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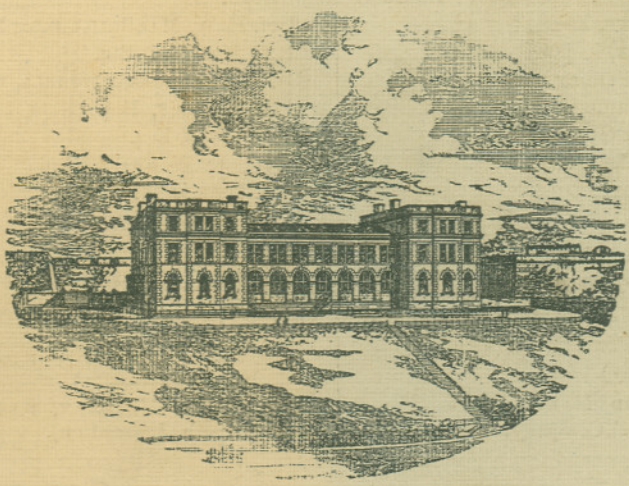

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Contributions to the Comparative Anatomy of some British Actiniæ.

By

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With Figures 1–16 in the Text.

The main object of this paper is to give a comparative anatomical description of some British Anemones as well as to describe each individually; but the account is not so full as it was expected to be, as it was not possible to get all the species required.

In most cases the specimens were examined externally before sections were cut. Each specimen was prepared according to the usual method used with paraffin wax, and I found during the progress of the work that borax carmine was the stain which gave the most satisfactory results.

I should like to thank Miss E. de Fraine, D.Sc., Mr. F. W. Durlacher, and Mr. F. S. Wright for much assistance in the course of the work.

For specimens collected and sent I am deeply indebted to Dr. E. J. Allen and his staff at Plymouth, Miss Delap, of Valentia Island, and Monsieur Louis Fage, of the Laboratoire Arago, Banyuls-sur-Mer, France.

Fam. **SAGARTIDÆ** (Gosse, 1858).

"Actiniinæ with a contractile pedal disk; body-wall smooth, or provided with verrucæ or tubercles, and usually perforated with cinclides, with or without a cuticle. Tentacles usually numerous and retractile, not very long, smooth, simple and generally entacmæous, sphincter muscle characteristically well developed and mesogloeal, occasionally diffuse endodermal, or even absent. At least six pairs of mesenteries, may be fertile or sterile. Acontia present." The above is the definition used by Haddon in "The Actiniaria of the Torres Straits" in 1898. There has been a great deal of discussion concerning this family.

Many other authors in defining the family include the provision of the "sphincter muscle mesogloeal." This is not important, as Bourne has shown the presence of an endodermal sphincter in Metridium (Actinoloba). Again, other authors define this family as "Hexactiniæ furnished with acontia."

SUB-FAMILY. SAGARTINÆ (Verrill).

"Sagartidæ with naked ectoderm. Cinclides usually present." (Haddon.)

Genus SAGARTIA (Gosse, 1855).

"Sagartinæ with smooth body-wall; margin tentaculate; sphincter fairly strong; tentacles concealed in contraction." (Haddon.)

Sagartia miniata (Gosse).

Gosse regarded *S. miniata* as the type species of his genus Sagartia. Gosse had made the possession of two œsophageal grooves one of the important characters of the genus, but now it has been proved that many of the typical Sagartids possess one as often as two grooves.

Specimens of *S. miniata* were kindly sent here by Miss Delap from Valentia Island. When they arrived they were still alive, but not in a condition fit for observation.

Column colour varying shades of orange, passing from pale below to either a dark chocolate, or purplish at the summit. Suckers irregularly arranged, but more numerous and conspicuous near the summit.

Tentacles of the outer cycle all possessed the crimson core and showed the following variations :—

(*a*) Light orange-crimson core.
(*b*) Lake, with orange-crimson core.
(*c*) Pale flesh-coloured, with light orange-crimson core.

Tentacles of inner cycle dusky, with indistinct white bar across inner face.

Tentacles of the Middle Series, crimson lake, resembling those of *S. rosea*.

Tentacles of the Marginal Series, usually pale reddish white, with three black patches on the inner face and a yellowish area about the base. This specimen had also a white transverse bar at the tentacle foot within the dark area on the periphery of the disk. Acontia white, very freely emitted.

The following are the measurements taken from a preserved specimen:—

Diameter of pedal disk	13 mm.
,, ,, column	7 mm.
Height of column	18 mm.
Length of tentacles	3 mm.

Comparing the size of this specimen with that of *S. viduata* described by Carlgren in "Studien über Nordische Actinien," 1893, I find that

S. miniata is a much smaller anemone, *S. viduata* being about 50 mm. long and 15 mm. broad. *S. viduata* is also characterised by grey, green, and brown colours instead of the lake, orange, and crimson found in *S. miniata*. In *S. viduata* the warts (which Gosse called suckers) lie in the upper third of the column. The cinclides open in the middle of these prominences. In *S. miniata*, the cinclides seem to be very few, opening, as in *S. viduata*, in the middle of some of these prominences near the oral disk.

Arrangement of the mesenteries.

In *S. viduata*, Carlgren has found a definite number of mesenteries, i.e. 96 pairs, including two pairs of directives, arranged in five cycles thus,—6+6+12+24+48. The last cycle is represented by mere projections of tissue developed in the lowest part of the column. In this species the arrangement coincides with the number and arrangement of the tentacles which are in 6 cycles, 6+6+12+24+48+96=192. I have cut sections of several specimens of *S. miniata* but am unable to make out any definite plan of the arrangement and number of mesenteries. The same difficulty has arisen in connection with other members of this genus, in *S. venusta*, *S. troglodytes*, and *S. nivea*.

In his paper "On the arrangement of the mesenteries in the Genus Sagartia," in *Proc. R.D.S.*, 1888, F. Dixon says that he was unable in most cases to recognise a completely hexamerous arrangement of the mesenteries. The only regularity seen was the correspondence of the number of directives with that of the œsophageal grooves. Dixon gives the number of mesenteries, etc., from three specimens collected near Dalkey Island. The following data are taken from three specimens from Valentia Island, probably older and larger than those examined by Dixon :—

Specimen (*a*) : 20 pairs of mesenteries reaching the œsophagus, including 1 pair of directives. There is 1 œsophageal groove present. About 20 pairs belong to 2nd cycle and are incomplete. The 3rd cycle consists of about 40 small mesenteries which penetrate only a very short distance into the cœlenteron.

Specimen (*b*) : This has 24 pairs of mesenteries reaching the œsophagus, including 2 pairs of directives arranged in the order :

D. 9, D. 13.

The 2nd cycle consists of about 24 mesenteries, and the 3rd cycle of about 48 ; these latter project only a short distance beyond the column wall. There are 2 œsophageal grooves here.

Specimen (*c*) : This showed 1 œsophageal groove and 1 pair of direc-

tives. The number of mesenteries reaching the œsophagus was about 24 pairs, including the directives.

The column wall is strong, the mesogloea being much thicker than the ectoderm. The ectoderm has a spongy appearance and contains a large number of gland cells, which are arranged near the outer margin, and most of them contain a granular substance like those of *S. viduata*. The opening of the cinclides is like that described and figured by Carlgren for *S. viduata;* the canal consists exclusively of ectoderm, endoderm only beginning at the inner end.

The mesogloea has a fibrous appearance when examined under a low power of the microscope, but under the high power, the cavities of the cells give it an almost spongy appearance. The cells become smaller and the whole mesogloea becomes stronger near the endodermal margin, and this gives rise to an endodermal muscle. As in *S. viduata* this is fairly well developed and much folded in transverse section. The folds are not branched and are irregular in shape. In the upper part of the column the muscle is differentiated into a mesogloeal sphincter which is very strong especially at the top, diminishing downwards. There are numerous mesogloeal processes projecting into the endoderm, and they are deeply set and are often branched. These projections are not present in the sphincter muscle of *S. viduata* as figured in "Nordische Actinien." The endoderm of the column wall is of about the same thickness as the ectoderm and contains numerous zooxanthellæ; and the number of these increases on the mesenteries, especially in the region near the œsophagus.

The primary mesenteries all have a large and well-developed retractor muscle.

As in *S. viduata* and *S. undata*, the muscle cushions of the directive septa are quite near the œsophagus, while those of the remaining septa are nearer the middle of the septa. The former are more concentrated and higher than the latter, which are extensive and more shallow. The retractor muscle is of the usual shape and contains a large number of arborescent folds.

In the largest specimen (*c*) this muscle in section was divided up into a number of folds, each fold being supplied with numerous mesogloeal fibres, as shown in the figure (Fig. 1). In this way the whole septum is very much elongated.

The parieto-basilar muscle is well developed and appears very long in cross section, and most of the mesogloeal processes arise from the side on which the retractor muscle occurs. These processes are not numerous

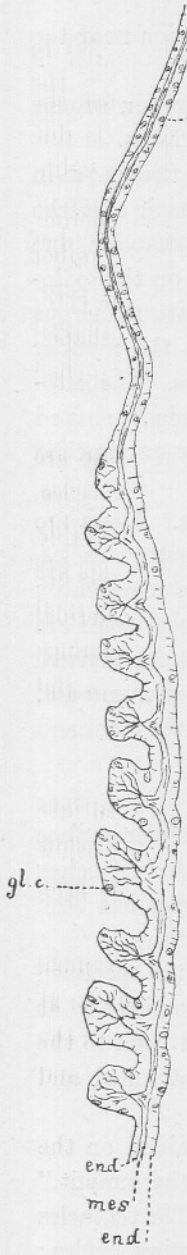

*Fig. 1.—*Sagartia miniata.* Transverse section of a portion of a mesentery from a large specimen, showing the curious folding of the retractor muscle.

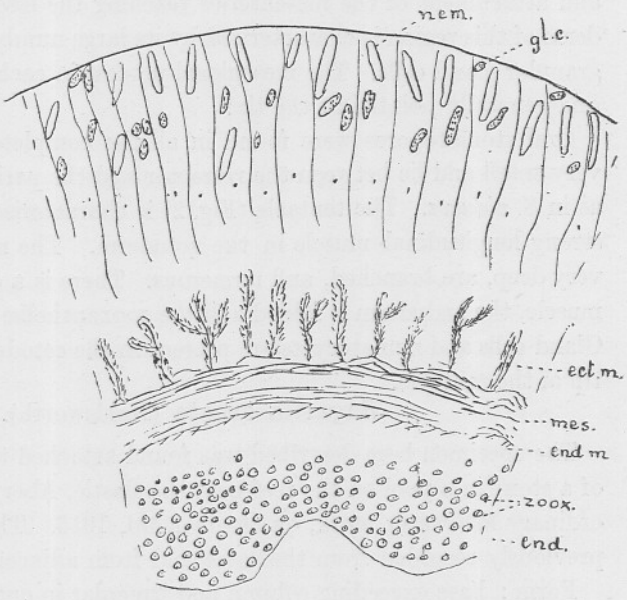

Fig. 2.—*Sagartia miniata.* Portion of the tentacle wall, showing the strongly developed ectodermal muscle.

* For Index to Lettering, see page 552.

and are very small near the base, but get large in the region near the retractor muscle.

