Aphrocallistes beatrix, Gray.
Hyalonema infundibulum, Topsent.
Pheronema Grayi, Kent.

Order TETRAXONIDA.

Grade TETRACTINELLIDA.

Plakortis simplex, Schulze.
Thrombus abyssi (Carter).
Thenea muricata, Bowerbank.
Pachastrella monilifera, Schmidt.
Characella pachastrelloides (Carter).
Poecillastra compressa (Bowerbank).
Sphinctrella ornata, Sollas.
Pachymatisma johnstonia (Bowerbank).
Geodia nodastrella, Carter.
Sidonops atlantica, n.sp.
Tethya cranium (Müller).

In addition to these species, part of a Dictyonine sponge and a few fragments of one of the Geodiidae were found in the collection, but they were too incomplete to identify.

Of the sixteen species enumerated in the foregoing list, twelve are now recorded for the first time for the Irish area. Three species, *Aphrocallistes beatrix*, *Pachymatisma johnstonia* and *Tethya cranium* have previously been collected within that area, the first-mentioned being recorded under the name *Aphrocallistes Bocagei*, Wright. The remaining species is described as new.

Three of the species, *Mellonympha velata*, *Thrombus abyssi* and *Geodia nodastrella* were described in various publications dealing with the sponges collected during the cruises of the *Porcupine* in the years 1869-70, and up to this, they had not since been taken.

Leucopsacus scoliodocus is known only from specimens taken in the Sagami Sea, Japan, except for one specimen, described as a variety, which was dredged off the Cape Verde Islands. It is therefore interesting to find this sponge within the Irish area.

Hyalonema infundibulum is known only from two specimens taken in the Bay of Biscay and off the Azores.

Plakortis simplex, long known only from the Mediterranean, has been recorded twice off the western coasts of Europe, namely, off Spain and off Norway, so that its occurrence at an intermediate station was to be expected.

The remaining sponges belong to well-known species, which have been fully redescribed within recent years, chiefly by Professor Topsent in his various works dealing with Atlantic sponges. Some of these species have been dredged many times in different parts of the Atlantic Ocean, while the known geographical range of others has been extended northwards by their discovery off the Irish coast.

Four other species of Tetractinellida, not represented in the present collection, are known to occur off the Irish coast, namely, *Dercitus Bucklandi* (**1** and **33**), *Stelletta Grubei* (**1**), *Pilochrota lactea* (**33**) and *Stryphnus ponderosus* (**33**). Thus the total number of Tetractinellid species taken up to the present time in Irish waters is fifteen.

Numerous slides from Canon Norman's collection, with sections and spicule-preparations of specimens dredged by the *Porcupine*, and of type and other specimens of Bowerbank, Schmidt, Topsent and others, have been of great assistance in determining some of the species. Of great assistance also was a collection of slides, now in the Irish National Museum, with sections and spicules of type-specimens of many Tetractinellida, prepared by Professor Sollas in the course of his work on the *Challenger* sponges.

Order TRIAXONIDA.

Sub-order HEXASTROPHORA.

Family *LEUCOPSACIDAE.*

Leucopsacus scoliodocus, Ijima.

Plate IV, fig. 2.

S.R. 506—12 IX '07. 50° 34′ N., 11° 19′ W., soundings 661–672 fms. Trawl. Temperature at 600 fms., 8.22°C.—One specimen.

With the exception of a variety, *L. scoliodocus*, Ijima, var. *retroscissus*, Topsent (**46**), described from a single specimen dredged off the Cape Verde Islands, this species is known only from the Sagami Sea, Japan (**10**). It is therefore interesting to find the species represented in the present collection.

The specimen is about 9 mm. in height by 11 mm. It is in a bad state of preservation and is broken off from its support. Two or three nodules at the base, formed of fused, thick-rayed hexactines, are the only remnants of the basidictyonal plate. The species is easily recognized by its distinctive spiculation, and the spicules of the Irish specimen agree well, both in size and character, with those of the Japanese specimens.

Topsent's variety is separated from the type solely on account of the fact that the most abundant form of microsclere is a hexactinose discohexaster, with slightly flexuous teeth,

which are a little longer than the teeth of the remaining hexactinose discohexasters. The latter kind is that described and figured by Ijima (**10**, Pl. III., fig. 29). At the same time Topsent states that the spicule shown in fig. 30 on the same plate would lead one to suppose that the first-mentioned kind of discohexaster, which is not specially described by Ijima, is occasionally present in the Japanese specimens, though probably badly developed in them.

In the Irish specimen the majority of the discohexasters (Pl. IV, fig. 2*b*) exactly correspond with the typical one figured by Ijima (**10**, Pl. III, fig. 29). They have teeth 0·01 mm., or more rarely 0·013 mm. in length. But accompanying them are discohexasters with rather longer recurved teeth (Pl. IV, fig. 2*a*), which recall those of Topsent's variety. These teeth are from 0·019 to 0·027 mm. long, not quite reaching 0·03 mm., the length given by Topsent for the teeth characteristic of the discohexasters of his specimen.

The teeth are 4–5 in number at the end of each ray in both these forms of discohexaster.

Ijima (**10**, p. 66) has shown in the case of an allied sponge, *Caunoplectella cavernosa*, possessing three different forms of large discohexasters, which probably represent developmental stages of the same kind of discohexaster, that one form is absent from young individuals, but makes its appearance later, becoming predominant in the fully developed specimens. Referring to this fact, Topsent suggests that, when more specimens are examined, the Cape Verde Islands sponge may prove to be simply a specimen of *Leucopsacus scoliodocus* with highly differentiated spiculation. In view of this statement, and of the fact that the typical short-toothed discohexaster predominates over the longer-toothed form, the Irish specimen is referred to the type rather than to the variety.

No tylfloricomes were seen in the Irish sponge. Ijima, however, states that this form of hexaster is of inconstant occurrence in the Japanese specimens.

Distribution.—Pacific Ocean: Sagami Sea, Japan, 313 fms. (**10**). The variety *L. scoliodocus*, var. *retroscissus*, Topsent, was dredged off the Cape Verde Islands in 633-598 metres (**46**).

Family *ROSSELLIDAE*.

Sub-family *LANUGINELLINAE*.

Mellonympha velata (Wyville Thomson).

Rossella velata, Wyville Thomson.

S.R. 327—8 v '06. 51° 43′ 30″–51° 38′ N., 12° 15′–12° 18′ W., soundings 550–800 fms., ooze. Sprat net on trawl. Temperature at 530 fms., 8.95°C.—One specimen.

The only specimen in the collection is in a very bad state of preservation. It is about 15 mm. in height by 7 mm. in

breadth. The prostalia pleuralia are much broken; only two of them still show the four tangential rays. These rays, when the spicules are complete, form the beautiful veil-like covering which gives the sponge its name.

Remains of the basal tuft of spicules are present. The spicules agree exactly in character with the short descriptions given by Schulze (**27** and **28**). The oxyhexasters are very abundant. They are usually about 0·1 mm. in diameter. Each of their short principal rays bears two or three terminal rays. The two kinds of discohexasters are rather scarce; one form, similar to the oxyhexasters in shape, but with discs on the terminal rays, is about 0·1 mm. in diameter; the other form, with numerous terminal rays, is rather smaller. Plumicomes are present, but are very scarce. They are about 0·06 mm. in diameter.

In his later description of the species Schulze (**28**) assigns this sponge to a new genus, *Mellonympha*, which is characterised by the presence of plumicomes, in addition to oxyhexasters and discohexasters, and restricts the genus *Rossella* to those species which possess for hexasters, only oxyhexasters and discohexasters.

Distribution.—North Atlantic, off the Strait of Gibraltar, 651 fms. (**34**, p. 418). Carter (*Ann. Mag. Nat. History* (4), xv, 1875, p. 121) states that fragments of *Rossella velata* were found among sponges dredged by the *Porcupine* to the N.W. of the Shetland Islands, in 345 fms.

Family *APHROCALLISTIDAE.*

[1] **Aphrocallistes beatrix,** Gray.

Aphrocallistes Bocagei, Wright.

Aphrocallistes ramosus, Schulze.

Aphrocallistes azoricus, Topsent.

Helga cxx—24 viii '01. 77 miles W.N.W. of Achill Head, soundings 382 fms. Trawl.—Several pieces.

S.R. 479—28 viii '07. 51° 20′ N., 11° 41′ W., soundings 468–560 fms. Trawl. Temperature at 400 fms., 9.55°C.—Numerous pieces.

S.R. 483—30 viii '07. 51° 37′ N., 11° 56′ W., soundings 610–664 fms., mud and sand. Trawl. Temperature at 550 fms., 8.34°C.—Several pieces.

S.R. 504—12 ix '07. 50° 42′ N., 11° 18′ W., soundings 627–728 fms., coral. Trawl. Temperature at 600 fms., 8.22°C.—Numerous pieces.

[1] See also Addenda, p. 38.

S.R. 505—12 IX '07. 50° 39′ N., 11° 14′ W., soundings 464–627 fms. Trawl. Temperature at 600 fms., 8.22°C.—One small fragment.

S.R. 1242—14 VIII '11. 56 miles W. ¼ S. of Great Skellig, 51° 27′ N., 11° 55′ W., soundings 550–590 fms. Trawl. —A few small fragments.

The specimens obtained are more or less broken, but several of the larger pieces are well preserved. The largest is 150 mm. in height by 105 mm.; another piece is 120 mm. high by 100 mm., with a fine sieve-plate measuring 80 mm. by about 50 mm. in diameter. Some of the specimens are growing on *Lophohelia*. The specimens are of the characteristic shape, with radial thimble-like diverticula, as shown in the figures of the species given by Schulze, Wright and others, whether under the name of *Aphrocallistes beatrix*, or under one of the names now recognized by Schulze (**29**) as its synonyms.

The soft parts of the sponge are sometimes well preserved, and preparations are easily obtainable showing the characteristic spicules of the species which have been so often described and figured.

Aphrocallistes beatrix was taken off the S.W. of Ireland in 500 fms. by the *Flying Fox*, and was recorded under the name of *A. Bocagei* (**14**). It was dredged twenty years previously by the *Porcupine* at Station 36, 1869, 48° 50′ N., 10° 9′ W., 725 fms., nearly 1° to the south of what is now usually taken as the southern limit of the Irish area.

Distribution.—North Atlantic: from the S.W. of Ireland to the Cape Verde Islands. South Atlantic: off St. Paul. Indian Ocean: Bay of Bengal, off the Andaman Islands, off the Nicobar Islands, Strait of Malacca, etc. Pacific Ocean: off Japan and the Philippines and at various stations off the East Indies.

Bathymetrical range, about 77 to 1075 fms.

Sub-order AMPHIDISCOPHORA.

Family *HYALONEMATIDAE*.

Hyalonema infundibulum, Topsent.

Plate II, fig. 3.

S.R. 494—8 IX '07. 51° 59′ N., 12° 32′ W., soundings 550–570 fms. Trawl.—Two specimens.

The specimens agree exactly, both in external appearance and in spiculation, with the descriptions and figures given by Topsent (**37**, **40** and **45**) of the species.

The sponges are extremely soft to the touch and very fragile. Both are cup-shaped, with the edges of the cup very thin and

ragged. The more complete of the two is 75 mm. in height by 35 mm. in diameter near the base, and 55 mm. in diameter near the summit. The central cavity is about 50 mm. deep and has four large, and many small, irregular openings at the bottom. There is no trace of a central cone, nor are there any indications that a cone has been torn away. The second specimen is about 70 mm. in height by 55 mm. across. Part of the wall of the cup is missing, but the bottom of the central cavity is uninjured and here again there is no trace of a central cone.

Each sponge has, at its base, a rounded hole from which the root-spicules were evidently torn. Three tufts of basal spicules were dredged at the above station, but there is nothing to show that any of them belonged to the specimens obtained.

Distribution.—North Atlantic: Bay of Biscay, 1710 metres, one specimen (**40**); off the Azores, 1372 metres, one specimen (**37** and **45**).

In addition to the root-tufts of spicules above referred to, which were dredged at S.R. 494, tufts of rooting spicules of *Hyalonema* were obtained at the following stations:—

S.R. 501—11 IX '07. 50° 49′ N., 11° 22′ W., soundings 447–625 fms. Trawl.—One root-tuft.

S.R. 502—11 IX '07. 50° 46′ N., 11° 21′ W., soundings 447–515 fms. Trawl. Temperature at 447–515 fms., 8.8°C. —Several root-tufts.

Pheronema Grayi, Kent.

Plate I, and Plate II, fig. 2.

S.R. 327—8 V '06. 51° 41′ N., 12° 16′ 30″ W., soundings 550–800 fms., ooze. Trawl.—One specimen.

S.R. 331—9 V '06. 51° 12′ N., 11° 55′ W., soundings 610–680 fms., ooze. Trawl.—Ca. two hundred and thirty specimens.

S.R. 332—10 V '06. 51° 12′ N., 12° 2′ 30″ W., soundings 680–735 fms., ooze. Trawl.—Seven specimens.

S.R. 333—10 V '06. 51° 37′ N., 12° 9′ W., soundings 557–579 fms., ooze. Trawl. Temperature at 500 fms., 9.2°C.—Two specimens.

S.R. 334—10 V '06. 51° 35′ 30″ N., 12° 26′ W., soundings 500–520 fms. Trawl.—Fifty-two specimens.

S.R. 364—10 VIII '06. 51° 23′ 30″ N., 11° 47′ W., soundings 620–695 fms., ooze. Trawl. Temperature at 600 fms., 7.92°C.—Two small specimens.

S.R. 387—7 XI '06. 51° 47′ N., 12° 12′ W., soundings 530–535 fms., ooze. Trawl. Temperature at 500 fms., 9.13°C.—One specimen and fragment.

S.R. 400—5 II '07. 51° 18′ N., 11° 50′ W., soundings 525–600 fms., mud and ooze. Trawl. Temperature at 580 fms., 8.35°C.—Three small specimens.

S.R. 477—28 VIII '07. 51° 15′ N., 11° 47′ W., soundings 707–710 fms., ooze. Trawl. Temperature at 707–710 fms., 7.19°C.—Ca. one hundred specimens.

S.R. 479—28 VIII '07. 51° 20′ N., 11° 41′ W., soundings 468–560 fms. Trawl. Temperature at 400 fms., 9.55°C.—One specimen.

S.R. 497—10 IX '07. 51° 2′ N., 11° 36′ W., soundings 775–795 fms., ooze. Trawl.—One specimen.

S.R. 500—11 IX '07. 50° 52′ N., 11° 26′ W., soundings 625–666 fms. Trawl. Temperature at 600 fms., 8.22°C.—One specimen.

S.R. 506—12 IX '07.—50° 34′ N., 11° 19′ W., soundings 661–672 fms. Trawl. Temperature at 600 fms., 8.22°C.—Eighteen small specimens.

S.R. 593—6 VIII '08.—50° 31′ N., 11° 31′ W., soundings 670–770 fms., ooze. Trawl. Temperature at 650 fms., 7.75°C.—Three specimens.

S.R. 753—17 V '09. 65 miles W. by S. ½ S. of Tearaght Light, 51° 24′ N., 11° 59′ 30″ W., soundings 561–572 fms. ooze. Trawl. Temperature at 550 fms. 8.79°C. —Three small specimens.

From a study of the foregoing list of stations it will be seen that *Pheronema Grayi* has been taken in great numbers over an area off the S.W. coast of Ireland extending from 53° 31′ N., to 51° 37′ N., and from 11° 19′ W. to 12° 26′ W. The depths at which the species was dredged are from 468 to 800 fms. At one station about two hundred and thirty specimens were taken in a single haul.

The specimens in the collection are of very different sizes. The smallest is 8 mm. in height by 6 mm. in diameter, exclusive of the prostalia, which project singly from all over the body, except from a narrow region round the osculum, a region which is not so well marked in the young sponge as it is in the older specimens.

A large number of specimens vary between 12 mm. and 35 mm. in height, while many more are from 75 mm. to 110 mm. high. The largest measures 145 mm. in height by 135 mm. The large sponges are about the size of specimens of *Pheronema Grayi* obtained farther south in the Atlantic. Saville Kent (**12**) gives four to four and one half inches for the height and breadth of the first-found specimens, and Topsent (**45**) states that 80 mm. to 100 mm. is an average size for specimens dredged off the Azores. The largest noted by the latter writer is a specimen from the Bay of Biscay, which is 180 mm. in diameter (**40**).

The oscular cavities of some of the sponges from S.R. 477 and S.R. 500 were half filled with the large eggs of a species of

Cephalopod, *Rossia* sp. (see Anne L. Massy, The Cephalopoda Dibranchiata of the Coasts of Ireland, *Fisheries, Ireland, Sci. Invest.*, 1907, I, [1909]).

Distribution.—North Atlantic; off Setubal, Portugal, 400–600 fms. (**12** and **13**); Bay of Biscay, 650–1410 metres (**40**); off the Azores, dredged in great abundance at a number of stations at depths of 793–1557 metres (**37** and **45**).

A fragment of a Dictyonine sponge was dredged at S.R. 480, 28 VIII '07. 51° 23′ N., 11° 38′ W., soundings 468 fms., stones. Trawl. It is growing on a piece of dead coral, and is about 14 mm. in diameter by 6 mm. in height. It is so much injured that its original shape cannot be made out. Numerous free spicules are present, which I have not been able to identify with those of any known species, and the specimen is unfortunately in too fragmentary a state to describe at length.

The beams of the dictyonal framework are spined; they are usually between 0·025–0·05 mm. in thickness. The following kinds of spicules are present:—

(1) Large sword-like dermal hexactines, which vary a good deal in size. The distal ray is up to 0·1 mm. in length by 0·012 mm., the tangential rays are about 0·25 mm. long, and the proximal is nearly 1 mm. long. All the rays are spined.
(2) Scopulae, about 0·8 mm. long by 0·005 mm. with slightly spined arms.
(3) Numerous slender diacts, up to about 0·6 mm. in length. No uncinates were seen.
(4) Oxyhexasters, about 0·085–0·1 mm. in diameter. The principal rays are 0·024–0·027 mm. long; each bears two or three terminal rays of about the same length as the principal ray.
(5) Discohexasters, the principal ray bears usually three terminal rays. The diameter of the whole is rather less than that of the oxyhexaster.

Both forms of hexasters are present in numbers, the oxyhexasters being more abundant than the discohexasters.

About half a dozen small, rounded sponge-like masses were dredged at S.R. 506—12 IX '07. 50° 34′ N., 11° 19′ W., soundings 661–672 fms. Trawl. These, at first sight, looked like Hexactinellid sponges, but, on examination, they proved to be merely accumulations of Hexactinellid spicules.

The large spicules form a felted mass, holding together small or broken spicules and ooze. Similar accumulations of Hexactinellid spicules have been described from time to time. They are sometimes found in much shallower water than are the living sponges to which they belong. It has been suggested by Professor Topsent (Spongiaires, *Expédition antarctique française*, 1903–1905, Paris, 1908) that these accumulations of Hexactinellid spicules may be due to the action of currents.

Order TETRAXONIDA.

Grade TETRACTINELLIDA.

Sub-order HOMOSCLEROPHORA.

Family *PLAKINIDAE*.

Plakortis simplex, Schulze.

S.R. 151—27 VIII '04. 50 miles W.N.W. of Eagle Island, 54° 17′ N., 11° 33′ W., soundings 388 fms., stones and rock. Dredge. Temperature at 388 fms., 9.15°C.—One specimen.

The sponge is about 40 mm. by 18 mm. in diameter, with a thickness of 10 mm.

The spicules agree exactly with the descriptions of the species given by Schulze (**26**) and Topsent (**39**), and they have been compared with preparations made from one of the specimens from Banyuls named by the latter author.

Distribution.—North Atlantic : Trondhjem Fjord (Norman Coll., see **45**, p. 103) ; off the Cantabrian coast of Spain (**44**). Mediterranean : Naples (**26**) ; Banyuls, between tide-marks (**39**) ; La Calle (**44**) : Red Sea (**22**).

The specimen from Amboina recorded as *P. simplex* (**41**) proves to be *Placinastrella clathrata*, Kirkpatrick (**44**, p. 344, and **45**, p. 103). Hentschel (**9**) has recently recorded a sponge from the Aru Islands under the name of *Plakortis simplex*.

Sub-order ASTROPHORA.

Family *THROMBIDAE*.

Thrombus abyssi (Carter).

S.R. 353—6 VIII '06. 50° 37–50° 40′ N., 11° 32′ W., soundings 250–542 fms., mud and sand. Trawl. Temperature at 500 fms., 8.58°C.—Two specimens.

The smaller specimen obtained is a fragment 6 mm. in length by little more than 1 mm. in breadth ; the larger is a thin encrustation about 25 mm. long by 10 mm. broad. Both are growing on dead *Lophohelia*. The oscula are small and scattered. The colour in spirit is pale greyish-yellow.

The spiculation is exactly as described for the original specimens (**2** and **39**). It is made up of trichotriaenes and amphiasters. The former are very regular in shape, nor do they vary much in size. The shaft projects above the cladome and is 0·055–0·06 mm. in length by 0·007 mm. The protocladi are 0.01 mm. long ; the deuterocladi are as much as 0.016 mm. in length. The cladome is 0·055–0·06 mm. across.

[1] See also Addenda, p. 38.

The amphiasters are 0·005 mm. long.

With the exception of a variety, *Thrombus abyssi* (Carter) var. *niger*, Topsent (**45**), obtained off the Azores in 1360 metres, the species has only been taken by the *Porcupine* Expedition. It was dredged at Station 3, 1870, at the western entrance of the English Channel, 48° 31′ N., 10° 3′ W., in 500 fms. (**2**).

Family *THENEIDAE*.

[1] **Thenea muricata,** Bowerbank.

S.R. 336—12 v '06. 51° 19′ N., 12° 20′ W., soundings 673–720 fms. Trawl. Temperature at 700 fms., 6.84°C.—Two specimens.

S.R. 497—10 ix '07. 51° 2′ N., 11° 36′ W., soundings 775–795 fms., ooze. Trawl.—Four specimens.

S.R. 499—11 ix '07. 50° 55′ N., 11° 29′ W., soundings 666–778 fms. Trawl. Temperature at 600 fms., 8.22°C.—One small specimen.

S.R. 500—11 ix '07. 50° 52′ N., 11° 26′ W., soundings 625–666 fms. Trawl.—One specimen.

S.R. 506—12 ix '07. 50° 34′ N., 11° 19′ W., soundings 661–672 fms. Trawl. Temperature at 600 fms., 8.22°C.—Two specimens.

S.R. 593—6 viii '08. 50° 31′ N., 11° 31′ W., soundings 670–770 fms., ooze. Trawl. Temperature at 650 fms., 7.75°C.—Five specimens.

S.R. 944—17 v '10. 86 miles W. ¼ N. of Great Skellig, 51° 22′ N., 12° 41′ W., soundings 982 fms., ooze. Trawl. Twenty-two small specimens.

The specimens obtained vary in size from 6 mm. in diameter and 7 mm. in height to about 105 mm. in diameter by 40 mm. in height. Apart from their differences in size, they vary a good deal in external appearance, as regards shape, number of oscula present, and degree of hispidation due to long projecting spicules.

The small specimens from S.R. 944 are from 10 to 25 mm. in diameter, and are very similar to the figures of *Thenea muricata* given by Vosmaer (**48** and **49**). Each has one small osculum, or, occasionally, two small oscula. Except for the few long tufts of spicules, these specimens are fairly smooth in appearance, though harsh to the touch from slightly projecting spicules. Buds are present on many of the specimens.

One specimen, about 67 mm. by 55 mm. in diameter and 32 mm. in height, has one irregularly shaped osculum, 25 mm. in length.

The remaining specimens vary from 70 mm. to 105 mm. in diameter, and have a height of 30 mm. to 40 mm. Several of them possess one long narrow osculum, and are very similar in appearance to some of Lendenfeld's figures of *Thenea*

[1] See also Addenda, p. 38.

Valdiviae (**19**, Pl. XVIII). Others have a number of small oscula, up to about 8 mm. in diameter. The oscula vary in number from 7 to 17 to each sponge. Some of the sponges are fairly smooth, others are very shaggy, with a dense thatch of long, projecting spicules.

With regard to the spiculation, emphasis has been laid on the length of the shaft of the dichotriaenes and on the size and relative abundance of the plesiasters in differentiating the North Atlantic species of *Thenea*.