Many of the mesenteries which are incomplete develop sex organs and mesenterial filaments. The latter have three distinct lobes.

The stomatodæum is very long and in cross section is triangular in shape in all the specimens that I examined, because in each case the specimen was more or less contracted. This triangular shape is due probably to the equal pressure exerted by the mesenteries on the cylindrical œsophagus during contraction. The wall is raised into numerous folds, the number and position usually corresponding to the number and attachment of the mesenteries reaching the œsophagus. The ectoderm of this region is characterised by its large number of spindle-shaped granular gland cells. The mesogloeal process in each fold is unbranched and generally pointed at the tip.

Oral stomatopores were found in all the complete septa. These are very small and lie between the retractor and the parieto-basilar muscles, as in *S. viduata*. The tentacle (Fig. 2) is characterised by a remarkably strong longitudinal muscle in the ectoderm. The mesogloeal folds are very deep, are branched, and numerous. There is a distinct endodermal muscle, the endoderm is folded and the zooxanthellæ are very numerous. Gland cells and nematocysts are present in the ectoderm of the stem and tip of the tentacle.

Sagartia ornata (Holdsworth).

The specimen here described was found attached to the under surface of a stone in a pool on the reef near the Castle, Aberystwyth, just below ordinary low-water mark, on October 3rd, 1913. This species has been previously recorded from the same and from adjacent localities.

Form : base exceeding column and irregular in outline ; the specimen was never seen fully expanded in the day time and only partially so at night. Soon after its capture it left the stone and attached itself to the vessel in which it was kept, and there remained firmly attached and much flattened.

Column, according to Gosse, " minutely corrugated, studded on the upper half with ' suckers,' more numerous as they approach the summit." A fair amount of mucus was given off from time to time. The tentacles appear to be about 96, probably arranged in the following cycles : 6+6+12+24+48. They are rather short and obtuse at the tip.

Disk (seen only by artificial light), mouth appeared slightly raised, lips somewhat thickened. Œsophageal grooves could be distinguished. Acontia, one was seen emitted from the mouth.

Colour : column buff, paler at base, with numerous faint longitudinal lines best marked near the base.

Disk pale yellow in the centre, darker on the outer area, radii paler. A cycle of twelve distinct, nearly circular white spots is situated at the junction of the two-colour areas.

Tentacles dark chocolate-brown or mahogany, paler towards the tips ; the tentacles of outer cycles are paler than those of the inner, and have the basal bar more prominent. Innermost tentacles more or less dusky, but always darker on their inner faces. There are three or four white bars on this side ; Holdsworth calls them " rings," but if so they are very indistinct on their outer faces. The apical bar is often very faint or barely visible ; the basal bar, the third or fourth from the tip, is very distinct.

The following measurements were taken from a preserved specimen :—

Diameter of pedal disk=7 mm.
,, ,, oral disk =3·5 mm.
Height of column =4 mm.
Length of tentacles =2 mm.

Arrangement of the mesenteries : This specimen shows an hexamerous arrangement. There are four cycles, 6+6+12+24=48. The mesenteries of the first two cycles are fully formed bearing reproductive organs and mesenterial filaments. There are two pairs of directives and two œsophageal grooves. The 4th cycle of mesenteries is only slightly developed.

The column wall is not very strong, the mesogloea being less than half the thickness of the ectoderm. The latter is a broad layer consisting of tall columnar cells, which seem to get broader near the outer edge. This ectoderm has an appearance quite different from that of *S. miniata*, where it is more spongy and the cells are neither so regularly arranged nor of such a uniform size as those of *S. ornata*. Gland cells seem to be absent in the ectoderm of the column wall.

The mesogloea is not very dense and a fibrous structure is distinctly visible ; the fibres are very fine and form a close network, which becomes denser near the endoderm. The mesogloea is not of uniform thickness, because the ectoderm is raised into folds and these are supported by processes of mesogloea, at any rate in a state of contraction. In transverse sections near the summit of the column I have found a few cinclides, but I have not found them present between two septa of a pair, as Carlgren found in *S. undata*. The structure of these openings is the same as that described for *S. viduata* and *S. miniata ;* they are ectodermal invaginations.

In the mesenteries (Fig. 4) of the first two cycles the parieto-basilar is comparatively strong; it is slightly constricted near the base, and is an elongated muscle. Most of the muscle folds are given off on one side only. These folds are short and stout, sometimes globular at the head, sometimes slightly branched. Before the parieto-basilar muscle passes into the retractor muscle the former becomes swollen and a projection of the mesogloea sends out a number of branches towards the edge away from the retractor muscle.

The longitudinal retractor muscle is rectangular in section and has an appearance quite different from that of *S. miniata*. In the latter the muscle folds are delicate and very numerous—about 80 in number; while in *S. ornata* the folds are fairly short and stout and number only about 10–20.

Oral stomatopores are present in the complete mesenteries, and there are slits between the retractor and parieto-basilar muscles.

The mesenteries of the third cycle reach about half-way across the cœlenteron. Each mesentery has a stout axis of mesogloea, which gives off about five branches.

The mesenteries of the 4th cycle are present in the lower half of the column only. They are very small and are indicated by a thin projection of mesogloea surrounded by a layer of endoderm.

Stomatodaeum. The two œsophageal grooves are well marked. The ectoderm is thick and has a granular zone near the free surface. The mesogloea is thick near the base of the groove, but becomes thinner along the sides of the groove. The wall of the stomatodaeum is raised into about 24 deep folds, corresponding to the number and attachment of the mesenteries, and the ectoderm of these folds contain a large number of gland cells whose contents are not granular.

The sphincter muscle (Fig. 5) is a mesogloeal one. It is very much like that of *S. milmani* (H. and S.) figured by Haddon in *Trans. R.D.S.*, 1898. The cavities in the muscle are large and numerous and tend to radiate in the same direction as shown in the figure. The broadest region is near the summit, while lower down in the column wall the muscle becomes very narrow and the cavities become fewer. The gland cells of the ectoderm in this region contain a number of spherical bodies which are highly refractive.

Tentacles. Near the tip the ectoderm is more than twice as thick as the rest of the tissue. In a section through this region of a tentacle there are very numerous nematocysts, some seen in section and some seen from the side. They are fairly short and stout, spindle-shaped bodies,

and a fine, much-coiled spiral thread is faintly distinguished in one or two cases. Near the base of the tentacle (Fig. 3) the endoderm is

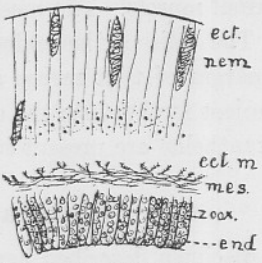

FIG. 3.—*Sagartia ornata.* Portion of a transverse section from near the base of a tentacle.

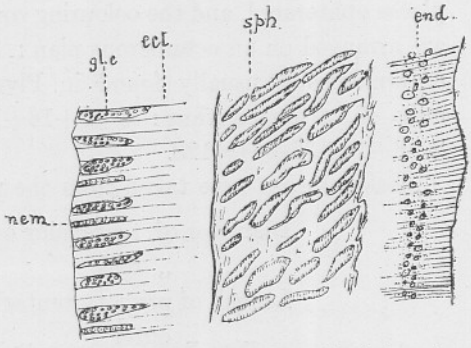

FIG. 5.—*Sagartia ornata.* Vertical section of the column wall, showing a portion of the middle region of the sphincter.

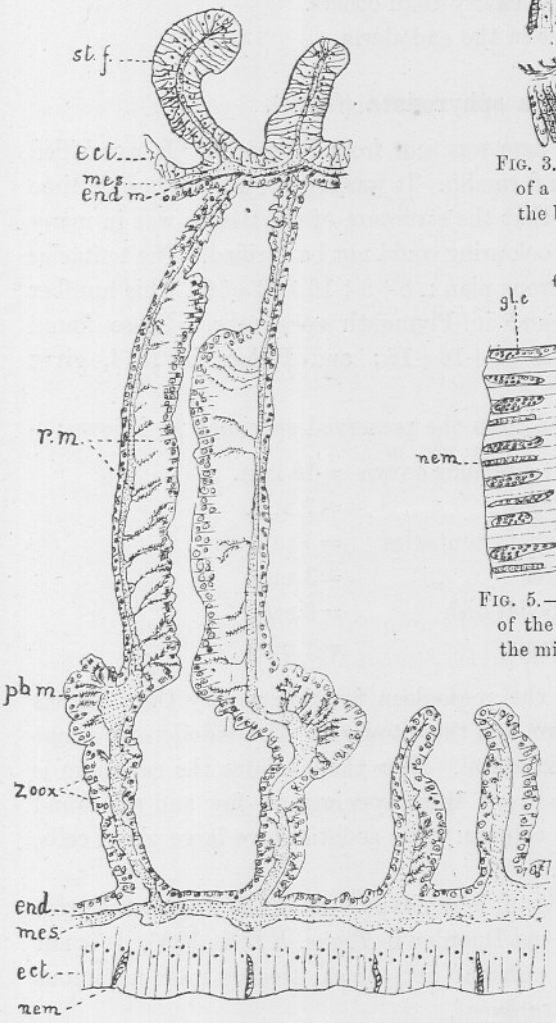

FIG. 4.—*Sagartia ornata.* Portion of a transverse section through the column, showing two complete mesenteries and two mesenteries of the third series.

narrower and the nematocysts, although very numerous, are fewer in number than above. The mesogloea is not strong and in some cases is reduced to a fine strand.

At the point where the tentacle joins on to the peristome the tissues are much thicker, the nerve layer is much broader, and there is a stronger ectodermal muscle. The mesogloea is thicker and has a plaited appearance. The cells of the endoderm have a columnar structure, but the inner margin of that region appears to be very irregular; some of the cells project farther into the cavity than others.

Zooxanthellæ are present in the endoderm.

Sagartia sphyrodeta (Gosse).

The specimen described here was sent from Plymouth. It was killed expanded and preserved in formalin. It was left for a considerable time before being examined, so that the structure of the tissues was in many places obliterated, and the colouring could not be verified. The tentacles are arranged on an octamerous plan: 8+8+16+32=64. This number of tentacles is usually found in Plymouth specimens. Gosse found only 48, arranged thus: 8+8+16+16; and Fisher, in 1874, gives 8+8+16+32+64=128.

Measurements were taken from the preserved specimen as follows:—

Diameter of tentacular crown	=18 mm.
,, ,, disk	=7 mm.
Length of primary tentacles	=5 to 6 mm.
,, ,, outer ,,	=3 mm.
Diameter of pedal disk	=6 mm.
Height of column	=4 mm.

The body-wall is weak, the mesogloea forming a very thin, fibrous strand between the endoderm and the ectoderm. The endoderm is about half the thickness of the ectoderm. Near the cinclides the ectoderm is very much swollen in each case; these openings are few and are found near the upper part of the column. The acontia have large gland cells, nematocysts, and granules.

The sphincter muscle (Fig. 6) is in shape very much like that figured for *S. carlgreni* by Haddon and Duerden in *Trans. R.D.S.*, 1896. It is not nearly so long as that of *S. milmani*, and the cavities are more numerous than in the sphincter of *S. carlgreni*.

The mesenteries (Fig. 7) are very weak, the retractor muscle forms a shallow cushion, and the parieto-basilar muscle is very long and thin. The endoderm contains numerous oval gland cells, which are full of deeply stained granules.

The œsophagus has one groove; the folds in the ectoderm of the wall

are neither so deep nor so regularly arranged as those examined in *S. miniata* and *S. ornata*.

In the upper part of the column wall a very strong radial ectodermal muscle is present; an endodermal muscle is also present. There are

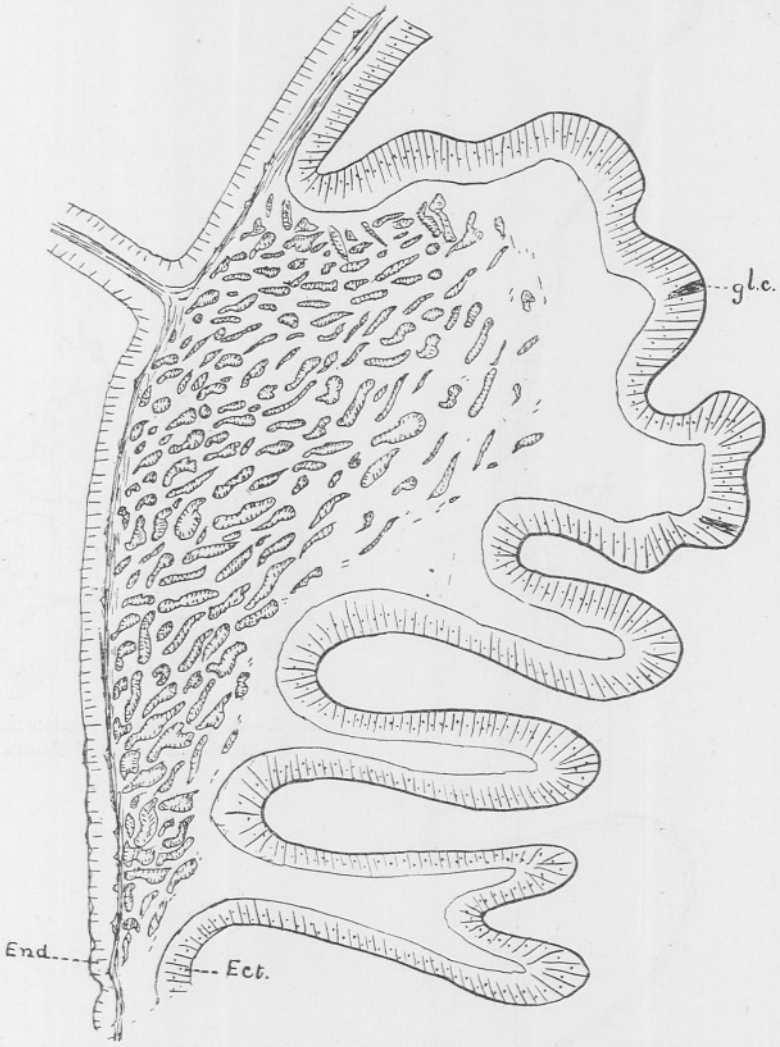

FIG. 6.—*S. sphyrodeta.* Vertical section through the body-wall, showing the sphincter muscle.

three distinct lobes to the mesenterial filaments (Fig. 8); they are shaped differently from those figured for *S. milmani*.

The mesogloea in the tentacle is very weak and the endoderm forms a very thin layer.

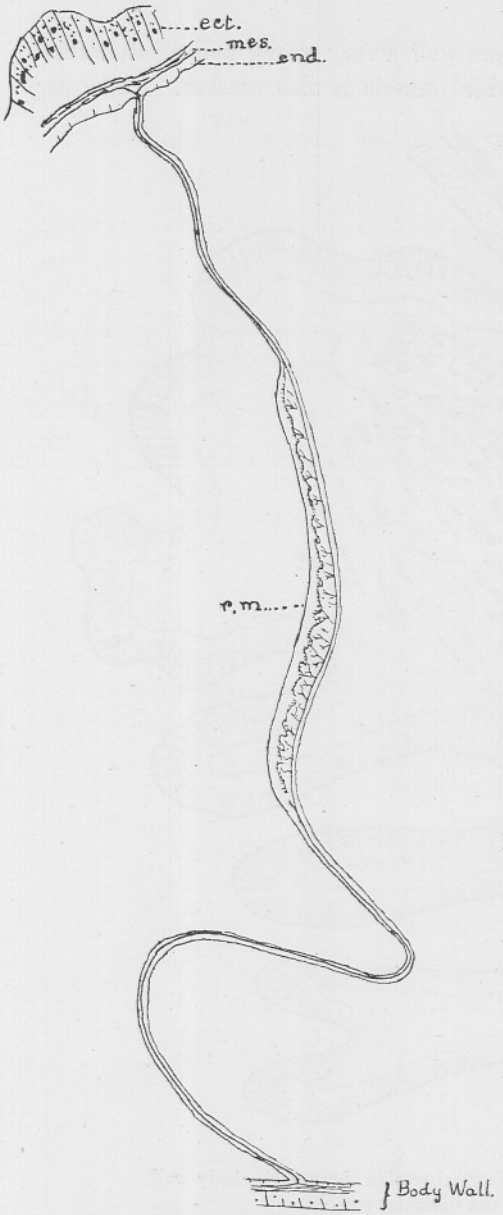

FIG. 7.—*S. sphyrodeta.* Transverse section through a young specimen in a fully expanded condition, showing one of the perfect mesenteries.

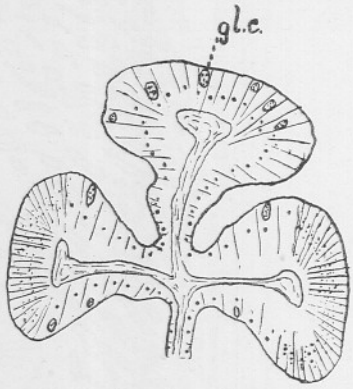

FIG. 8.—*S. sphyrodeta.* Section through the trilobed mesenterial filament.

S. sphyrodeta resembles *S. milmani* (H. and S.) in the following respects :—

1. The mesogloea is not thick.
2. The mesenterial filaments are weak.
3. The parieto-basilar muscle is very feeble ; only a few small folds can be seen on the side of the mesentery bearing the retractor muscle.

With regard to character and shape, the sphincter of *S. sphyrodeta* resembles the sphincter of *S. carlgreni*, but the arrangement of the mesenteries is quite different in the three species.

S. milmani has 48 mesenteries, among which a sex radiate symmetry is maintained thus : 12+12+24. There are two pairs of directives arranged thus :—

D. 4, D. 6.

In *S. carlgreni* the mesenterial formula is 6+6+12+24=48.

In *S. sphyrodeta* there is one œsophageal groove and one pair of directives.

The mesenteries are irregularly arranged and I am unable to make a mesenterial formula. Since the tentacles are arranged on an octamerous plan we should expect the mesenteries to be arranged in the same way. In a young specimen I counted 20 pairs and one odd mesentery. Some of these were complete and bore reproductive organs, the others were rudimentary. In an older specimen there were 48 pairs of mesenteries arranged, probably, in four cycles.

The mesenteries of this species are stronger and the retractor muscle forms a definite cushion with branched muscle folds.

COMPARATIVE TABLE OF BRITISH SPECIES OF SAGARTIA FOR WHICH ANATOMICAL DATA ARE OBTAINABLE.

Anatomical Features.	Data given by O. Carlgren, Stud. über Nord. Act. Kongl. Sv. Vet. Akad., Bd. 25, No. 10.			
	S. viduata.	*S. undata α.*	*S. undata β.*	*S. undata-troglodytes.*
Column Colour.	(Norway.) Ground colour grey-green, yellow-brown or green lines.	(Norway.) Red-brown or dull brown, small flesh-coloured stripes.	(Norway.) Red spots on white or flesh-coloured ground.	(Norway.) Salmon or flesh colour, sometimes grey-green.
Not Carlgren's Data.	(Great Britain.) Ground colour pinkish buff, white or yellowish lines.	(Great Britain.) Olive-green, brown, grey, pink, numerous longitudinal stripes. Gosse recognised about 20 varieties.		
Disk Colour.	Ochreous grey radial lines, green or yellowish spots.	Ochre-orange radial lines. B. mark at tentacle basis.	Brownish or orange with white lines. Red or red-brown B. marks at tentacle bases.	White to ochre lines on grey or grey-black ground. Black B. marks at tentacle bases.
Tentacles. Form.	Fine, tapering, often branched.	Tentacles	long and	tapering.
Tentacles. Order.	6+6+12+24+48+96=192.	6+7+13+26+52=104.	In 6's or 5's or 8's.	In 6's.
Mesenteries. Order.	6+6+12+24+48=96.	In 5's or 7's.	Usually in 8's.	6+6+12+24=48.
Mesenteries. Directives.	Two pairs of directives.			
Œsophageal Grooves.	Two grooves.	Two grooves or one groove—sometimes three grooves.		
Column Structure. Strength.	Strong.	Firm.	Firm.	Firm.
Column Structure. Relative strength of ectoderm and mesoderm.	E. and M. of same thickness.	E. and M. of same thickness.	E. and M. of same thickness.	E. and M. of same thickness.
Column Structure. Sucker-warts.	Small, cinclides open on some.	Never	distinct.	Common on upper part, cinclides open on some.
Sphincter.	Mesogloeal, strong at the top.	Mesogloeal muscle masses radial and more rounded than in *S. viduata.*		

This is possibly identical with Gosse's (not Müller's) *Sagartia coccinea* according to Carlgren.

S. miniata (from 3 British specimens).	*S. ornata* (from 2 British specimens).	Anatomical Data given by Messrs. Dixon, Proc. R. Dubl. Soc., 1888-9, etc. *S. nivea.*	*S. venusta.*	*S. sphyrodeta* (from 3 British specimens).
Orange. Pale below, dark chocolate above.	Buff, pale at base, with numerous longitudinal lines.	Pale brown with white lines.	Upper half buff to brown, lower half paler with faint white stripes.	White with dull drab stripes, some varieties yellow.
Centre olive to orange whitish radial lines.	Umber to purple-brown. Yellow radial lines with white spots between.	White to olive.	Varying shades of orange.	White, sometimes yellow, with radial lines.
Tapering.	Short, with obtuse tips.	Tapering. Outer cycles may be reduced to papillæ.	Tapering. Outer cycles may be reduced to papillæ.	Short and stout, thickened towards the base.
Difficult to estimate. Probably in 6's.	6+6+12+24+48=96.	6+6+12+24+48+96=192.	6+6+12+24+48+96=192.	8+8+16+32=64.
Either 20+20+40=80, or 6+6+12+24+48=96.	6+6+12+24+48=96.	6+6+12+24=48.	6+6+12+24+48=96.	Either 5+5+10=20, or 6+6+12+24=48.
One or two pairs of directives.	2 pairs of directives.	1 pair of directives.	1 pair of directives.	1 pair of directives.
One or two grooves.	Two grooves.	One groove.	One groove.	One groove.
Strong.	Weak.	Moderate.	Strong.	Weak.
E. thinner than mesoderm.	E. twice as thick as mesoderm.	M. thicker than E.	M. irreg. thicker than E. in many places.	Mesoderm thin.
Around summit of column, oval. A few cinclides, open on some of the warts.	Numerous on the upper half. A few cinclides, open on some of the warts.	On upper half, some on upper third perforated by cinclides.	On upper half, some on upper third are perforated by cinclides.	Few, found on upper part of column, perforated by cinclides.
Mesogloeal, strong at the top, diminishing downwards, projections into the endoderm.	Mesogloeal, not so broad at top as in *S. sphyrodeta.*			Mesogloeal, fairly broad at top.