In the small Irish specimens the shaft of the dichotriaenes is about 4·5 mm. long; in the larger specimens it is often between 6 and 9 mm. in length. Sollas' measurement, 5 mm. (**30**) is usually quoted for the length of the dichotriaenes in *T. muricata*. In medium-sized specimens of *T. muricata* from the Shetlands, with which the Irish specimens were compared, the shaft of the dichotriaenes varies from 5 to 8 mm. in length. In a specimen of the same species from Davis Strait only three or four dichotriaenes were measured, and these were from 8·5–10·5 mm. in length.

As to the plesiasters, in two or three Irish specimens of very different sizes, they are rather scarce, and their rays reach a maximum length of about 0·085 mm. In the majority of the specimens the rays of the plesiasters reach a maximum length of 0·125 mm., or more rarely, 0·135 mm.

Sollas (**30**) states that the rays of the largest plesiasters in *T. muricata* may reach a length of 0·005 inches (0·127 mm.) or more. One of his preparations from a specimen from Kors Fjord, shows rather numerous plesiasters with rays up to 0·125 mm. in length. The two specimens from the Shetlands, above referred to, have plesiasters with rays up to 0·15 mm. in length. The plesiasters are rare in one specimen, abundant in the other. The Davis Strait sponge, which has such large dichotriaenes, possesses plesiasters with rays not more than 0·075 mm. in length. The plesiasters, too, are very scarce.

In spite of these differences in the size and relative abundance of the plesiasters, and in the length of the dichotriaenes, as well as the difference in the external appearance of the sponges, the Irish specimens cannot be regarded as belonging to more than one species, and they are assigned to *Thenea muricata*, because they agree so well with descriptions given of the species, and with the specimens from Norway, the Shetlands and Davis Strait, with which they have been compared. Moreover, it seems doubtful if specific differences can really be maintained between the North Atlantic specimens of *Thenea* now assigned to several species.

The specimens of *Thenea Schmidti*, Sollas, from the Mediterranean and the Azores, with which the Irish specimens have been compared, have much larger plesiasters than have any of the Irish specimens, though it is impossible to decide whether these spicules are in greater abundance in *Thenea Schmidti*, or in some, at least, of the Irish specimens. The rays of the

plesiasters in the specimens of *Thenea Schmidti* that were examined had a maximum length of about 0·25 mm.

Lendenfeld (**19**) states that the chief differences between his species, *Thenea Valdiviae*, obtained off the Färöes, and *Thenea muricata*, lie in the possession by the former of one large irregularly-shaped osculum and 9–12 mm. long dichotriaenes, while the latter possesses one small round osculum and 5 mm. long dichotriaenes.

Small specimens of *Thenea muricata* certainly possess one small round osculum, but the larger specimens possess either one large osculum, or several small round oscula (Sollas mentions one Norwegian specimen which possessed six oscula), or sometimes several small oscula and one larger, slit-like osculum may be present in the same specimen.

From the measurements given above of the length of the dichotriaenes, it will be seen that the shaft varies from 4·5 mm. to at least 10·5 mm. in length in different specimens of *Thenea muricata*, so that no value can be laid on the length of the dichotriaenes in separating *Thenea Valdiviae* from *Thenea muricata*.

The plesiasters in *Thenea Valdiviae* seem to be intermediate in size between those of *Thenea muricata* and *Thenea Schmidti*, as their longest rays reach a length of 0·17 mm., or, more rarely, 0·2 mm.

It seems possible that a series of specimens might be obtained (as was suggested from the first with regard to the two older species) which would fill in all the gaps between these three species.

Distribution.—Arctic and North Atlantic Oceans, at many localities and at depths between 78 and 1913 fms.

Family *PACHASTRELLIDAE*.

Pachastrella monilifera, Schmidt.

Pachastrella abyssi, Schmidt.

S.R. 151—27 VIII '04. 50 miles W.N.W. of Eagle Island, 54° 17′ N., 11° 33′ W., soundings 388 fms., stones and rock. Dredge. Temperature at 388 fms., 9.15°C.—Three specimens.

The sponges are growing over dead coral and small pebbles. The largest is 64 mm. by 40 mm. in extent.

Colour, in spirit, pale yellow, with a pinkish tinge.

Distribution.—North Atlantic: off Cape St. Vincent, 292 fms. *Porcupine* Expedition (**3**); off Spain, 135 metres, and off the Azores, 318–1557 metres (**38** and **45**); Florida and the Gulf of Mexico (**24** and **25**). Mediterranean: off Banyuls and off Algeria (**38** and **44**). South Atlantic; off Tristan da Cunha, 110 fms. (**31**); off Gough Island, 100 fms. (**47**).

Characella pachastrelloides (Carter).

S.R. 151—27 VIII '04. 50 miles W.N.W. of Eagle Island, 54° 17′ N., 11° 33′ W., soundings 388 fms., stones and rock. Dredge. Temperature at 388 fms., 9.15°C.—One minute fragment.

S.R. 504—12 IX '07. 50° 42′ N., 11° 18′ W., soundings 627–728 fms., coral. Trawl. Temperature at 600 fms., 8.22°C.—Two specimens and several fragments.

The sponges are growing on dead *Lophohelia*. The two unbroken specimens are more or less rounded in shape, and are very harsh to the touch. They are about 40 and 60 mm. across, respectively.

The colour, in spirit, is pale yellow, with a pinkish tinge. The minute fragment from S.R. 151 is black in colour.

Distribution.—North Atlantic: off Cape St. Vincent, 374 fms, *Porcupine* Expedition (**3**); off Spain and the Azores, 300 and 736 metres, recorded as *C. Sollasi* (**37**); off the Azores, 523–845 metres (**45**).

[1] **Poecillastra compressa** (Bowerbank).

S.R. 479—28 VIII '07. 51° 20′ N., 11° 41′ W., soundings 468–560 fms. Trawl. Temperature at 400 fms., 9.55°C.—Numerous large pieces.

S.R. 483—30 VIII '07. 51° 37′ N., 11° 56′ W., soundings 610–664 fms., mud and sand. Trawl. Temperature at 550 fms., 8.34°C.—Numerous large pieces.

S.R. 504—12 IX '07. 50° 42′ N., 11° 18′ W., soundings 627–728 fms., coral. Trawl. Temperature at 600 fms., 8.22°C.—One small piece.

S.R. 1004—12 VIII '10. 51 miles W. ½ S. of Great Skellig, 51° 22′ 30″ N., 11° 44′ 30″ W., soundings 641–636 fms., fine sand. Trawl. Temperature at 630 fms., 7.12°C.—Numerous small pieces.

Nearly all the specimens are flat and plate-like in shape and are very similar in appearance to the figures of the species given by Topsent (**45**, Pl. IV, Figs. 1 and 3). Only two or three show any tendency to become cup-shaped. One specimen, growing on dead coral, seems to be practically complete. It is oval in outline, and is about 80 mm. long by 63 mm. in breadth with a thickness of about 9 mm. The remaining specimens are all broken; the largest pieces measure about 100 mm. across and are about 12 mm. thick.

One of the specimens is growing over a number of pebbles, another, as just mentioned, on a piece of dead coral; while several others are spreading over *Aphrocallistes beatrix*. The remaining pieces are all broken off from their support.

[1] See also Addenda, p. 38.

The species is here taken, not in the restricted sense maintained by Lendenfeld (**18** and **19**), but in the wider sense in which it is understood by Topsent (**45**), *Hymeniacidon placentula*, Bowerbank and *Pachastrella stylifera*, Lendenfeld, being included among its synonyms.

With regard to the spiculation of the Irish specimens, the large oxea normally occur with both ends sharply pointed, but usually some of them can be found with one or both ends rounded off. These abnormal spicules are often thicker than the typical oxea. In some specimens they are present in great abundance and are much more numerous than are similar spicules in one of the Rockall specimens of *P. stylifera*, now in the National Museum, Dublin.

Rather short, slender oxea can always be found among the fully developed ones, but no special dermal oxea are present, such as are described for *Pachastrella tenuipilosa*, Lendenfeld (**19**), and the surface of the sponge is smooth.

The tetractines, in some individuals, are usually malformed, having their rays shortened or sharply bent in various directions, or forked. In other specimens they are more frequently normal, but malformed ones can always be found on searching for them.

The spined microxea and the metasters are of the usual type.

Lendenfeld (**19**) suggests a separation of *P. compressa* from *P. stylifera* on the grounds that amphiasters and malformed tetractines are present in, and styli absent from, the former, while amphiasters and malformed tetractines are absent from, and styli present in, the latter.

In the Irish specimens, styli and malformed tetractines occur in one and the same specimen, as they do also in the Rockall sponge above referred to. Nor is there any appreciable difference in the asters of the Rockall and the Irish specimens. Among the asters are found, often in great numbers, very slender, small asters, some of which assume more or less the form of amphiasters. All varieties in shape occur, as described by Topsent (**47**, p. 613), but the different forms cannot be sharply divided from each other.

Distribution.—North Atlantic: off the Shetlands, 110 fms., and Hebrides (**1**); off Rockall, 60 and 120 fms., recorded as *P. stylifera* (**17**); off the coast of France, 50 metres (**38**); off the Azores, 200–1384 metres (**45**). Mediterranean: in 126 metres (**38**). South Atlantic: Gough Island, 100 fms., a variety (**47**). Pacific: Queen Charlotte Islands (**31**).

Sphinctrella ornata, Sollas.

S.R. 353—6 VIII '06. 50° 37′–50° 40′ N., 11° 32′ W., soundings 250–542 fms., mud and sand. Trawl. Temperature at 500 fms., 8.58°C.—Several specimens.

S.R. 504—12 IX '07. 50° 42′ N., 11° 18′ W., soundings 627-728 fms., coral. Trawl. Temperature at 600 fms., 8.22°C.—Several specimens.

This species is growing in cavities in dead *Lophohelia prolifera*. Only the long, silvery oscular fringe can be seen externally, the rest of the sponge being quite hidden in the coral. Topsent (**45**) has described specimens of this species from the Azores, which grow in an exactly similar way in holes in coral.

Distribution.—North Atlantic : off the Cape Verde Islands, 100–128 fms. (**31**) ; off the Azores, 523–1600 metres (**45**). Pacific : off Amboina (**41**).

Family *GEODIIDAE*.

Pachymatisma johnstonia (Bowerbank).

W. 141—13 VIII '10. Off Reenacry Head, Co. Kerry, soundings 37 fms., gravel. Dredge.—One specimen.

The only specimen obtained is very small. It spreads in a thin encrustation over a stone, and is about 15 mm. by 10 mm. in extent.

This well-known species has previously been obtained off several parts of the Irish coast, usually between tide-marks at extreme low water.

Distribution.—North Atlantic : off the north-western coasts of Europe, from Norway to France. Bathymetrical range from between tide-marks to 180 fathoms.

[1] **Geodia nodastrella,** Carter.

Plate IV, fig. 1.

S.R. 480—28 VIII '07. 51° 23′ N., 11° 38′ W., soundings 468 fms., stones. Oyster dredge.—One specimen.

The sponge is a good deal injured and is broken into two pieces. It shows no signs of having been attached to any support. It is 30 mm. by about 22 mm. in diameter. A cribriform membrane covers the sponge. No oscular areas could be made out. The surface is smooth and the colour, in spirit, is a pale yellowish white. The spiculation agrees exactly with that of a fragment of one of the specimens dredged by the *Porcupine* at Station 65, 1869, with which the Irish specimen was compared.

The spicules in the Irish specimen measure as follows :—

(1) Somal oxea, curved, sharply pointed and rather slender for their length, which varies between 2 and 4·5 mm. Thickness, 0·03–0·04 mm.

[1] See also Addenda, p. 38.

(2) Cortical oxea, 0·35 mm. in length by 0·007 mm.

(3) Dichotriaenes. Shaft straight, tapering to a long slender point, or with the point rounded off; 2–4 mm. in length by 0·08–0·1 mm. beneath the cladome. Protocladi 0·15–0·2 mm. in length. Deuterocladi about 0·2–0·25 mm. in length.

(4) Anatriaenes. Shaft up to 5·5 mm. in length by 0·02–0·025 mm. beneath the cladome. Cladi, 0·1 mm. long. Chord, 0·15 mm.

(5) Promesotriaenes. Only broken ones were seen. The cladi are about 0·175 mm. long.

(6) Sterrasters, oval, rather uniform in size, averaging 0·11 mm. by 0·09 mm.

(7) Somal spherasters, with fairly well-marked centrum and blunt rays. Diameter 0·005–0·008 mm.

(8) Spherasters occurring in numbers beneath the sterrasteral layer. Centrum large, with numerous rays. These rays vary very much in shape. In some of the spherasters they are fairly long and sharply pointed; in others they are short and blunt; in others, again, they are reduced to rounded tubercles. These spherasters are from 0·014 mm. to 0·024 mm. in diameter.

(9) Choanosomal oxyasters, with slender rays 0·01–0·012 mm. in length. The rays are usually 8–9 in number. Diameter of the whole aster, 0·02–0·024 mm.

These spicules agree exactly in shape with those of the fragment of the *Porcupine* specimen, and their measurements also agree closely with those of the earlier specimen, as far as the latter could be ascertained, the megascleres being rather broken in the only fragment available.

The following are some of the measurements of the spicules of the *Porcupine* specimen:—Somal oxea, 2–3 mm. long by 0·03 mm. in thickness; cortical oxea, 0·25 mm. long by 0·007 mm.; dichotriaenes, shaft 0·075–0·09 mm. in thickness beneath the cladome. A few broken promesotriaenes were seen. Sterrasters, 0·1 mm. by 0·08 mm.; somal spherasters, 0·005 mm. in diameter; subcortical spherasters, with large centrum and with sharp or blunt rays, or with rounded tubercles, 0·014–0·02 mm.; choanosomal oxyasters with rays 0·008–0·01 mm. long.

Distribution.—North Atlantic: "in deep water between the north of Scotland, the north-west of Shetland, and the Färöe Islands, at Stations 51, 57, 61–63 and 65, respectively; also near Cape St. Vincent." *Porcupine* Expedition, 1869 (**3**, p. 399).

The specimen at first named *Geodia nodastrella* by Topsent (**37**) has since been assigned by him to *Geodia eosaster*, Sollas (**45**).

Sidonops atlantica, n. sp.

Plate II, fig. 1, and Plate IV, fig. 3.

S.R. 151—27 VIII '04. 50 miles W.N.W. of Eagle Island, 54° 17′ N., 11° 33′ W., soundings 388 fms, stones and rock. Dredge, 388 fms. Temperature at 388 fms., 9.15°C.—One specimen.

The sponge is growing on a piece of *Retepora*. It is more or less rounded in shape, and measures 27 mm. in length by 20 mm. in height. It is a good deal broken at one end.

The surface is perfectly smooth for the most part, but here and there a few megascleres project beyond it.

The oscula are confined to the upper surface of the sponge. They are small, simple openings, averaging about 0·5 mm. in diameter. Some of them have a very slightly raised margin.

The pores are restricted to the free part of the under surface of the sponge. They are from 0·075 to 0·3 mm. in diameter, and they occur in sieve-like areas which are about 0·3–0·5 mm. across. Each pore-sieve contains usually from two to four pores.

The colour, in spirit, is pale buff-yellow.

The skeleton consists, as is usual in the genus, of radiating bundles of megascleres. The cladi of the orthotriaenes are extended beneath the sterrasteral layer, which is about 0·35 to 0·5 mm. in thickness.

Neither cortical oxea nor promesotriaenes could be found in situ. A few small oxea were scattered through several of the spicule-preparations, but it was impossible to decide whether they belonged to the sponge or not. Two or three broken promesotriaenes were also seen.

Spicules :—

(1) Somal oxea, curved, tapering to fairly sharp points. Length 2·4–3·4 mm. by 0·045–0·06 mm.

(2) Orthotriaenes. Shaft 2–3 mm. long by 0·07–0·09 mm. beneath the cladome, tapering to a blunt point. Cladi 0·4–0·55 mm. long by about 0·05 mm. at the base. Occasionally the cladi divide so that a few dichotriaenes are to be seen.

(3) Anatriaenes. Shaft 2–3 mm. in length by 0·01–0·02 mm. beneath the cladome, tapering to a long slender point. Cladi 0·09–0·16 mm. long. Chord 0·125–0·2 mm.

(4) Promesotriaenes. One broken spicule measured as follows: shaft, 3 mm. long by 0·015 mm., cladi about 0·13 mm. long.

(5) Sterrasters, oval, 0·1 mm. by 0·08 mm. in diameter.

(6) Somal spherasters, with comparatively large centrum and numerous slender, sharply-pointed, or occasionally blunt rays, 0·005–0·01 mm. in diameter. Towards the interior of the sponge the spherasters are slightly larger, being about 0·015–0·02 mm. in diameter.

(7) Choanosomal oxyasters, with minutely spined rays which are conical, and which taper to a sharp point. The rays are usually 3–9 in number and are 0·04–0·055 mm. in length by about 0·006 mm. at the base. Diameter of the whole aster 0·075–0·11 mm. The oxyasters are very abundant.

A few small fragments of a Geodine sponge are in the collection. These fragments are, for the most part, from the interior of the sponge, and are too incomplete to identify. They were dredged at S.R. 151–27 VIII '04. 50 miles W.N.W. of Eagle Island, 54° 17′ N., 11° 33′ W., soundings 388 fms., stones and rock. Dredge. Temperature at 388 fms., 9.15°C.

Sub-order SIGMATOPHORA.

Family *TETILLIDAE*.

Tethya cranium (Müller).

S.R. 151—27 VIII '04. 50 miles W.N.W. of Eagle Island, 54° 17′ N., 11° 33′ W., soundings 388 fms., stones and rock. Dredge. Temperature at 388 fms., 9.15°C.—Two specimens.

S.R. 196—11 II '05. 54° 42′ N., 10° 34′ W., soundings 242 fms., stones and coral. Oyster dredge. Temperature at 235 fms., 9.8°C.—One specimen.

S.R. 277—15 XI '05. 50 miles W.N.W. of Eagle Island, 54° 17′ 30″ N., 11° 34′ W., soundings 550 fms., gravel and shells. Oyster dredge.—Two specimens.

The specimens obtained are all small, being only from 4 to 6 mm. in diameter. They are growing on specimens of *Mycale* sp. and *Stylostichon* sp.

The species has been previously recorded for the Irish area, namely, in Dingle Bay and off the Aran Islands, Co. Galway (**50**).

Distribution.—Arctic and North Atlantic Oceans from many localities at depths of 15 to 550 fms.

iii. Monaxonellida (sub-order Astromonaxonellida).

Of the Monaxonellid sponges obtained by the Fisheries Branch, only those belonging to the sub-order Astromonaxonellida, Dendy, are described in this paper.

The Astromonaxonellida which were obtained during the cruises of the *Helga* off the Mayo coast in the years 1909-1911, and which, therefore, belong to the collections of the Fisheries Branch, are included in this report. They have previously been recorded in the report on the sponges of the Clare Island Survey (**33**), and in a paper on the Results of a Biological Survey of Blacksod Bay (**5**), but details of the Stations were not given in the first-mentioned report.

Twenty-seven species of Astromonaxonellida are in the collection. The classification is taken from Professor Dendy's work on Ceylon sponges (**4**).

The following is a list of the species :—

Order TETRAXONIDA.

Grade **MONAXONELLIDA.**

Sub-order ASTROMONAXONELLIDA.

Topsentia glabra (Topsent).
Donatia lyncurium (Linn.).
Timea Hallezi (Topsent) var. *crassa*, Topsent.
Latrunculia Normani, n. sp.
Cliona celata, Grant.
Cliona vastifica, Hancock.
Cliona lobata, Hancock.
Cliona levispira, Topsent.
Cliona Pruvoti, Topsent.
Cliona labyrinthica, Hancock.
Cliona coralliophaga, n. sp.
Alectona Millari, Carter.
Vibulinus stuposus (Montagu).
Vibulinus rigidus (Montagu).
Polymastia mammillaris (Müller).
Polymastia robusta, Bowerbank.
Tentorium semisuberites (Schmidt).
Quasillina brevis (Bowerbank).
Spinularia spinularia (Bowerbank).
Atergia corticata, gen. et sp. n.
Suberites caminatus, Ridley and Dendy.
Suberites gibbosiceps, Topsent.
Suberites carnosus (Johnston).
Ficulina ficus (Linn.).
Laxosuberites incrustans, n. sp.
Laxosuberites durus, n. sp.
Terpios fugax, Duchassaing and Michelotti.

Of the foregoing, one genus and five species are described as new, while the following fourteen species are now obtained for the first time within the Irish area.

Topsentia glabra.
Timea Hallezi, var. *crassa* (**33**)
Cliona vastifica.
Cliona lobata.
Cliona levispira.
Cliona Pruvoti.
Cliona labyrinthica.
Alectona Millari.
Vibulinus rigidus (**33**).
Tentorium semisuberites.
Quasillina brevis.
Spinularia spinularia.
Suberites caminatus.
Suberites gibbosiceps.

With the exception of the following six species, *Cliona vastifica*, *C. lobata*, *Alectona Millari*, *Vibulinus rigidus*, *Quasillina brevis* and *Spinularia spinularia*, these sponges are also new to the British area.

Three of the species, *Cliona levispira*, *C. Pruvoti* and *Suberites gibbosiceps* have been recorded only once previously.

With regard to the Clionidae, only one species, *Cliona celata*, was, up to the present, known to occur off the Irish coast. Eight species of boring sponges are included in this collection. Three of these, *Cliona celata*, *C. vastifica* and *C. lobata*, have been found boring in oyster shells taken from oyster beds at different parts of the coast. So far, the first named only has been found in abundance, but *C. vastifica* will probably prove to be fairly common when specially looked for. The third species, *C. lobata*, bores very small galleries in shells and is, therefore, easily overlooked, but it is apparently not as common as *C. vastifica*. The remaining species of boring sponges in the collection have all been dredged in deep water. They are boring in masses of coral (*Lophohelia* and *Amphihelia*). *C. vastifica* is the only species so far found off the Irish coast boring in both coral and oyster shells.

Professor Topsent (**43**) in his detailed account of the Clionidae of France gives nine species and one variety as occurring off the French coast.

With the exception of two of these species and the variety, namely, *Cliona Schmidti*, *C. viridis* and *C. viridis* var. *Carteri*, all the species enumerated by Professor Topsent in his monograph have now been found within the Irish area.

Order TETRAXONIDA.

Grade MONAXONELLIDA.

Sub-order ASTROMONAXONELLIDA.

Family *EPIPOLASIDAE*.

Topsentia glabra (Topsent).

S.R. 353—6 VIII '06. 50° 37′–50° 40′ N., 11° 32′ W., soundings 250–542 fms., mud and sand. Trawl. Temperature at 500 fms., 8.58°C.—Three specimens.

The sponges are growing on coral (*Lophohelia prolifera*), and one of them spreads over an *Arca* shell which is attached to the coral.

The largest specimen is a thin encrustation about 20 mm. by 15 mm. in extent. In spite of its small size it is noticeable on account of its smooth, shining surface.

The large oxea have a maximum size of about 1 mm. by 0·02 mm. They are thus rather more slender than the oxea

of the type which reach a maximum diameter of 0·03 mm. In the remaining specimens the large spicules are modified into strongyloxea, a modification noted by Topsent in two of his specimens. Here again the large spicules are rather slender; a few only among them reach a diameter of 0·015 mm., while the corresponding spicules of the first-found specimens have a maximum diameter of 0·02 mm.

Distribution.—Off the Azores in 200–1360 metres (**45**), and in the Mediterranean, off La Calle, Algeria (**44**).

Family *DONATIIDAE.*

Donatia lyncurium (Linn).

L. 37—11 II '02. Black Rocks, Ballynakill Harbour. Shore collecting.—Two specimens.

S. 568–570—24–25 I '08. Ballyvaldon, soundings 10½–7 fms. Oyster dredge.—Three specimens.

W. 141—13 VIII '10. Off Reenacry Head, Co. Kerry, soundings 37 fms., gravel. Dredge.—One specimen.

S. 597—6 II '11. Ballyvaldon oyster beds, Norris Castle Coastguard Station, Co. Wexford, soundings 7–8 fms. Naturalist's dredge.—One specimen.

This well-known species is fairly common off the Irish coast between tide-marks, at extreme low tide, and in deeper water. The largest specimen in the present collection is 40 mm. in diameter.

Distribution.—Arctic and North Atlantic Oceans; Mediterranean; Gulf of Manaar. Bathymetrical range between tide-marks, at extreme low water, to 216 fathoms.

Family *SPIRASTRELLIDAE.*

Timea Hallezi (Topsent), var **crassa**, Topsent.

W. 83—25 V '09. 2·3 miles S.E. ½ S. of Inishturk Tower, soundings 13 fms., coral. Naturalist's dredge.—One specimen.

The single specimen obtained by the *Helga* has already been recorded in the report on the sponges taken during the Clare Island Survey (**33**).