Anthopleura alfordi (Gosse).

Classification.—Family Cribrinidæ, McMurrich (=Bunodidæ, Gosse). Genus, Anthopleura, Duchassaing et Michelotti (=Aulactinia, Verrill).

The following definition of the genus is that given by McMurrich under the name of Aulactinia: "Bunodidæ with the upper portion of the column provided with longitudinal rows of verrucæ, the lower portion being smooth. The margin forms a more or less distinct collar, and the tentacles are polycyclic and entacmæous. The six pairs of mesenteries of the first cycle are alone perfect."

Haddon has queried the last statement of the above [11, page 442] because he includes in Aulactinia a species *Aulactinia gelam* (=*Condylactis gelam*, Hadd. and Shackl., 1893) from the Torres Straits which has more than six pairs of mesenteries.

The specimen of *Anthopleura alfordi* which I have examined also has more than six pairs of perfect mesenteries. Therefore if these two species, *Anthopleura gelam* and *Anthopleura alfordi*, are to be included in the genus Aulactinia, the definition of the genus will have to be slightly altered (see end of this section).

Externally, the genus Aulactinia differs from the genus Cribrina (Bunodes) in having suckers in the upper portion of the body-wall only; whereas the latter genus is more or less uniformly tuberculated. Delage and Hérouard in describing the genus Aulactinia say that there are four or five cycles of mesenteries, but in this specimen of *A. alfordi* I have found only two cycles, one of complete mesenteries and another of incomplete mesenteries; there is no indication of a third cycle.

The external characters of this species have been described by Gosse (*Ann. Mag. Nat. Hist.*, 3rd Series, Vol. XVI, 1865), under the name *Ægeon alfordi* of the family Antheadæ.

The specimen which I have examined was kindly sent from Valentia Island by Miss M. Delap, in May, 1914.

External characters: (The animal was living, but moribund after the long journey.) The following description applies to the above specimen:—

Pedal disk: outline slightly irregular, in size scarcely exceeding column; wrinkled and appears capable of but slight adhesion.

Column somewhat changeable in form; at times widest about the middle, at others considerably expanded at the summit. Substance somewhat lax. The margin is crenulated with a series of larger irregular

warts—the acrorhagi. The warts get smaller in the region near the base, as shown in the figure included by Gosse in his paper. Many of the vertical rows of warts die out rapidly downward, while even the primary rows become faint and the warts distant; the whole of the intervening space is wrinkled (probably owing to the animal being partially contracted).

Tentacular disk: diameter exceeding that of column; mouth rather large, lips somewhat pouting, gonidial tubercles or acrorhagi prominent and inflated.

Tentacles stout, lax, of no great length, tapering but slightly to an obtuse tip, conical during contraction. When the animal is not fully expanded there is a distinct fosse between the margin of the warted column and the base of the tentacles. Tentacles contractile, but not retractile, bear a considerable resemblance to those of Aiptasia. Owing to the laxity of the tentacles it was extremely difficult to make a correct enumeration, or even to determine the number of series. There appear to be about a hundred tentacles, probably in the order $6+6+12+24+48=96$. Fragments of sand adhered to the column wall, this suggests the presence of either numerous small suckers or adhesive mucus.

Colour: pedal disk pale yellowish white with a few small red streaks.

Column pale yellowish green, but so thickly covered with minute irregularly shaped red specks as to appear brick-red to the naked eye; only a few specks can be distinguished without a lens. There are also longitudinal series of larger spots of clear yellow-green, each with a bright red central dot; these spots are irregularly shaped and are well spaced in the series, nearer together and more prominent near the summit, where they are seen on the warts. The acrorhagi are of a leaden grey hue with several dull red spots on each. There are fifteen or sixteen of these red-centred spots in each linear series, and the spots are connected by faint lines of yellow-green. There is also a number of intermediate series of these red-centred dots on the upper part of the column, but these soon die out lower down. Thus the column possesses 24 longitudinal pale greenish yellow stripes, each of which contains 15 to 16 spots of a brighter yellow colour, with a bright red central dot.

Tentacular disk: stomatodaeum white, lip pale grey. Disk iridescent, umber or bluish green (according to the incidence of light) succeeded by an indefinite area of dull greyish white. The tentacle bases are of a much darker umber, the gonidial radii are fairly well demarcated and the mesenteries appear as faintly marked radial lines.

Tentacles umber, the inner faces shaded with iridescent purple.

There are numbers of irregularly shaped spots of a pale yellow colour scattered over the inner surface of the tentacles. Each tentacle from the inner series has two opposite, lateral, irregular patches of white, situated about one-third the length of a tentacle from the base. The purple shade is strongest upon the central area of the inner surface of the tentacle.

The series of minute spots is described by Gosse and their presence seems to be characteristic of this species. Haddon does not mention their presence in *A. gelam*.

Size : diameter of column very variable during life, 6–10 cm. Column 15 cm. in height, but probably capable of much greater extension. Diameter of disk about 10 cm. Expanse of tentacular crown about 20 cm. Length of larger tentacles 7 cm. Average diameter of pedal disk 7 cm.

This specimen is about the same size as *A. gelam ;* the height of the column of the latter being 150 mm. The specimen of *A. alfordi* collected by Gosse was also fairly large, the height being about 100 mm., it was obtained in the Scilly Isles.

The specimen from Valentia Island disgorged a partially digested Actinian—probably a Cerianthus ; a number of these were packed with the Aulactinia and were in contact with it.

Anatomy and Histology :—

The column wall is thick, the mesogloea being broader in section than the ectoderm ; the latter is deeply folded. The cells of the ectoderm are long and narrow ; they contain numerous granules, which become deeply stained. These granules form a broad zone in the ectoderm. On the outside of the layer is a clear zone, and on the inside near the mesogloea is another narrower zone, which marks the position of the nerve layer. Between these two lie the granules.

The mesogloea is thick, stains deeply and is homogeneous in structure. The large spaces which are seen in the sections are probably due to the fact that the specimen became very hard before the sections were cut, and this caused the mesogloea to break.

On its endodermal border the mesogloea shows a delicate fibrous structure, giving rise to a thin plate of circular endodermal muscle. There is no trace of any ectodermal musculature.

The endoderm is a much narrower layer ; in section it is about half the width of the ectoderm and one-third the width of the mesogloea. The cells of the endoderm do not show such a definite columnar structure as those of the ectoderm, and the cells are not so regularly arranged.

The spherical granules seen here are of the same kind as are found in the ectoderm. They are more numerous near the free border of the endoderm. Zooxanthellæ are present in the endoderm of the column wall, but are not very plentiful.

There are 24 pairs of fully developed mesenteries, 2 pairs being directives. Alternating with these are the secondary mesenteries, so that in all there are 24 primary pairs and 24 secondary pairs, making 48.

The number of tentacles is the same as that of the mesenteries. All the primary mesenteries except the directives are fertile, and in this specimen bear gonads. The musculature in the mesenteries is strongly developed, especially in the region near the column wall (Fig. 10). The parieto-basilar muscle is cordate in shape with a stout projection on the side towards the intramesenterial space. The mesogloea forms a short stout stem where the muscle is attached to the column wall. The muscle then broadens out rapidly, giving off short processes on either side, and these are sometimes slightly branched. Most of them are narrow at the base, and widen out into broad spherical knobs at the distal ends. There are between 9 and 15 of these branches on either side. One side of this muscle is continued into the large retractor muscle ; this is very wide in the region near the column wall, but becomes narrower towards the distal end of the mesentery, where it is continued into a very narrow plate of tissue. The mesogloea continuing from the parieto-basilar muscle becomes slightly narrower before it enters the retractor muscle and is very thin where it enters the filament. On one side, the mesogloea has short stout projections, these send out long and delicate strands which are much branched. These strands are so numerous that they are not easy to count ; the folds, including their chief branches, number between 80 and 100.

At the distal end of the muscle the folds radiate towards the middle line. No mesogloeal processes are given off on the other side of the muscle. The endoderm is continued from the column wall, along both sides of the mesentery ; it is slightly narrower here and contains some zooxanthellæ. In some parts deeply stained glandular cells are seen.

The secondary mesenteries are very stout, but reach only a short distance into the cœlenteron. They consist chiefly of a parieto-basilar muscle which appears to be almost fully developed. The retractor muscle is beginning to be formed showing a feathery bunch of muscle folds. In some cases these folds are pressed back owing to the development of large gonads.

The mesenterial filaments contain large gland cells the contents of which are granular and take stain deeply with borax carmine. There is also a number of nematocysts, some of which are very large ; these are spindle-shaped and do not stain. I am unable to detect the spiral coil in any of the nematocysts of this region. There are also a few nematocysts scattered about. It is very difficult in this specimen to follow the mesenterial filaments, because the gonads tend to push them together into one mass. I can distinguish only one lobe at the tip of each filament and in most cases this is rounded. In the directive mesenteries the lobe is pointed at the tip.

There are two œsophageal grooves, one of which is better developed than the other. The ectoderm is of uniform thickness along the groove ; there is present a wide zone formed by the granules, as in the ectoderm of the column wall. There are no nematocysts or gland cells here, this ectoderm resembling that of the column wall. Beyond the groove the ectoderm is deeply folded, the folds being supported by processes of mesogloea. Gland cells and nematocysts are present on these folds.

The ectoderm of the peristome (Fig. 12) possesses a large number of the gland cells, also a large number of spindle-shaped bodies filled with dark granules, probably empty cases of nematocysts filled with zooxanthellæ. The number of gland cells increases rapidly towards the entrance of the mouth, and the ectoderm in this region is raised into folds supported by mesogloeal processes.

The sphincter muscle (Fig. 11) is situated along a line joining the bases of the acrorhagi. It is a well circumscribed endodermal muscle and seems to be very much like that of *Aulactinia gelam* figured by Haddon (Plate XXVIII, Fig. 6). In a vertical section of the oral disk it arises from the outer wall near the base of the acrorhagi. It is almost circular, and the surrounding endoderm contains numerous zooxanthellæ. The pedicle is very short and stout, and gives rise to numerous delicate muscle fibres. These are much finer and more numerous than those of *A. gelam*. They branch frequently near their tips, but are not so arborescent as those of *A. gelam*. In a transverse section of the tentacle cut near the base (Fig. 9) the ectoderm contains numerous spindle-shaped and rectangular nematocysts. The spiral coil cannot be distinguished and many gland cells are present. A nerve layer at the base of the ectoderm cells is broad and distinct. The mesogloea consists of a narrow layer of homogeneous structure, except in some parts where it is slightly fibrous. There is a distinct ectodermal muscle, processes of the mesogloea being pushed out on the ectodermal side. There is no indication of an endo-

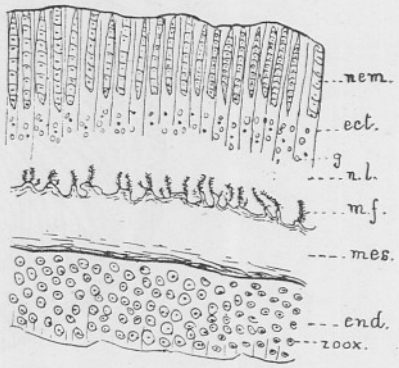

FIG. 9.—*Anthopleura alfordi.* Transverse section of a tentacle near the base, showing a portion of the wall.

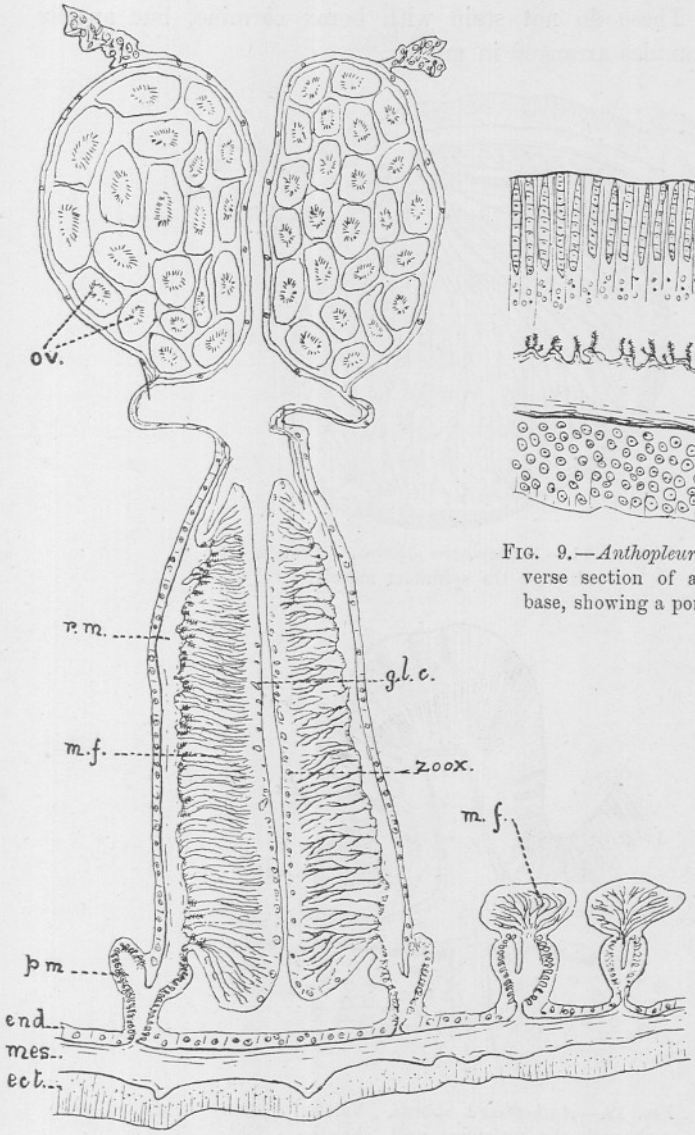

FIG. 10.—*Anthopleura alfordi.* Transverse section through the column, showing two primary and two secondary mesenteries.

dermal muscle. The endoderm consists of a spongy layer, which is about the same thickness as the ectoderm, and this is full of colonies of zooxanthellæ. These do not stain with borax carmine, but appear as brownish granules arranged in groups.

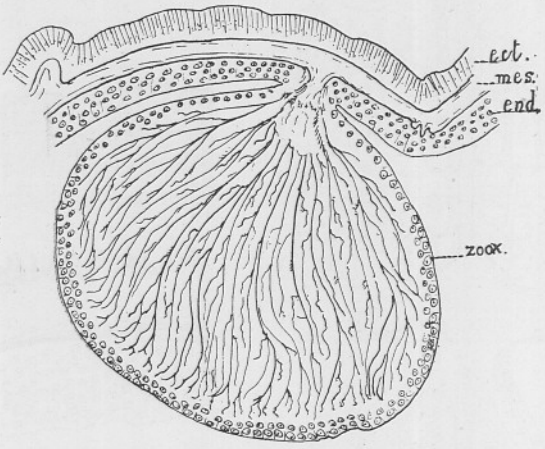

FIG. 11.—*Anthopleura alfordi.* Section through the sphincter muscle.

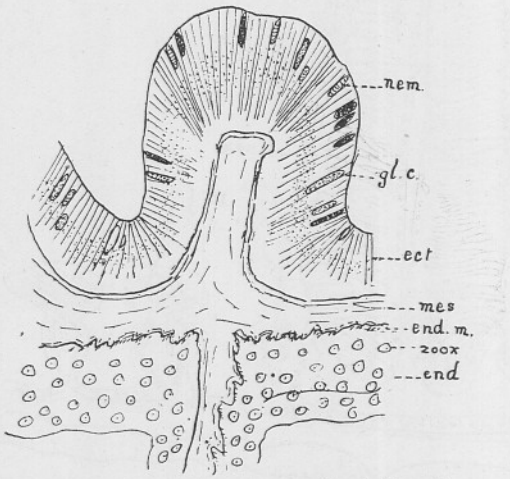

FIG. 12.—*Anthopleura alfordi.* Vertical section through the peristome wall, showing a fold, and the origin of a mesentery.

In a longitudinal section through a tentacle the ectodermal muscle can be seen as a thin plate of tissue arising from the more deeply stained mesogloea. Lobes and stunted irregular processes penetrate the endoderm. Full-sized nematocysts are situated near the outer edge of the ectoderm,

while immature ones are embedded in the middle of the ectodermal tissue and are deeply stained. The older ones are longer and more transparent. The spiral thread could be faintly distinguished in one or two cases ; it is very fine and has a large number of coils. The nematocysts are more numerous at the tip, but they are well developed along the stem.

A. alfordi and *A. gelam* are alike in the following respects : they have more than six pairs of perfect mesenteries ; they possess a well-circumscribed endodermal muscle. I therefore suggest the following as an amended definition of Anthopleura : Cribrinidæ with the upper portion of the column wall provided with longitudinal rows of verrucæ, the lower portion being smooth. The margin forms a more or less distinct collar and the tentacles are polycyclic and entacmæous. More than six pairs of mesenteries of the first cycle are perfect.

Corynactis viridis (Allman, 1846).

Classification : The following is the classification adopted by Haddon :—

Tribe : Hexactiniæ (Hertwig, 1882).
Order : Stichodactylinæ (Andres).
Sub-order : Homodactylinæ (Duerden).
Family : Corallimorphidæ (Hertwig).
Genus : Corynactis (Allman).
Species : viridis.

Haddon gives the following definition of the Stichodactylinæ : " Hexactiniæ in which more than one tentacle may communicate with a mesenterial chamber. Usually a peripheral series of one or more cycles can be distinguished from an inner accessory series, the members of which are radially arranged or in groups, and are of different form. The sphincter muscle may be endodermal or absent." Branched tentacles appear quite often.

Duerden has divided the Stichodactylinæ into two sub-orders :—

(*a*) The Heterodactylinæ in which the tentacles are of two kinds, usually marginal and accessory, and separated by a bare portion of the disk, e.g. Actinotryx, Rhodactis, Heterodactyla.

(*b*) The Homodactylinæ in which the tentacles are of one kind, simple or complex, and usually follow one another in continuous rows, e.g. Richordea, Corynactis, Stoichactis.

Family : Corallimorphidæ. Stichodactylinæ with a marginal corona of tentacles, and accessory tentacles, arranged in radial series each con-

sisting of from one to many tentacles. The muscular system is weak throughout the body.

Genus: Corynactis. Corallimorphidæ in which the body-wall is smooth. The tentacles are all knobbed and are arranged in radial series so that more than one communicates with each inter- or intra-mesenterial space. Tentacles and mesenteries tetramerous. Gonidial groove present or absent. Endodermal sphincter very weak. Mesenterial filaments devoid of ciliated streak.

Mesogloea practically homogeneous.

Corynactis viridis (Allman, 1846).

The word Corynactis (Greek=club-stick) refers to the shape of the tentacle.

The emerald-green ring round the capitulum was said to be characteristic of *C. viridis* found in European seas; this green ring was also found on *C. carnea* (Buenos Ayres) and on *C. australis* (Port Phillip, Australia).

The specimens I examined were obtained from Plymouth, and were collected on the Breakwater. Some were brightly coloured, green and yellow, others were almost colourless. The following measurements were taken from a preserved specimen from Plymouth :—

Diameter	of	pedal disk	=5 mm.
,,	,,	column	=2·5 mm.
,,	,,	oral disk	=4 mm.
Length	of	column	=5·5 mm.
,,	,,	tentacle	=1 mm.

The external appearance of *C. viridis* has been described by many of the older writers. In 1884 Andres describes it in *L'Attinie* in page 266. In the report on Actiniaria dredged by H.M.S. *Challenger*, 1873–76, Hertwig gives the arrangement of the mesenteries. The first account was written by Allman in the *Annals and Magazine of Natural History* in 1846. Allman obtained his specimens near low-water mark in the pools left by the retiring tide in Crook Haven, Co. Cork. One of his specimens was a fairly large one measuring ·5 inch across the tentacular disk.

In Allman's specimen the colour of the tentacular disk was bright green, except for a circle of radiating brown striæ which surrounded the mouth at a short distance from its margin. The stems of the tentacles were of a sienna colour and their extremities were of a bright rose. He found varieties which were not uncommon, in which the green colour

except in a narrow ring at the upper margin of the body was entirely replaced by a light flesh colour. Andres' specimen possessed a brilliant metallic iridescence.

In all the paler varieties the animal becomes translucent when expanded, so that the septa and vermiform filaments may be seen through the body-wall. This is evidently an example of albinism. The animal changes its form very often, at one time it will assume the appearance of a slender cylindrical stem, fixed by one extremity and bearing on the other extremity a flattened disk. Sometimes a contraction will take place in the middle of the body so as to cause the animal to present somewhat the appearance of an hour-glass. In assuming its many different forms the stomatodaeum is never everted.

Allman found two concentric rows of tentacles arising near the margin of the disk, but the number and arrangement is variable. They are tubular like the tentacles of other Actiniæ and communicate freely with the interseptal spaces. They are imperforate at the apices, which are very much swollen.

I have examined specimens of *C. viridis* chiefly with the aim of comparing it anatomically with the Australian specimens, which are the only Corynactids well known in this respect.

Anatomy and Histology :—

The ectoderm of the column wall is fairly spongy in places, in other places it is like that of *C. myrcia*, described by Duerden, and consists of large unicellular gland cells mingled with narrow supporting cells. The gland cells become swollen near the free surface, where in places they give rise to a clear zone. The contents of these cells are usually clear, and then they do not take stain easily but stand out as highly refractive bodies. In other cases they become deeply stained because the contents are granular.

The nuclei of the ectoderm cells are deeply stained, and as in *C. hoplites* and *C. myrcia* they are arranged in a zone a little within the middle of the ectoderm layer.