Latrunculia Normani, n. sp.

Plate V, fig. 2.

S.R. 151—27 VIII '04. 50 miles W.N.W. of Eagle Island, 54° 17′ N., 11° 33′ W., soundings 388 fms., stones and rock. Dredge. Temperature at 388 fms., 9.15°C.—One specimen.

S.R. 480—28 VIII '07. 51° 23′ N., 13° 38 W., soundings 468 fms., stones. Oyster dredge.—One specimen.

The specimen from S.R. 151 is a mere fragment growing on a block of sandstone. The second specimen spreads in a very thin encrustation, of considerable extent, over the branches of a piece of coral (*Lophohelia prolifera*).

The surface of the sponge is smooth, but is here and there raised up into minute hillocky elevations.

The colour, in spirit, is cream white.

The pores are arranged in areas; the oscula are not apparent.

The main skeleton consists of strong fibres, made up of closely-packed, multiserially arranged styli, which run upwards through the sponge, and which are continued in a horizontal direction beneath the dermal layer of discasters.

The dermal skeleton consists of a single layer of vertically placed discasters, which are set closely together. Discasters also occur scattered through the choanosome.

Spicules.

(1) Styli, with a straight, polytylote shaft, having a length of 0·5–0·65 mm. by 0·008 mm.

(2) Discasters of two kinds—(*a*) Somal discasters, which possess a basal verticil of, usually, 4 to 6 downwardly directed simple spines. At the middle of the spicule is another verticil, which is cut into four broad lobes by four deep indentations reaching nearly to the shaft. Each of these lobes has a denticulated outer margin. At the upper end of the spicule is a verticil of 4 strong, upwardly directed spines, with slightly serrated outer margins. Above this verticil is the short, serrated cone-shaped apex of the spicule. Somal discasters, 0·06–0·075 mm. in length, with a diameter of 0·05 mm. across the middle verticil. (*b*) Choanosomal discasters. The shaft of this kind of spicule is continued to a strong point at either end. There are two verticils of spines, one at the middle of the spicule, and the other, which consists of 4 simple, upwardly directed spines, about 0·04 mm. long, towards one end of the spicule. The point at the other end of the spicule is sometimes bifurcated. Length of the spicule, 0·1–0·13 mm.

The somal discasters of the new species are very similar in shape to those of *Latrunculia natalensis*, Kirkpatrick (**15**), but they are about twice their size. The African species differs also in the shape of its choanosomal discasters and megascleres, as well as in its external appearance.

A spicule-preparation, labelled "*Latrunculia cratera* Bocage, variety, Lervig, Norway, 1879," in a collection of Canon Norman's slides proved to belong to the same species as the Irish specimen, which is therefore named after Canon Norman, the first collector of the species.

Family *CLIONIDAE*.

Cliona celata, Grant.

M.L. CXVId.—17 XII '01. 1 mile S.E. of Lyon Head, Ballynakill Harbour, soundings 14 fms.

Helga 119—21 I '03. Off Arklow, soundings 10 fms.

L. 257—20 X '03. Channel off Coastguard Bay, Ballynakill Harbour, soundings 4–8 fms.

A. 5—1 VI '04. ½ mile S. by E. of Mutton Island, Galway Bay, soundings 6 fms.

A. 32—26 VII '04. Between Renville Point and Hare Island, Galway Bay, soundings 4 fms.

S.R. 147—24 VIII '04. 120 miles W.N.W. of Slyne Head, Porcupine Bank, 53° 27′ N., 13° 37′ W., soundings 91½ fms., gravel, sand and shells.

Ardfry, Co. Galway.—Oyster beds, October and December, 1906, and December, 1909.

W. 74—24 V '09. 3·3 miles N. ½ W. of Clare Island Light, soundings 25 fms., rock. Oyster dredge.

W. 106—23 VIII '09. 0·7 miles S. of Mallaranny Pier, Clew Bay, soundings 5½–11 fms.

Blacksod Bay, between tide-marks to 8 fms., at the following stations:—

W. 125—18 IX '09.	W. 183—16 III '11.
W. 131—11 III '10.	W. 185—17 III '11.
W. 137—14 III '10.	W. 233—21 IX '11.
W. 163—18 IX '10.	W. 234—23 IX '11.
W. 178—13 III '11.	W. 235—24 IX '11.
W. 180—15 III '11.	W. 237—26 IX '11.

W. 204—20 VIII '11. 0·9 miles S.S.E. ¼ S. of Caher Point, Caher Island, soundings 11 fms., stones. Naturalist's dredge.

W. 206—21 VIII '11. 3·8 miles N.W. ¼ N. of Clare Island Lighthouse, soundings 25 fms., stones. Naturalist's dredge.

W. 222—22 VIII '11. 2 miles S.W. by S. ½ S. of Clare Island Look-out Tower, soundings 25½ fms., stones. Canvas dredge.

Mizzen Head, Co. Wicklow, public oyster beds.

Cliona celata is common off the Irish coasts, especially in shallow water. It is frequently found boring in oyster shells and in limestone, and it often occurs massive.

The specimen dredged at S.R. 147 is boring in a shell of *Liomesus Dalei*.

Distribution.—Eastern and western shores of the North Atlantic; Mediterranean; off the south and south-west coasts of Australia, and off New Guinea. Bathymetrical range from between tide-marks to 110 fathoms.

Cliona vastifica, Hancock.

Off Cleggan Head.—September, 1901.

Mizzen Head, Co. Wicklow; public oyster beds.

S.R. 1177—22 V '11. 53 miles W. ½ N. of Blackball Head, 51° 21′ N., 11° 24′ W., soundings 152½ fms., sand. Naturalist's dredge.

This widely-spread species, although previously unrecorded for Ireland, will probably prove to be fairly abundant in our waters, when it is specially looked for, as it is common off the coasts of France, from between tide-marks to deep water (**43**).

The specimen dredged off Cleggan Head is boring in a shell of *Fusus propinquus*, while those from S.R. 1177 are in coral (*Lophohelia prolifera*). The Mizzen Head specimens are boring in oyster shells.

Distribution.—European coasts of the North Atlantic; Mediterranean; Black Sea; Gulf of Mexico; Red Sea, Indian Ocean; off Japan, New Zealand and South-west Australia. Bathymetrical range from between tide-marks to 328 fathoms.

Cliona lobata, Hancock.

Mizzen Head, Co. Wicklow; public oyster beds.

Ardfry, Co. Galway, October, 1906; "Main Pond" oyster beds.

This species is probably not very common off our coasts, but it is liable to be overlooked, owing to the small size of its papillae.

Only two specimens are in the present collection. Each is boring in an oyster shell.

Distribution.—Western coasts of Europe, from Great Britain and Denmark to France; Mediterranean, off the south coast of France; off the west coast of Cape Colony (25 fathoms).

[1] **Cliona levispira,** Topsent.

S.R. 353—6 VIII '06. 50° 37′–50° 40′ N., 11° 32′ W., soundings 250–542 fms., mud and sand. Trawl. Temperature at 500 fms., 8.58°C.

S.R. 504—12 IX '07. 50° 42′ N., 11° 18′ W., soundings 627–728 fms., coral. Trawl.

S.R. 1004—12 VIII '10. 51 miles W. ½ S. of Great Skellig, 51° 22′ 30″ N., 11° 44′ 30″ W., soundings 641–636 fms., fine sand. Trawl.

This well-characterised species has, up to the present, only been obtained off the Azores (**45**), where it appears to be common, boring in coral, taken at depths of 1165–1360 metres.

The Irish specimens agree in every particular with the description of the first-found specimens. The species is not abundant in the present collection, and occurs boring in coral (*Lophohelia prolifera*).

[1] See also Addenda, p. 38.

Cliona Pruvoti, Topsent.

S.R. 151—27 VIII '04. 50 miles W.N.W. of Eagle Island, 54° 17′ N., 11° 33′ W., soundings 388 fms., stones and rock. Dredge.

S.R. 480—28 VIII '07. 51° 23′ N., 11° 38′ W., soundings 468 fms., stones. Oyster dredge.

This species has been taken only off the Mediterranean coast of France at depths of 500–600 metres, nor does it appear to be common off the Irish coast.

The specimens dredged by the *Helga* are boring in coral (*Amphihelia oculata*). They agree exactly with the description given by Topsent (**43**) of the first-found specimens. The small oxea are 0·1–0·15 mm. in length by 0·002 mm ; the large oxea have a maximum size of 0·3 mm. by 0·009 mm. The spinispirae are 0·005 mm. in length.

Cliona labyrinthica, Hancock.

S.R. 277—15 XI '05. 50 miles W.N.W. of Eagle Island, 54° 17′ 30″ N., 11° 34′ W., soundings 550 fms., gravel and sand. Oyster dredge.

S.R. 353—6 VIII '06. 50° 37′–50° 40′ N., 11° 32′ W., soundings 250–542 fms., mud and sand. Trawl. Temperature at 500 fms., 8.58°C.

S.R. 480—28 VIII '07. 51° 23′ N., 11° 38′ W., soundings 468 fms., stones. Oyster dredge.

S.R. 504—12 IX '07. 50° 42′ N., 11° 18′ W., soundings 627–728 fms., coral. Trawl.

S.R. 1004—12 VIII '10. 51 miles W. ½ S. of Great Skellig, 51° 22′ 30″ N., 11° 44′ 30″ W., soundings 641–636 fms., fine sand. Trawl. Temperature at 630 fms., 7.12°C.

This species is fairly abundant in the collection. It occurs boring in coral (*Lophohelia prolifera*). The spicules agree exactly in size and shape with the spicules of specimens of *C. labyrinthica* found boring in coral.

The oxea are from 0·125–0·15 mm. in length by 0·009 mm. They are thus both longer and thicker than the spicules of specimens found boring in shells (**43**).

Distribution.—Off the Azores, 793–1424 metres (**45**); off the Mediterranean coast of France, 500–600 metres (**43**).

The locality from which the first-found specimen was obtained is unknown (**8**).

Cliona coralliophaga, n. sp.

Plate V, fig. 1.

S.R. 504—12 IX '07. 50° 42′ N., 11° 18′ W., soundings 627–728 fms., coral. Trawl. Temperature at 600 fms., 8.22°C.

The sponge forms extensive cavities in coral (*Lophohelia prolifera*). It has the lobed form typical of boring sponges. The lobes are usually elongated and are somewhat quadrangular in outline; they are up to 7 mm. in length by 5 mm. in width, but they vary considerably in size and shape; they are joined to each other by very slender connections.

The papillae are small and are few in number. They are about 0·4–0·5 mm. in diameter.

The colour in spirit is a pale pinkish purple where the sponge is exposed at the broken ends of the coral to the direct action of the spirit. The colour is deeper in those parts of the sponge which are protected by the unbroken coral.

"Cellules sphéruleuses" are extremely abundant through the sponge, and are 0·008–0·01 mm. in diameter.

The skeleton consists of an irregular reticulation of rather closely packed oxea. At the surface of the sponge the spicules lie, for the most part, tangentially, but the ends of a few of them project very slightly from the sponge. The skeleton is as irregular in the papillae as in the lobes.

Spicules:—

The only kind of spicules present are oxea. Spinispirae were looked for carefully, but without success. The oxea are of very different sizes, but all are of the same type. They vary from 0·08 mm. to 0·55 mm. in length by 0·0025 mm. to 0·011 mm. in thickness. The oxea taper gradually to long points; they are biangulated, that is to say, they are bent twice in the same direction, the bends being rather far from each other. Sometimes there is a slight swelling in the middle of the spicule. The oxea are very similar in shape to those of *Spongosorites placenta*, Topsent (**43**).

Two species of Cliona, namely, *C. labyrinthica*, Hancock, and *C. nodosa*, Hancock, are known, which possess oxea as the sole form of spicule. The new species differs from both these in the size and shape of the oxea.

Three species, dredged off Madeira, have been described by J. Y. Johnson (**11**) as boring sponges possessing oxea only. It is possible, as Topsent (**45**) suggests, that these sponges are not all Clionids. In any case, their oxea differ altogether in size and shape from those of the new species.

[1] **Alectona Millari,** Carter.

S.R. 151—27 VIII '04. 50 miles W.N.W. of Eagle Island, 54° 17′ N., 11° 33′ W., soundings 388 fms., stones and rock. Dredge. Temperature at 388 fms., 9.15°C.

S.R. 277—15 XI '05. 50 miles W.N.W. of Eagle Island, 54° 17′ 30″ N., 11° 34′ W., soundings 550 fms., gravel and sand. Oyster dredge.