The interior part of the layer forms a clear zone, this marks the position of part of the nervous system. The ectodermal muscle can be distinguished at the base of the ectoderm. The body-wall of the pedal disk is fully expanded, and therefore appears very narrow as compared with that of the column. The ectoderm of the base appears to be one-fourth of the thickness of that of the column wall. In this region the ectodermal muscle is very strong and thick processes of mesogloea can be seen

projecting into the ectoderm. A layer of foreign material is attached to the outer region of the ectoderm. The mesogloea is a very thin layer, being only one-quarter the thickness of the ectoderm. It becomes deeply stained, is homogeneous, showing no fibrillar structure ; and is thicker in places owing to the contraction of the body-wall. In structure it appears to resemble *C. hoplites* and *C. myrcia*, but in *C. hoplites* it is about the same average thickness as the ectoderm. The mesogloea of *C. australis* is also of considerable thickness.

The endoderm of the column is much narrower than the ectoderm. In this *C. viridis* differs from *C. myrcia*, where endoderm and ectoderm are of about the same thickness. In *C. viridis* the endoderm becomes thicker near the base. It consists of a spongy mass, and is not so deeply stained on the whole as the ectoderm. In some places there are large oval gland cells which contain a granular substance, these seem to be more numerous in the endoderm than in the ectoderm. The endodermal muscle is very feebly developed, but appears stronger in the base.

There are no zooxanthellæ present in this anemone, nor has their presence been indicated in any of the other members of this genus.

The sphincter muscle (Fig. 13) is endodermal, intermediate between a diffuse and a restricted form, and is stronger than that of either *C. australis* or *C. myrcia*. The mesogloeal processes are longer than those of *C. myrcia* and are slightly branched. The muscle becomes much stronger towards the upper part of the body. I have failed to recognise the simple circumscribed endodermal portion of the upper part of the sphincter as described and figured by Haddon.

The tentacles were described by Allman in 1846, and he was able to recognise two kinds of nematocysts, the small oval nematocysts which are very numerous and the large stinging cysts. Both kinds have also been found in *C. myrcia*. The structure of the tentacle (Fig. 15) is very much like that of *C. myrcia ;* the knobs consist almost wholly of deep ectoderm ; the mesogloea and endoderm are very thin, and the ectoderm consists of a mass of nematocysts, which are long oval cells with the internal spiral coil showing perfectly. These nematocysts did not stain, but appeared as highly refractive bodies and are also present along the stems of the tentacles and in the ectoderm around the mouth. In *C. myrcia* the stems of the tentacles are devoid of nematocysts, but they are found in the endoderm near the tip of the tentacles in *C. viridis ;* they have not been mentioned as occurring in the endoderm of any of the other members of this genus. There is a distinct nerve layer at the base of the ectoderm, and that

of the stem contains nematocysts, but they are not so numerous as on the tip. The nematocysts in the endoderm are not so numerous as those in the ectoderm, and none are present in the endoderm near the base of the tentacle. They are also present in the oval swelling at the tip of the mesenterial filaments. The stomatodaeum is oval in section and the wall is thrown into numerous deep and regular longitudinal folds. As in *C. myrcia*, these folds show a rough approximation to the points of attachment of the complete mesenteries. The ectoderm contains a large

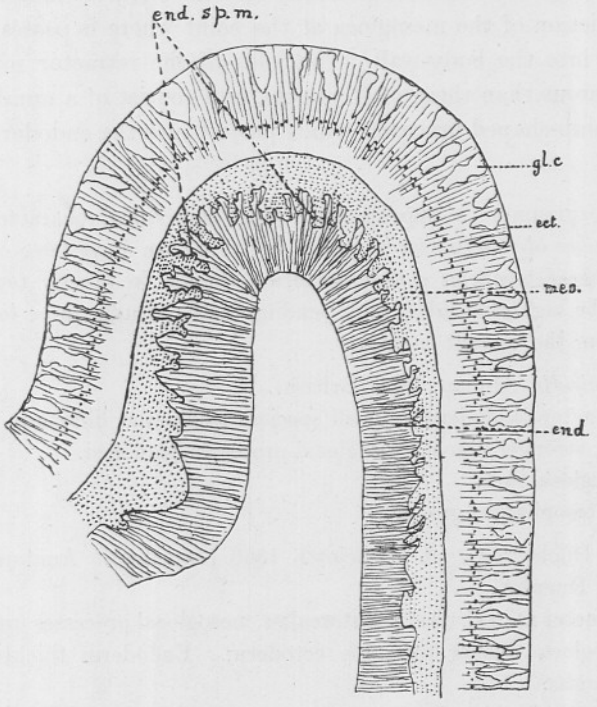

FIG. 13.—*Corynactis viridis.* Vertical section through the body-wall, showing the sphincter muscle.

number of gland cells, and near the base of this layer there is a quantity of granular material. The mesogloea is thin except at the summit of the folds, where it is thick and gives off small branches which form a strong ectodermal muscle. The endoderm is spongy as in the column wall, it is thicker than the mesogloea and contains large gland cells. One gonidial groove is present, which is not very deep.

The number and arrangement of the mesenteries vary in different specimens. Transverse sections of three different specimens were cut. In one there are 48 mesenteries, some complete and some incomplete,

including two pairs of directives ; in another there are 36 mesenteries, including one pair of directives ; and in a third there are 46 mesenteries, including two pairs of directives.

There are two cycles of mesenteries (Fig. 14), a primary series, consisting of complete ones, and a secondary series in which they are incomplete. The incomplete mesenteries project for some distance into the cœlenteron ; in section they are nearly as broad as the primary mesenteries. The parieto-basilar muscle is stronger than that represented in the figure of *C. myrcia* and passes gradually into the retractor muscles. There is a constriction of the mesogloea at the point where it passes from the mesentery into the body-wall. The folds of the retractor muscles are more numerous than those of *C. myrcia*, and consist of a number of unbranched club-shaped processes which project into the endoderm.

A serial summary is appended showing anatomical characters of the various species of Corynactis in so far as these data have been obtainable. The ordering of tentacles and mesenteries, though frequently tetramerous, appears to be highly variable, and, pending further study, these features are omitted from the present summary.

Corynactis viridis, Allman, 1846 (British).

Sphincter (endodermal in all species) feeble and diffuse in the lower part, stronger above, mesogloeal processes branched.
Mesogloea thin.
One œsophageal groove.

C. myrcia, Duchassaing et Michelotti, 1866 (Jamaica). Anatomical data from Duerden.

Sphincter as in *C. viridis*, but weaker, mesogloeal processes unbranched.
Mesogloea thicker than the ectoderm. Endoderm thicker than in *C. viridis*.
No œsophageal groove.

C. carnea, Studer, 1878 (Buenos Ayres). Anatomical data from Kwietniewski [23]. Sphincter strong, fibres long and branching; mesogloeal processes branched. Mesogloea about as thick as ectoderm, sometimes thicker.
Two pairs of directives, grooves weak.

C. hoplites, Haddon and Shackleton, 1896 (Torres Straits). Anatomical data from Haddon.

Sphincter strong but diffuse. Mesogloeal processes slightly branched.
Mesogloea about as thick as the ectoderm.
Two pairs of directives and one groove.

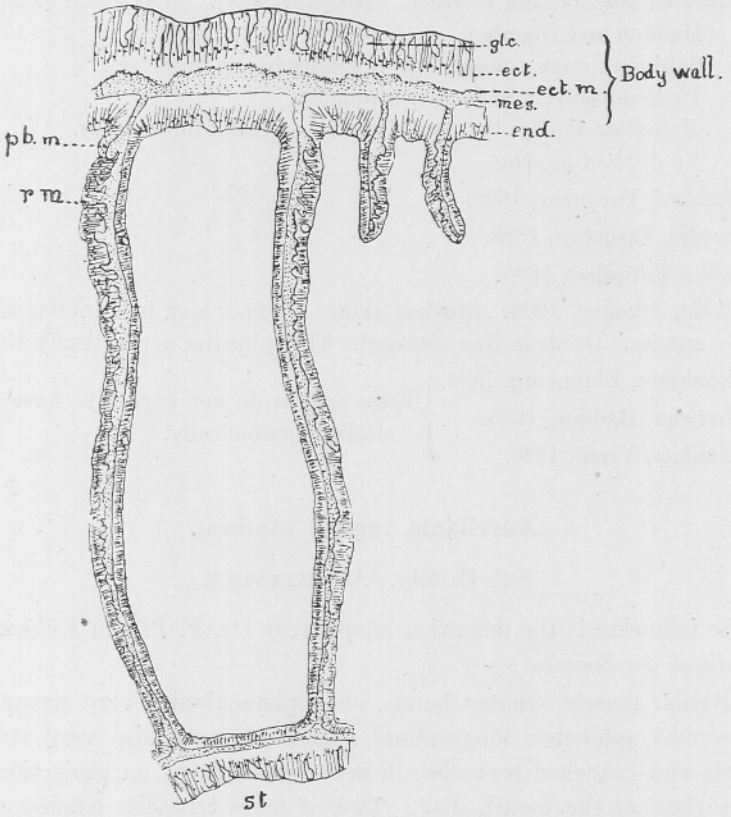

FIG. 14.—*Corynactis viridis.* Portion of a transverse section of the column in the region of the stomatodaeum, showing one pair of directives and one pair of incomplete mesenteries.

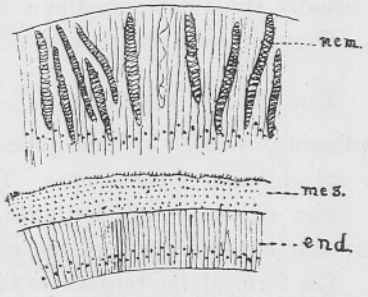

FIG. 15.—*Corynactis viridis.* Portion of a transverse section of a tentacle, showing the spiral coil in the nematocysts.

C. australis, Haddon and Duerden, 1896 (Australia). Anatomical data from Haddon and Duerden.
Sphincter weak ; mesogloeal processes barely branched.
Parieto-basilar muscle very strong.
Mesogloea thicker than ectoderm above, thins downwards.
No distinct grooves.

C. Haddoni, Farquhar, 1898.

C. gracilis, Farquhar, 1898.

C. mollis, Farquhar, 1898.

C. albida, Stuckey, 1909. Stuckey thinks all four may be varieties of one species. Occur in New Zealand. The sphincter is practically absent.

C. globulifera, Ehrenberg, 1834.
C. Hertwigi, Haddon, 1893.
C. annulata, Verril, 1869.
} These species do not appear to have been studied anatomically.

Aureliania regalis (Andres).

Sub-Family. AURELIANIDÆ.

The following is the definition adopted by Dr. F. Pax in Kükenthal, *Handbuch der Zoologie* :—

" Basilar muscle, ciliated bands, one siphonoglyphe, very strong circumscribed sphincter, longitudinal muscle of septa also very strong. Simple and branched tentacles, in some cases placed on projections of the surface of the mouth disk. Two or more tentacles communicate with each exocoel."

Andres' definition is formed from external characters. " Base adhering, column obconical, not tuberculate, imperforate. Tentacles arranged in radial series, numerous and detached, not simple, but swollen at the apices ; the knobs usually spherical, sometimes giving rise to buds. Colour yellowish red. Found in sand and on rocks."

The Genus, AURELIANIA.