[1] See also Addenda, p. 38.

S.R. 353—6 VIII '06. 50° 37′–50° 40′ N., 11° 32′ W., soundings 250–542 fms., mud and sand. Temperature at 500 fms., 8.58°C.

S.R. 479—28 VIII '07. 51° 20′ N., 11° 41′ W., soundings 468–560 fms. Trawl. Temperature at 400 fms., 9.55°C.

S.R. 480—28 VIII '07. 51° 23′ N., 11° 38′ W., soundings 468 fms., stones. Oyster dredge.

S.R. 487—3 IX '07. 51° 36′ N., 11° 57′ W., soundings 540–660 fms. Temperature at 500 fms., 8.65°C.

S.R. 1004—12 VIII 10. 51 miles W. ½ S. of Great Skellig, 51° 22′ 30″ N., 11° 44′ 30″ W., soundings 641–636 fms., fine sand. Trawl. Temperature at 630 fms., 7.12°C.

The Irish specimens of this well-known sponge are boring in coral (*Lophohelia prolifera* and *Amphihelia oculata*). The species occurs in far greater abundance, and forms more extensive cavities, than any other of the sponges in the collection which are boring in coral.

Distribution.—Off the eastern shores of the North Atlantic, from the Färöes to the Azores, and in the Mediterranean. Bathymetrical range from 250 to 660 fathoms.

Family *ASTRAXINELLIDAE.*

Vibulinus stuposus (Montagu).

Plate III, fig. 7.

L. 322—23 III '04. Coastguard Deep, Ballynakill Harbour, soundings 6–8 fms. Naturalist's dredge.—One specimen.

W. 96—26 V '09. 6·2 miles E. by S. ¾ S. of Clare Island Light, soundings 16 fms. Naturalist's dredge.—One specimen.

W. 141—13 VIII '10. Off Reenacry Head, Co. Kerry, soundings 37 fms., gravel. Dredge.—One specimen.

The largest specimen is 65 mm. in height and 99 mm. in width. It is fan-shaped and bears numerous branches.

Distribution.—Off the western coast of Europe, from the Orkneys to Spain. From shallow water to a depth of 74 fms.

Vibulinus rigidus (Montagu).

W. 106—23 VIII '09. 0·7 miles S. of Mallaranny Pier, Clew Bay, soundings 5½–11 fms. Dredge. One specimen.

The single specimen obtained by the *Helga* has already been recorded in the report on the sponges of the Clare Island Survey (**33**).

Distribution.—Off the coasts of England and France.

Family *POLYMASTIIDAE.*

Polymastia mammillaris (Müller).

Helga LXXXVa.—5 vii '01. 40 miles N. of Cleggan Head, soundings 87 fms., sand and stones. Naturalist's dredge. Temperature at 80 fms., 9.5°C.—Two small specimens.

L. 36—10 ii '02. Roeillaun Rocks, Ballynakill Harbour, shore collecting.—One specimen.

S.R. 178—16 xi '04. 40 miles N.W. by W. ¾ W. of Cleggan Head, 53° 36′ 30″ N., 11° 15′ 30″ W., soundings 74½ fms., coarse gravel and stones. Oyster dredge. Temperature at 74½ fms., 10.8°C.—Five small specimens.

W. 83—25 v '09. 2·3 miles S.E. ½ S. of Inishturk Tower, soundings 13 fms., coral. Naturalist's dredge.—Three small specimens.

The smallest specimens, which are growing on stones, vary from 3 to 8 mm. in diameter and each bears one papilla. The specimens obtained off Inishturk Island, at Station W. 83, are about 15 mm. in diameter and possess from one to four papillae each; they have already been recorded in the report on the Sponges of the Clare Island Survey (**33**), and they are interesting on account of the fact that several of the papillae bear buds at their summit.

Distribution.—Arctic Ocean; eastern and western shores of the North Atlantic; Mediterranean; Pacific Ocean. Bathymetrical range from between tide-marks at extreme low water to 630 fms.

Polymastia robusta (Bowerbank).

S. 568–570—24–25 i '08. Ballyvaldon, Co. Wexford, soundings 10½–7 fms. Oyster dredge.—Two specimens.

S. 597—6 ii '11. Ballyvaldon oyster beds, Norris Castle Coastguard Station, Co. Wexford, soundings 7½–8 fms. Naturalist's dredge.—Two specimens.

The largest specimen is oval in shape and measures 75 mm. by 47 mm., with a height of 45 mm.

This well-known species was only once previously noted for Ireland, namely, for Birterbuy Bay (**1**).

Distribution.—European and North American shores of the North Atlantic. Bathymetrical range from 7 to 693 fathoms.

Tentorium semisuberites (Schmidt).

S.R. 151—27 viii '04. 50 miles W.N.W. of Eagle Island, 54° 17′ N., 11° 33′ W., soundings 388 fms., stones and rock. Dredge. Temperature at 388 fms., 9.15°C.—Two specimens and a fragment.

S.R. 277—15 XI '05. 50 miles W.N.W. of Eagle Island, 54° 17′ 30″ N., 11° 34′ W., soundings 550 fms., gravel and shells. Oyster dredge.—Two specimens.

S.R. 353—6 VIII '06. 50° 37′–50° 40′ N., 11° 32′ W., soundings 250–542 fms., mud and sand. Trawl. Temperature at 500 fms., 8.58°C.—A fragment.

The specimens are growing on sandstone, on pebbles, and on a piece of dead coral. The largest is 20 mm. in height by 8 mm., and the smallest is 5 mm. in height by 1·5 mm.

Distribution.—Arctic Ocean; off the eastern and western shores of the North Atlantic; South Atlantic, off Tristan da Cunha. Bathymetrical range 60 to 1650 fathoms.

Quasillina brevis (Bowerbank).

S.R. 151—27 VIII '04—50 miles W.N.W. of Eagle Island, 54° 17′ N., 11° 33′ W., soundings 388 fms., stones and rock. Dredge. Temperature at 388 fms., 9.15°C.—One specimen.

The sponge is 15 mm. in height by 3 mm. at its greatest breadth. It is oval in shape and has a well-marked stalk. There is a single osculum at its summit.

The large spicules are from 0·6–1 mm. in length, with a maximum thickness of 0·014 mm. The longer of these are often styli or subtylostyli, but the shorter ones have a well-defined head.

The small subtylostyli, situated in vertical bundles at the surface of the sponge, average about 0·2 mm. in length.

Distribution.—Arctic Ocean; eastern and western shores of the North Atlantic Ocean; Mediterranean. Bathymetrical range from 85 to 388 fathoms.

Spinularia Gray.

In 1867 Gray (**7**) erected the genus *Spinularia* for the reception of *Tethea spinularia*, Bowerbank (**1**), altering, at the same time, the specific name of Bowerbank's sponge to *tetheoides*. Gray's definition of his new genus is as follows:—"Sponge, massive, depressed, minutely hispid. Oscules terminal, slightly raised. Spicules of two kinds:—1. Fusiform, sometimes curved. 2. Pin-shaped, head ovate."

Through the kindness of Mr. R. Kirkpatrick, I have been able to examine some of Bowerbank's sections, and a spicule-preparation of the type specimen of *Tethea spinularia*, Bowerbank. An examination of the slides shows that the spicules called "fusiformi-acerate" by Bowerbank, and "fusiform" by Gray are not oxea as one might conclude from the figure given by the first-named author (**1**, Plate XV, fig. 28), but rhaphides, collected into trichodragmata. The structure of the skeleton

is that of a Polymastid sponge; the trichodragmata occur in the choanosome. An emended definition of the genus *Spinularia*, Gray, would therefore be as follows—Polymastidae possessing two kinds of spicules, tylostyli and rhaphides collected into trichodragmata, the latter occurring in the choanosome.

This definition at once recalls Topsent's genus *Rhaphidorus* (**42** and **45**), which possesses a similar spiculation and which, therefore, must now be regarded as a synonym of *Spinularia*, Gray.

A comparison of the type slides of *Tethea spinularia*, Bowerbank, with Topsent's descriptions and figures of *Rhaphidorus setosus*, the only species assigned to the newer genus, shows that these two species are identical.

Spinularia spinularia (Bowerbank) is represented in the present collection by one specimen.

Spinularia spinularia (Bowerbank).

1866. *Tethea spinularia*, Bowerbank (**1**).
1867. *Spinularia tetheoides*, Gray (**7**).
1870. *Radiella spinularia*, Schmidt (**24**).
1898. *Rhaphidorus setosus*, Topsent (**42**).

Plate III, fig. 5. Plate V, fig. 3.

S.R. 277—15 XI '05. 50 miles W.N.W. of Eagle Island, 54° 17′ 30″ N., 11° 34′ W., soundings 550 fms., gravel and shells. Oyster dredge.—One specimen.

The sponge is 12 mm. in diameter, with a thickness of about 2 to 3 mm. It is nearly square in outline owing to the shape of the small pebble on which it is growing, and one side of which it completely covers. Near the summit of the sponge there is a single osculum, which is a little raised above the general surface.

The surface is hispid, especially towards the edge of the sponge, where the spicules project to a considerable distance. The drawings of the first-found specimens (**1**, Plate XV, figs. 23–26) do not show these long, projecting spicules, but Bowerbank states that none of these specimens possessed its natural base, so that the part containing these very long spicules may have been cut away; or, as the sponges were dried, the long spicules may have been rubbed off.

The arrangement of the skeleton and the spiculation have been described by Topsent from the sponges dredged off the Azores and recorded by him, under the name of *Rhaphidorus setosus* (**42** and **45**). The tylostyli do not vary much from one specimen to another. They are rather thicker in the Azores sponges than in the more northern specimens, in which their maximum thickness is about 0·02 mm. The trichodragmata vary a good deal in length in the different specimens. In the

type they are 0·12 mm. in length ; in the Irish specimen they are 0·25 mm. long and in the Azores specimens from three different stations they are respectively 0·07 mm., 0·1 mm. and 0·26 mm. long. Fristedt (**6**) gives 0·3 mm. as the length of the corresponding spicules in the specimen from Swedish waters recorded by him under the name of *Radiella spinularia.*

Distribution.—Shetland (**1**); off the coast of Sweden (**6**); off Norway, 80–150 metres, as *R. spinularia* (W. Arndt, Jahresb. Schles. Gesell. vaterl. Cultur, 1913); off the Azores, at depths of 1360–4020 metres (**45**).

Atergia, n.g.

Polymastidae massive, sessile, without papillae; possessing two kinds of spicules, tylostyli and oxea, the latter occurring scattered irregularly in the choanosome.

Atergia corticata, n. sp.

Plate III, figs. 2, 3. Plate V, fig. 4.

S.R. 151—27 VIII '04. 50 miles W.N.W. of Eagle Island, 54° 17′ N., 11° 33′ W., soundings 388 fms., stones and rock. Dredge. Temperature at 388 fms., 9.15°C.—About ten specimens and fragments.

One small specimen is growing on a piece of *Retepora* ; another, the base of which only remains, is growing on a block of sandstone in company with several other species of sponges. The remaining specimens, which are larger and which are a good deal broken, have evidently been cut off similar pieces of sandstone.

The smaller and more complete specimens are nearly circular in outline and are thicker towards the centre than at the sides. The smallest is 5 mm. in diameter and bears one osculum, which is slightly raised above the general surface. Most of the specimens are more or less broken. Their greatest thickness is about 6 mm. Each possesses one to several oscula slightly raised above the surface. The largest piece is 18 mm. in diameter. The sponges are very similar in external appearance to the preceding species and to *Tylexocladus Joubini* Topsent (**45**, Plate I, fig. 9). The surface is slightly hispid over the greater part of the sponge, but where the long, projecting spicules are unbroken, the hispidation is very marked.

There is a very firm cortex about 0·35 mm. in thickness.

The colour in spirit is pale grey with a pink tinge.

The main skeleton consists of strong fibres running radially through the sponge from the base to the surface. These fibres are about 0·2 mm. in thickness near the base of the sponge; they divide into finer strands in their course to the periphery and fan out very slightly beneath the cortex, which they pierce. They are made up of multiserially arranged tylo-

styli, the points of which are directed upwards. The terminal tylostyli pierce the dermis and project for about half their length above the surface. These projecting tylostyli are usually broken off short on the more exposed parts of the sponge.

Isolated bundles of smaller tylostyli, one spicule in length, lie transversely to the main fibres.