" Form : Base adhering, wide. Column abconical with minute suckers secreting a membranous investment. Tentacles numerous, arranged in radial series of two tentacles each, and at the same time forming four circular cycles. Each of the cycles has a different number of tentacles. The form of the tentacle is tubercular, swollen at the apex, bilobed. Peristome convex, radially grooved. Colours yellowish orange, tinged with vermilion." The above is a translation of the description of the genus Aureliania given by Andres in *L'Attinie*. He

regards two species as belonging to this genus, namely *A. heterocera* and *A. regalis*. *A. regalis* and *A. augusta*, Gosse 1860 and Andres 1880, are given as synonyms. Andres in a note states that he found the number of tentacles to agree with that in Gosse's specimen. Since colour is too unreliable a character on which to base species and since the comparative anatomy of *A. augusta*, *A. regalis*, and *A. heterocera* still remains apparently unknown, it seems necessary to retain the name *regalis* (Andres) for the present, at the same time keeping in mind the possibility of this name being merely a synonym of *A. augusta* (Gosse). The name *regalis* is used in France, from which coast the specimen referred to here was obtained. Figs. 4, 5 and 6, in Plate X in *L'Attinie*, give an exact reproduction of the form and colour of the specimen when alive.

The following is a translation of Andres' description :—

" Form : Base adhering ; spreading, irregular. Column conical below, cylindrical above, smooth, fleshy, not greatly extensible, secreting abundant mucus to form a sheath. Margin turning upwards, minutely crenate, collar deeply grooved. Disk small, smooth. Tentacles retractile, numerous (144) in four cycles (36+36+36+36). [The tentacles may be more than 144 in number ; in one specimen I found 168 (42+42+42+42) as in *A. augusta* (Gosse).] Each tentacle is short, moniliform and directed outwards. They occupy more than half the periphery of the disk. The form, " monile " (resembling a necklace), is modified in the tentacles of the two external cycles, the swellings are unequal, the proximal is rounded and the apical is prolonged to a point. The peristome is smooth, scarcely striated at the radii. Mouth round, small, not prominent.

" Colour pale rose. Column orange-vermilion with whitish specks. Tentacles of indefinite yellowish colour, transparent with opaque stains and spots. Peristome reddish vermilion. Of the gonidial radii only one is indicated, and this has a whitish line where the radius touches the periphery. Situation in the sand usually covered as far as the disk, but sometimes protruding with part of the column."

Andres examined three individuals, two coincided with the above description, but the third had the peristome spotted.

I took the following measurements from the preserved specimen :—

Diameter of base=17 mm.
Height of column=18 mm.
Diameter of oval disk greatly contracted=9 mm.

The specimen contained a large amount of mucus, this caused the tissues to contract and become very hard in xylol. The specimen had become very much contracted ; for these reasons I am unable to give a full description of the species. The mesenteries are arranged in two cycles, 36+36=72. The incomplete mesenteries are unevenly developed, some appear as slight projections into the cœlenteron, others are larger and have produced many muscle folds.

The mesenteries (Fig. 16) possess a very long retractor muscle with a large number of short folds. The curious fact about this muscle is that it faces the intramesenterial space or exocoele instead of the intermesenterial space or endocoele, as is commonly found in Actinians. The longitudinal muscle of the directives faces the intermesenterial space. Near the proximial end of the mesentery lies the parieto-basilar muscle, which arises as a stout projection on the side away from the retractor muscle. It gives off a large number of folds which are longer than those of the retractor muscle, they have a somewhat reticulate appearance when examined under the high power of the microscope. The mesogloea is fibrous and has a number of cavities of irregular shapes. The wall of the œsophagus is raised into a number of lobes. There is one œsophageal groove corresponding to the pair of directive mesenteries present.

The body-wall is strong, the mesogloea forming a thicker layer than the ectoderm. The latter is raised into a large number of folds, each being supported by a process of mesogloea.

This species is extremely rare, and British specimens were not available. One specimen of *Aureliania regalis* was, however, most kindly sent by Monsieur Louis Fage from the laboratory at Banyuls-sur-Mer, and it is this specimen which has been anatomised and is described above.

INDEX TO LETTERING.

ect., ectoderm.
ect. m., ectodermal muscle.
end., endoderm.
end. m., endodermal muscle.
end. sp. m., endodermal sphincter muscle.
g., granules.
gl. c., gland cell.
mes., mesogloea.
mu., mucus.
n.l., nerve layer.
nem., nematocyst.
pb. m., parieto-basilar muscle.
r.m., retractor muscle.
sph., sphincter.
zoox., zooxanthellæ.

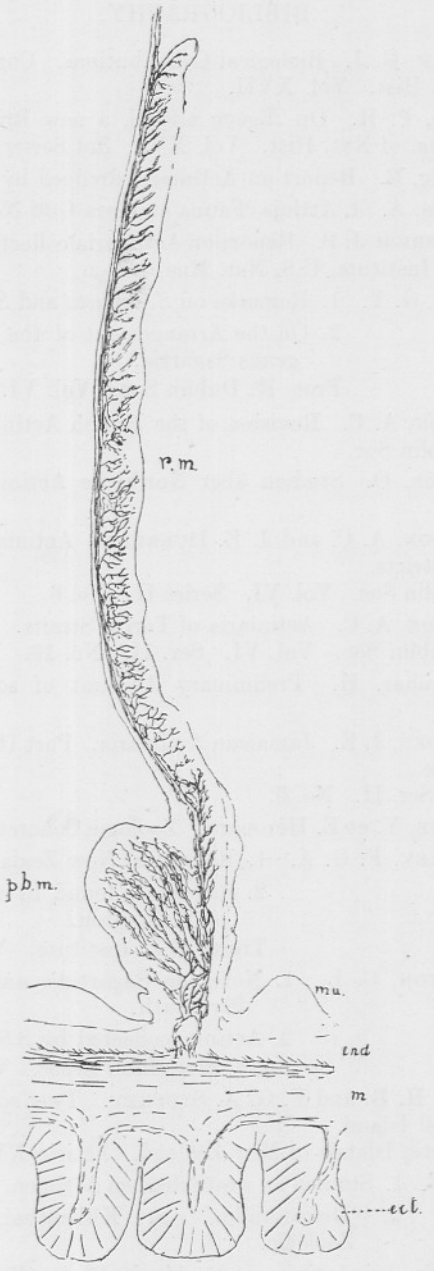

FIG. 16.—*Aureliania regalis.* Transverse section of the column, showing a portion of one of the mesenteries.

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Notes on Experiments in the Keeping of Plankton Animals under Artificial Conditions.

By

L. R. Crawshay, M.A.

TABLE OF CONTENTS.

Introduction.

THE experiments referred to in the following pages were carried out by the wish of the Director at the Plymouth Laboratory, between June, 1912, and February, 1913. They were undertaken with a view to keeping under observation some of the smaller zooplankton, and particularly the Copepoda, in order that they might be followed through the different stages of their life cycle. After a long series of disappointing results, the experiments were unavoidably interrupted at a time when apparently the chief obstacles to success had been located and largely overcome.

Continued observation of these small animals has only in the last few years been rendered certainly possible by the work of Dr. Allen on the culture of the marine Diatoms, which form the chief food supply of the great majority of them, and it is not surprising that until the problem of obtaining and keeping a suitable food culture was settled, attempts to keep

Copepoda alive in the Laboratory met with little success. Mention may here be made of one important result obtained by Dr. Allen himself, in the course of his Diatom experiments. In a flask of 1000 c.c. in capacity he kept, between August and September, 1905, some specimens of *Calanus finmarchicus* alive on a mixed Diatom culture for a period of about seven weeks, and obtained from them many nauplii, two of which developed into young *Calanus*, of which the exact life period was not recorded.* It was uncertain how far the exact conditions under which this experiment was carried out had been essential to its success, and with a view to locating harmful influences and removing them as they became apparent, the experiments came to be conducted under many different conditions in regard to position in the Laboratory, the kind of vessel employed and its capacity, the water used, the intensity of the light, the food culture, and the presence or absence of an air supply. Attention was also given to the question of the influence of some of the Bacteria and their destruction. Only after a large number of experiments had been made was it ascertained that due consideration had not been given to a factor, the importance of which cannot be overestimated, namely, temperature, and that to irregularities of temperature the repeated failure of the earlier experiments was without doubt to be attributed in a very large degree. The work which has since been resumed still needs careful attention to details of method before satisfactory results can be obtained, and in the meantime a short account of the experiments is given as a preliminary contribution to the subject.

The experiments will be considered, as far as may be, in the order in which they were carried out, while grouping them together according to different conditions, some reference to which is first necessary.

Position.

(A) In this room, where most of the earlier experiments were made, the aspect is north and the light moderate. The window was at all times kept partly open, and no artificial heating was used ; consequently the experiments were very susceptible to outside changes of temperature that occurred from one day to another. Records of the temperature of the water of the experiments were not made till the latter part of November, but twenty-five observations made between November 26th and January 13th showed a varying range of 6° or more,† a maximum daily variation of 3·8°, and a maximum change over two

* *Journ. Mar. Biol. Assoc.*, N.S., Vol. VIII., p. 470.

† All temperatures are recorded in degrees Centigrade.

days of 5·8°, the average temperature being 10·8°. During the summer months, the changes must have been very much greater.

(B) Here the vessels rested on a table close to a large double window, with a western aspect, partly lighted also from the northern side, and the light was consequently good. The position in the building being more central than Position A, the changes in temperature were probably, on the whole, less in extent and less sudden than in the latter. At times, however, they were greater, as, for example, in the month of July, when on four successive days the following temperatures of water in the bell-jars were recorded : July 17th, 25° ; July 18th, 20° ; July 19th, 16·3° ; July 20th, 17°.

(C) In this part of the building, the General Laboratory, well lighted with large windows, both on the southern and on the northern sides, the light obtained was always good, and often so strong as to need screening. In the colder weather the air temperature is kept by hot-water pipes between 13° and 18°, and in general it is subject to very much less change than in either of the other two positions. As, however, in all experiments here carried out, the vessels were kept submerged, either in the sea-water of the general circulation or in water artificially adjusted to a nearly constant temperature, the changes in air temperature were of minor importance and, as affecting the experiments, almost negligible. The water of the experiments, which was necessarily regulated by the temperature of the tank water, showed over a number of observations made between November 26th and February 7th a varying range of no more than 1·6°, a maximum daily variation of 1°, and an average temperature of 12·3°.

Vessels.

These consisted chiefly of the following :—

Glass Finger-bowls.	Capacity, 350 c.c.
,, Flasks.	,, 1 and 1·5 litres.
,, Jars.	,, 2 litres.
,, Beakers.	,, 2 ,,
,, Bell-jars.	,, 11 ,,

The vessels were covered with squares of glass or with watch glasses, as a provision against dust. Except in one special experiment (p. 562), there was no circulation of water through the vessels, the water being left standing, subject only to stirring by aeration or otherwise, and being only changed in certain occasional instances.

Water.

(A) Tank Water.—Water circulated through the tanks of the Laboratory from the supply stored in the reservoirs. This water is pumped up into the reservoirs from the sea below the Laboratory at high water spring tides. In consequence of the large number of animals living in the tanks it contains a considerable amount of excretory products.

(B) Berkefeld Water.—Tank water treated with animal charcoal, and filtered through a Berkefeld candle. In many experiments, owing to the high salinity of the tank water, this was diluted with 5% distilled water.