Small oxea occur in immense numbers scattered irregularly through the choanosome.

The cortical skeleton consists of small tylostyli, extremely densely packed together and placed vertically to the surface of the sponge, from which their points project very slightly.

Spicules :—

(1) Tylostyli. These can be divided into two groups according to their position in the sponge. The tylostyli of the main fibres have a straight, slightly fusiform shaft, tapering to a very long, slender point at one end, and to a well-marked, rather elongated head at the other end. The maximum size of these spicules is about 1·5 mm. long by 0·018 mm. thick. The tylostyli of the cortex and of the transverse bundles have a slightly curved, fusiform shaft tapering to a short point. The shaft is rather broad and the neck more slender, recalling the shape of the corresponding spicules in *Sphaerotylus capitatus* (Vosmaer). The head is well defined and rounded, with sometimes a slight mucron. Length 0·15–0·4 mm. with a maximum diameter of 0·012 mm.

(2) Oxea, small, slightly curved, tapering evenly to sharp points. Occasionally with a slight swelling at the centre of the spicule. Length 0·07–0·1 mm. by 0·0025 mm.

Small oxea are known to occur in one genus belonging to the Polymastidae, namely, in *Tylexocladus*, Topsent (**45**), which resembles *Atergia* n.g. closely in spiculation, but which is clearly marked off by the possession of the peculiar form of exotylus, called by Topsent cladotylostylus, which is characteristic of the genus.

Family *SUBERITIDAE.*

Suberites caminatus, Ridley and Dendy.

Plate III, fig. 4.

S.R. 277—15 XI '05. 50 miles W.N.W. of Eagle Island, 54° 17′ 30″ N., 11° 34′ W., soundings 550 fms., gravel and shells. Oyster dredge.—One specimen.

The sponge, which is hemispherical in shape, is 9 mm. in diameter and 5 mm. in height. It agrees in every particular, both in external appearance and in spiculation, with Ridley and Dendy's description of the *Challenger* specimens.

Distribution.—Off Marion Island, 50–75 fms. (**21**); South Atlantic, off the Rio de la Plata, 600 fms (**21**). North

Atlantic, off Newfoundland, 1267 metres, and off Fayal, Azores, at 130 and 1900 metres (**37** and **45**). A variety of this species was taken by the National Antarctic Expedition off Balleney Island in 254 fms.

Suberites gibbosiceps (Topsent).

Plate III, fig. 1.

S.R. 944—17 v '10. 86 miles W. ¼ N. of Great Skellig, 51° 22′ N., 12° 41′ W., soundings 982 fms., ooze. Shrimp trawl, 30′.—One specimen.

The sponge is growing on a piece of broken glass. It is about 61 mm. by 53 mm. in extent, with a greatest thickness of 16 mm., and it spreads over both sides of the glass. It agrees exactly in external appearance, as well as in spiculation, with Topsent's description (**45**) of the species. The large tylostyli have the same characteristically-shaped heads as described and figured by Topsent.

Up to this only five specimens of the sponge have been obtained. They were dredged at two stations off the Azores in 2252 and 1846 metres (**45**).

Suberites carnosus (Johnston).

Ballynakill, LXIII.—20 III '00. Channel off Ross Point, Ballynakill Harbour, soundings 2–4 fms. Rake dredge.—Two specimens.

L. 257—20 x '03.—Channel off Coastguard Bay, Ballynakill Harbour, soundings 4–8 fms. Naturalist's dredge.—One specimen.

W. 96—25 v '09. 6·2 miles E. by S. ¾ S. of Clare Island Light, soundings 16 fms. Naturalist's dredge.—Four specimens.

W. 108—25 VIII '09. Inishgowla Harbour, Clew Bay, soundings 1–4 fms. Naturalist's dredge.—One specimen.

W. 124—18 IX '09. North of Ardelly Point, Blacksod Bay, soundings 4¾ fms. Naturalist's dredge.—Two specimens.

W. 183—16 III '11. Elly Bay, South, Blacksod Bay. Shore collecting.—One specimen.

Suberites carnosus is not very abundant off the Irish coast; it is occasionally found between tide-marks, but is more usually taken in a few fathoms of water.

The largest specimen in the collection is growing on a *Turritella* shell. It is 68 mm. in height by 45 mm. at its greatest width. It is penetrated in every direction by worm borings.

The small, encrusting specimen obtained off Clare Island in 25½ fathoms, which is referred to this species in the report on the Clare Island sponges (**33**), proved on re-examination to be a fragment of a *Laxosuberites*.

Distribution.—Off East Greenland; off the western shores of Europe; off the Azores; Mediterranean; Red Sea and Indian Ocean; off Australia. Bathymetrical range from between tide-marks, at extreme low water, to 450 fathoms.

Ficulina ficus (Linn.).

Ballynakill Harbour, March, 1899.

Ballynakill LXIII—20 III '00. Channel off Ross Point, Ballynakill Harbour, soundings 2–4 fms.

Helga LIV—10 V '01. 2·9 miles N.E. by E. ¾ E. of Greenore Point, Co. Wexford, soundings 16 fms., stones, mud and sand. Oyster dredge.

Helga CXXIXd—11 IX '01. 40 miles W.N.W. of Cleggan Head, soundings 76½ fms., stones. Naturalist's dredge.

L. 264—9 XI '03. North Entrance, Ballynakill Harbour, soundings 6–8 fms. Otter trawl.

L. 287—2 II '04. "Unicorn," Fahy Bay, Ballynakill Harbour. Specimens scraped off bottom of ship.

L. 296—1 III '04. Roeillaun Rocks, Ballynakill Harbour. Shore collecting.

Galway Bay at depths of 1 to 10 fms. at the following stations—

A. 5—1 VI '04.	A. 27—18 VII '04.
A. 16—27 VI '04.	A. 35—1 VIII '04.
A. 17—28 VI '04.	A. 124—9 VI '05.

S.R. 145—23 VIII '04. 50 miles W.N.W. of Slyne Head, 53° 24′ 30″ N., 11° 38′ W., soundings 112 fms., fine sand.

S.R. 185—30 I '05. 70 miles S.W. of Fastnet, 50° 20′ N., 10° 20′ W., soundings 82½ fms., fine sand and shells.

S.R. 226—13 V '05. 53° 12′ N., 13° 57′ W., soundings 93 fms., gravel and shells.

W. 78—24 V '09. Inishlyre Harbour, Clew Bay, soundings 5 fms. Naturalist's dredge.

Blacksod Bay, between tide-marks to 8 fms., at the following stations:—

W. 115—16 IX '09.	W. 183—16 III '11.
W. 124—18 IX '09.	W. 186—18 III '11.
W. 134—13 III '10.	W. 187—18 III '11.
W. 167—21 IX '10.	W. 188—18 III '11.
W. 171—23 IX '10.	W. 237—26 IX '11.

W. 216—21 VIII '11. Clew Bay, 3·8 miles N.E. ½ N. of Carrowmore, soundings 18 fms., rock and sand.

S.R. 1446—20 VIII '12. 8½ miles S. by W. ½ S. of Tearaght Light, 51° 56′ 30″ N., 10° 39′ W., soundings 54 fms., sand.

River Lee, off Passage, Co. Cork.

In addition to the above stations, Miss A. L. Massy (**20**) gives a list of ninety-eight stations off the east coast of Ireland, at which the species was dredged by the *Helga*.

As may be judged from these long lists of stations, *Ficulina ficus* is very common and is widely distributed, especially in shallow water, round the Irish coast.

It is usually found in its massive form between tide-marks, at very low water, but it sometimes grows as a thin encrustation, usually on shells of *Pecten*. It most commonly occurs in shallow water, in its "*suberea*" form, on shells inhabited by hermit crabs (*Eupagurus cuanensis* and *E. bernhardus*). The elongated or "*ficus*" form is also found, sometimes in considerable numbers, growing on *Dentalium* shells.

Distribution.—Arctic Ocean; Behring Sea; eastern and western shores of the North Atlantic; Mediterranean; off Senegal; off Japan. Bathymetrical range from between tide-marks, at extreme low water, to 220 fathoms.

Laxosuberites incrustans, n. sp.

Plate V, fig. 5.

W. 141—13 VIII '10. Off Reenaery Head, Co. Kerry, soundings 37 fms., gravel. Dredge.—Three specimens.

S.R. 1176—22 V '11. 39 miles W. ½ N. of Blackball Head, 51 26′ 30″ N., 11° 2′ W., soundings 100 fms., sand. Naturalist's dredge.—Sixteen specimens.

W. 222—22 VIII '11. 2 miles S.W. by ½ S. of Clare Island Look-out Tower, soundings 25½ fms., stones. Canvas dredge.—One fragment.

One specimen coats the upper surface of a small stone, another is cut off from its support, while the remaining form thin encrustations on eighteen specimens of coral (*Caryophyllia clavus*). The thickness varies in the different specimens from about 0·7 mm. to nearly 2 mm.

The surface is even, but under the lens it is seen to be minutely hispid.

The skeleton consists of fibres, made up of multiserially arranged tylostyli, running perpendicularly from the base to the surface of the sponge. At the surface the fibres end in closely set vertical brushes of spicules; the tips of the spicules project very slightly beyond the dermis. All the tylostyli in the sponge are placed with their points directed upwards.

Spicules :—

The spicules are tylostyli which vary in length according to their position in the sponge. The longest occur in the main skeletal fibres, while the shortest form the superficial brushes of spicules. The length of the tylostyli varies from 0·15 mm. to 0·65 mm. by 0·005 mm. to 0·012 mm.

The long spicules have a well-defined, globular head. Occasionally there is a ring-like thickening beneath the head. The shaft is slightly fusiform, and slightly bent at a little distance below the head; at the other end the shaft tapers to a rather short point.

The spicules of the superficial brushes differ only in size from the large tylostyli. Two or three of the specimens differ from the others in having rather slender spicules, the maximum diameter of which is about 0·008 mm. or 0·01 mm.

The small fragment from W. 222 was erroneously recorded (**33**) as an encrusting specimen of *Suberites carnosus*. Its spicules are rather more slender than usual, a few only reaching a diameter of 0·01 mm.

Laxosuberites durus, n. sp.

Plate III, fig. 6. Plate V, fig. 6.

Helga XXXVIII—2 v '01. ½ mile off Ballyvalden, Co. Wexford, 7 fms.

The sponge, which is a good deal broken, is growing over pebbles and fragments of shells. It is in the form of a lobed mass, and is hard to the touch, but is easily broken. The lobes are closely pressed together and at the summit of each are one or more small oscula, about 0·5 mm. in diameter, which are level with the general surface of the sponge.

The surface is even, but under the lens it is seen to be minutely hispid.

The colour, in spirit, is a pinkish purple.

The skeleton consists of closely set strands of tylostyli running upwards through the sponge. The tylostyli are densely crowded together and all have their points directed upwards. The fibres end at the surface in vertical brushes of closely packed spicules, the tips of which project very slightly beyond the dermis.

Spicules :—

The spicules are all tylostyli, which vary considerably in size according to their position in the sponge. They measure 0·17–0·75 mm. in length by 0·005–0·014 mm. The largest make up the main mass of the skeleton, while the smallest form the superficial brushes of spicules. The tylostyli do not vary much in shape. They have a straight, or sometimes slightly curved shaft, which is very slightly fusiform, and which tapers to a rather short point. The head is well developed and is ovoid in shape, being usually surmounted by a short, cylindrical mucron.

This species is perhaps nearly allied to the Adriatic sponge, named by Schmidt (**23**) *Suberites lobatus*, Nardo. It is impossible to identify this species from Schmidt's brief description. Lendenfeld (**16**) unites it with *Suberites massa*, Nardo.

Terpios fugax. Duchassaing and Michelotti.

Ardfry, Co. Galway, October, 1906.
Blacksod Bay, between tide-marks, at the following stations :—

W. 116—15 IX '09. W. 234—23 IX '10.
W. 168—21 IX '10. W. 238—27 IX '10.
W. 233—21 IX '11.

The specimens from Ardfry are growing on oyster shells taken from the "Main Pond" oyster beds. They are of a pale yellowish colour in spirit. The specimens from Blacksod Bay were found between tide-marks, along the shore from Barranagh to Carrigeenmore. They grew, at extreme low water, on the under-surface of large, flat stones, in patches of a deep blue colour (**33** and **5**).

Distribution.—Off the coasts of England and France; Mediterranean; off the Azores, West Indies and East Indies and off the Malay Peninsula.

ADDENDA.

Several sponges belonging to species dealt with in the foregoing paper were received too late for insertion in their proper place.

The following five species were dredged at S.R. 1846—22 V '14. 50 miles W. ¼ S. of Great Skellig, 51° 26′ N., 11° 45′ 30″ W., soundings 550 fms., sand, mud and stones.—*Aphrocallistes beatrix*, Gray, several fragments; *Thrombus abyssi* (Carter), one specimen growing on *A. beatrix*; *Poecillastra compressa* (Bowerbank), several fragments; *Geodia nodastrella*, Carter, one small specimen, 13 mm. in diameter and nearly spherical in shape, not attached to any support; *Alectona Millari*, Carter, boring in coral (*Lophohelia prolifera*).

In company with these were dredged two small sponges belonging to a new Stellettid species which it is hoped to describe later.

One specimen of *Thenea muricata*, Bowerbank, only 4 mm. in height, was dredged at S.R. 851—9 XI '09. 50° 48′ N., 11° 41′ W., soundings 900 fms.

Cliona levispira, Topsent and *Alectona Millari*, Carter, boring in specimens of a simple coral (*Desmophyllum cristagalli*) were obtained at S.R. 1004—12 VIII '10, 51 miles W. ½ S. of Great Skellig, 51° 22′ 30″ N., 11° 44′ 30″ W., soundings 641–636 fms.

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EXPLANATION OF PLATES I–V.

Plate I.

Pheronema Grayi, Kent. Natural size.

Plate II.

Fig. 1. *Sidonops atlantica*, n. sp. Natural Size.

Fig. 2. *Pheronema Grayi*, Kent. Young specimen. Natural size.

Fig. 3. *Hyalonema infundibulum*, Topsent. Natural size.

Plate III.

Fig. 1. *Suberites gibbosiceps*, Topsent. Natural size.

Fig. 2. *Atergia corticata*, gen. et sp. n. Small, nearly complete specimen, ×2.

Fig. 3. *Atergia corticata*, gen. et sp. n. Part of larger specimen, ×2.

Fig. 4. *Suberites caminatus*, Ridley and Dendy, ×2.

Fig. 5. *Spinularia spinularia* (Bowerbank), ×2.

Fig. 6. *Laxosuberites durus*, n. sp. Part of specimen. Natural size.

Fig. 7. *Vibulinus stuposus* (Montagu). Specimen dredged off Clare Island. Natural size.

Plate IV.

Fig. 1. *Geodia nodastrella*, Carter.

a, somal oxea, ×48; *b*, cortical oxea, ×112; *c*, dichotriaene, ×48; *d*, promesotriaene, ×112; *e*, anatriaene, ×112; *f* somal spheraster, ×480; *g*, outline of sterraster, ×112; *h*, *i*, sub-cortical spherasters, ×480; *j*, choanosomal oxyaster, ×480.

Fig. 2. *Leucopsacus scoliodocus*, Ijima.

a, *b*, hexactinose discohexasters, with longer and shorter teeth, ×264.

Fig. 3. *Sidonops atlantica*, n. sp.

a, somal oxea, ×48; *b*, orthotriaene, ×48; *c*, *d*, anatriaene, ×48 and ×112; *e*, promesotriaene, ×112; *f*, somal spherasters, ×480; *g*, outline of sterraster, ×112; *h*, *i*, *j*, choanosomal oxyasters, ×264; *k*, pore-sieves, surface view, ×24.

Plate V.

Fig. 1. *Cliona coralliophaga*, n. sp. Oxea, ×297.

Fig. 2. *Latrunculia Normani*, n. sp.

a, choanosomal discaster, ×297; *b*, *c*, somal discaster, side and end views, ×297; *d*, stylus, ×297.

Fig. 3. *Spinularia spinularia* (Bowerbank).

a, tylostylus of the skeletal fibres, ×122; *b*, cortical tylostylus, ×297; *c*, head of tylostylus figured in *a*, ×297.

Fig. 4. *Atergia corticata*, gen. et sp. n.

a, tylostylus of skeletal fibres, ×122; *b–e*, cortical tylostyli, ×297; *f*, head of tylostylus figured in *a*, ×297; *g*, *h*, oxea, ×540.

Fig. 5. *Laxosuberites incrustans*, n. sp.

a, *b*, *c*, tylostyli, ×297.

Fig. 6. *Laxosuberites durus*, n. sp.

a, *b*, *c*, tylostyli, ×122; *d*, small tylostylus, ×297; *e*, *f*, heads of larger tylostyli, ×297.

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Pheronema Grayi.

1.

2.

3.

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1 Sidonops atlantica.
2. Pheronema Grayi.
3. Hyalonema infundibulum.

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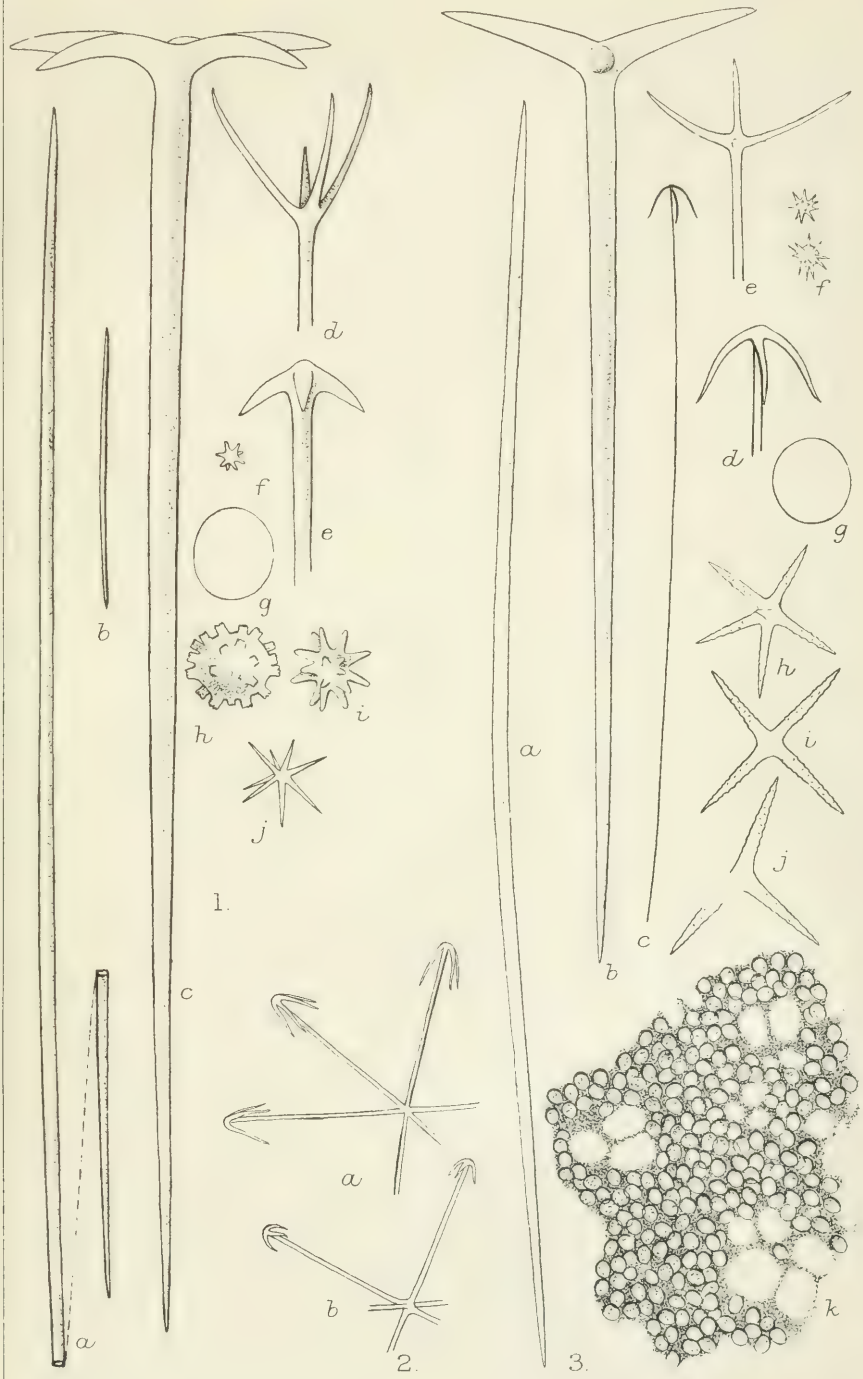
1. Suberites gibbosiceps.
2. 3. Atergia corticata.
4. Suberites caminatus.
5. Spinularia spinularia.
6. Laxosuberites durus.
7. Vibulinus stuposus.



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1. Geodia nodastrella.
2. Leucopsacus scoliodocus
3. Sidonops atlantica.

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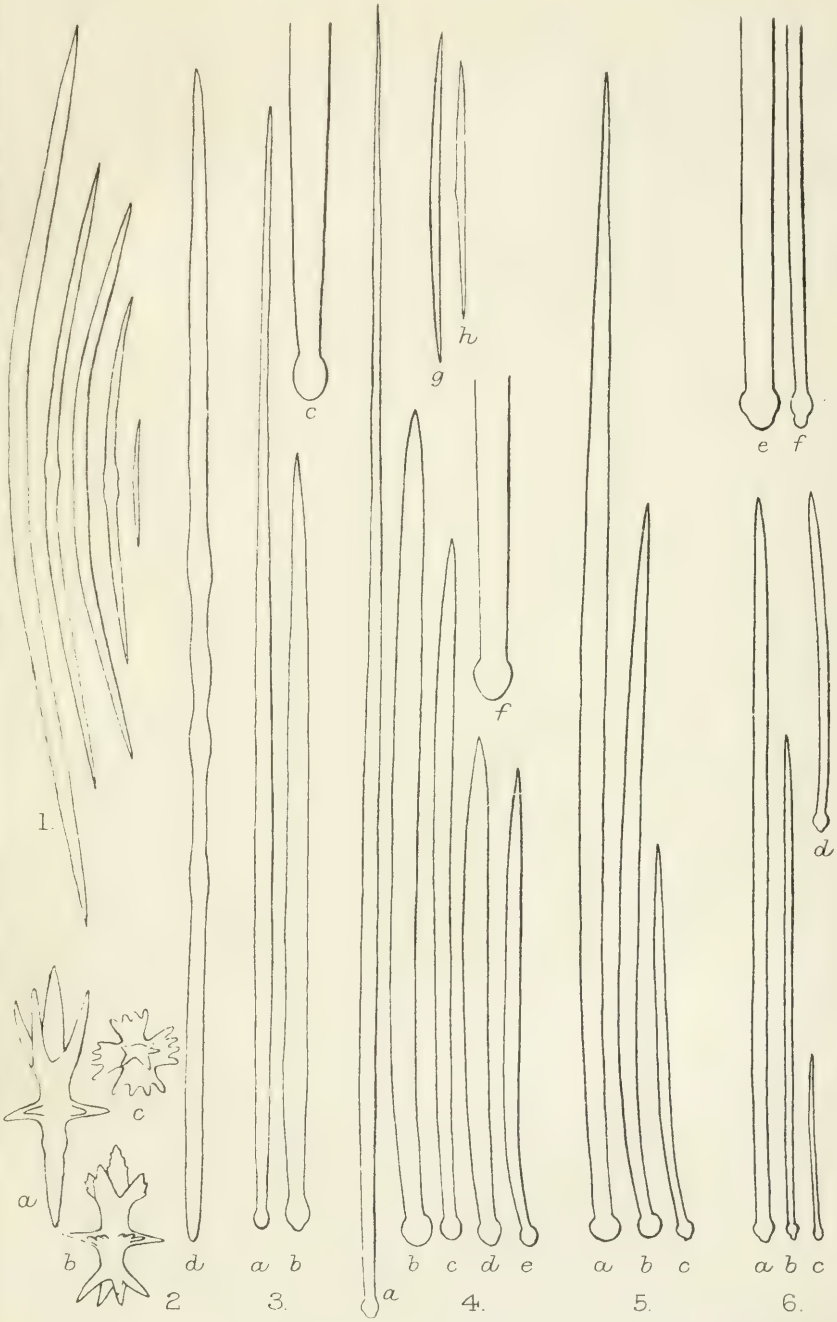

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1. Cliona coralliophaga.
2. Latrunculia Normani.
3. Spinularia spinularia.
4. Atergia corticata.
5. Laxosuberites incrustans.
6. Laxosuberites durus.

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