(C) " Outside " Water.—Water brought in from outside the Plymouth Breakwater, and largely free from the contamination of the inshore grounds. This was used sometimes untreated, sometimes sterilised, and sometimes filtered through a Berkefeld candle.

(D) Miquel Sea-Water.—Occasionally Berkefeld, usually " outside " water, treated with the modified Miquel solution employed by Allen and Nelson,* but chiefly used in considerably less strength, generally one-third, in experiments here to be considered.

Light.

Additional illumination was obtained when necessary by placing sheets of white paper or card, or of opal glass, under the vessels, and in many cases behind them also. In some experiments the light was partially or wholly cut off by screening the vessels with black paper.

Food.

In most of the experiments a culture of the Diatom *Nitzschia closterium* was used as food for the animals. In some, the Alga *Chlorodendron subsalsum* was used.

Air-supply.

Artificial aeration of the water was employed at intervals in many of the experiments for varying periods, and sometimes continuously, by means of drawn-out glass tubes led into the vessels, and connected with the general air-pressure system of the Laboratory. It may be said at once that no definite advantage seemed to be gained by its use, assuming the water to be naturally aerated at the outset.

* *Journ. Mar. Biol. Assoc.*, N.S., Vol. VIII., p. 428.

The Experiments.

For brevity, the results of the experiments will be considered in a summarised form, the experiments being grouped together according to the vessels in which they were carried out. The recorded averages and maxima refer to the life period in days occurring among animals of the several experiments in each group. The experiments carried out in Positions A and B, in all of which the vessels were exposed to the influence of air temperature changes, will first be dealt with. Later, the experiments in Position C, in all of which the vessels were submerged, will be treated in the same manner, and the results of these will then be compared with those in Positions A and B. The dates given are those on which the different experiments were started.

Positions A and B.

In the experiments to be referred to, all but those made in 11-litre bell-jars were carried out in Position A. The results are marked with great irregularity. In certain exceptional cases, specimens lived for a considerable period, but the averages are almost consistently low, and it is evident that some factor entered into all the experiments which rendered the conditions unsuitable and in most cases quite intolerable. In some preliminary experiments in tank water, to which no *Nitzschia* or other food was added, rather lower averages occurred, but in other respects no distinct advantage was traceable to the kind of water used, which included Berkefeld, Berkefeld diluted, the same with Miquel-Allen solution in full proportions, " outside " water untreated, and the same sterilised. Some species appear to be more delicate than others, and among nauplii the mortality was exceptionally high. The different forms will, therefore, be considered separately.

Zoaeae. These should perhaps be viewed in a different category from the rest, since it is doubtful whether a suitable food was found for them, though *Nitzschia*, *Chlorodendron*, and Ciliate cultures were tried. In a total number of 18 experiments with from 4 to 11 specimens, in finger-bowls (June 11th to July 30th), the average time of survival was from 5 to 7 days, the maximum ranging from 11 to 16 days.

Calanus finmarchicus. In finger-bowls, 5 experiments comprising from 5 to 12 specimens (June 19th to August 7th) showed in Berkefeld, Berkefeld diluted, and Berkefeld diluted plus Miquel-Allen solution, comparatively little difference of average, 11 to 14 days, from that of 3 experiments in tank water (10 days), to which no *Nitzschia* or other

food was added. Apart from one exceptional example in which a specimen, infected with the parasite *Microniscus*, lived for 40 days, the maximum was no higher than 23 days, which was 4 days in excess of the next highest period.

In 1-litre flasks, 5 experiments in " outside " water, containing from 3 to 5 specimens (September 27th to October 23rd) showed a higher average, of about 22 days, than was obtained in the finger-bowls, and a much higher maximum of 84 days. In the experiment in which this high maximum occurred (October 21st) the shortest life period was 23 days, and the average for the three individuals was about 44 days. No clear explanation was found for the fact that in three other *Calanus* experiments, started two days later under almost identically similar conditions, the maximum was no higher than 27 days, and the average about 16 days.

Temora longicornis. In finger-bowls, 9 experiments with from 6 to 12 specimens (June 19th to August 8th) were far less successful than in the case of *Calanus*, and a maximum of 23 days, which was obtained in one case in Berkefeld water, was far in excess of the life period that was usually sustained. The data for averages are incomplete, but with the exception mentioned the longest life did not exceed 11 days, and the average for all the experiments was probably not above 5 days.

In 1-litre flasks, 2 experiments, with 7 and 10 specimens, in sterilised " outside " water (September 18th and 27th), were little more successful than those in the finger-bowls, the maximum being about 17 days, and the average life probably not exceeding 5 or 6 days. In connection with the mortality of this species, it is very remarkable that in the first of these two experiments, 6 *Acartia* which were included in the same vessel at the same time subsequently reached the high average of about 60 days.

In 11-litre bell-jars (Position B), an experiment with 70 specimens, in Berkefeld water (July 17th) failed completely, all dying within two days. Of a similar number, placed in the same bell-jar with the same water (July 19th), none lived for more than about a fortnight. In an experiment with 50 specimens in " outside " water (July 17th), a few only survived the first fortnight, though a single specimen lived for 48 days. Mention has already been made (p. 557) of the irregular and high temperatures that were recorded for the water in bell-jars in this position at this period, showing over four successive days a range of nearly 9°, with a maximum daily variation of 5°, and these irregularities were

with little doubt accountable for the mortality of specimens, even in so large a volume of water.

Anomalocera Patersoni. In finger-bowls, 2 experiments with 6 and 3 specimens, were made in tank water only, to which no *Nitzschia* or other food was added (June 10th). These 9 specimens showed an average of 2 days only, the maximum being 4 days.

Acartia sp. In a 1-litre flask, a single experiment with 6 specimens in sterilised "outside" water (September 18th) showed the high maximum of 100 days, the average being about 60 days. This was the only experiment carried out in Position A in which nauplii were certainly produced, a few of these being observed continuously from the 30th to the 73rd days. The number of nauplii produced, and their individual life periods are uncertain. No more than four were recorded at any one time. Some showed distinct growth, but none reached an advanced stage. As it has been stated, 7 *Temora* which were included with these *Acartia*, all died within about 17 days, and it would seem on the evidence of this single experiment that the species (probably *A. Clausi*) is more hardy than *Calanus* or *Temora*. The experiment lasted till December 27th.

Nauplii (chiefly *Balanus*, *Temora*, and *Calanus*). In finger-bowls, 3 experiments with from 15 to 20 specimens in Berkefeld water (July 11th) showed a maximum of 4 days; in 3 experiments, with from 20 to 100 specimens, in Berkefeld diluted (July 19th to 30th), the maximum was about 15 days; in 2 experiments, each with 20 specimens, in Berkefeld diluted, plus Miquel-Allen solution (August 8th), the maximum was about 12 days. The average for all these experiments probably did not exceed 2 days. On the other hand, as it has been shown, among the *Acartia* nauplii hatched from eggs laid in the vessel, some appear to have lived for a considerable time though the individual life periods were not known.

Young Calanoids. In 1-litre flasks with several young forms naturally contained in this bulk of "outside" water, and with no additional food included, 2 experiments (September 24th) showed a maximum life period of 18 days only.

In a bell-jar (Position B) an experiment in Berkefeld water with mixed plankton including many young forms, and with some fine tow-netting added as food (June 10th), showed several young forms, including nauplii, alive and healthy on the 33rd day, and a few continued till the 42nd day. Soon after this all disappeared, the specimens apparently

failing, like others previously referred to, in consequence of high and irregular temperatures at the time in this position.

General. As bearing on the sensitiveness of some Calanoids to sudden changes in the water conditions, the following example is important. On June 15th, two *Calanus finmarchicus* were given to me by Mr. Fuchs in a large jar (breffit) of 2000 c.c. in capacity, in " outside " water containing a growth of *Nitzschia,* in which he had reared some Echinoplutei. The culture had been started by him on April 19th, and kept from that date on one of the slate slabs in the General Laboratory. In the water that was used the two *Calanus* had been introduced unobserved, evidently as young forms, possibly as nauplii, and these, feeding on the *Nitzschia* culture, had grown to nearly full size. On June 15th the jar was taken over by me and placed in Position A, where the *Calanus* continued healthy until July 9th. The *Nitzschia* having then grown too thick the *Calanus* were transferred to a new culture in Berkefeld water, in a clean jar. One specimen was stunned by the change, and fell to the bottom, remaining almost motionless afterwards, and both died within two days. The temperatures had been taken, and Mr. Matthews having kindly analysed samples of the water and ascertained the densities, the change of conditions from one jar to the other proved to have been as follows :—

		T.	S.‰	σ_t
Jar A.	" Outside " water	16·5	35·22	25·82
Jar B.	Berkefeld ,,	17·5	37·94	27·68

The temperature change being one of only 1°, it seemed evident that the death of these *Calanus* was to be attributed to a sudden change of 2·72 in salinity, and owing to this the Berkefeld water subsequently used in the experiments was diluted with 5% distilled water. It was thought that by thus obviating such sudden changes in salinity, much of the difficulty previously encountered in the experiments might be overcome. It was not realised till later that repeated changes in the air temperature communicating themselves less suddenly to the water in the exposed vessels might be equally harmful in their effects.

Special Experiment in Position A.

In the latter part of the year, it became increasingly evident that some factor which had escaped observation was a constant source of harm to the animals. In view of the possibility that this might be the presence of Bacteria, several experiments, which will be referred to in detail later, had been made in keeping Copepoda in the presence of strong cul-

tures of Bacteria raised on peptone. But the results of these experiments showed that species were capable of tolerating such conditions to a much greater degree than was expected, and did not bear out the supposition that bacterial infection had been the primary cause of failure. Experiments also made with and without an air-supply gave no definite evidence of the value of an air-supply as improving the conditions in water that was naturally aerated at the outset.

There remained a possibility that harmful conditions might be produced through the accumulation of excretory products in the vessels, and to test this a special experiment in Position A was arranged, by which a constantly changing supply of water and food was passed through the vessel in which the animals were contained. For this purpose a large bottle, of 10 litres in capacity, was filled with sterilised "outside" water, with Miquel-Allen solution in proportions one-third of those used by Allen and Nelson, and this water was infected with a culture of *Nitzschia*. The vessel of the experiment, in which 5 *Calanus* were placed, was a 1·5-litre flask, and into this the supply was led by a glass tube from the large bottle, the apparatus being arranged in the form of a self-regulating siphon, by which the water in the flask was kept at a constant level. From close against the bottom of the flask, a siphon tube was led out from the flask to the exterior, to serve as a waste pipe, and this, drawing on the contents of the flask, was so adjusted by a screw clip that the water and food-supply was made to pass through the flask at the rate of 1 litre per diem, nearly. An air-supply was also provided at a slow rate in the flask by connection with the air-pressure system of the Laboratory. A good light was ensured and, the food growth being strong, the conditions were such as appeared to meet all requirements. But little improvement was shown in the result of this experiment which, though more successful than most of the previous ones, produced only a maximum life of 28 days, and an average of about 21 days, the shortest life being 14 days. This experiment was started on October 16th, 5 days prior to the commencement of an experiment made in the same position, in a 1-litre flask under the ordinary conditions, in which 3 *Calanus* subsequently showed a maximum of 84 days, and an average of 44 days (p. 560).

Position C.

It had in the meantime been observed that a *Calanus* which had been left in a 2000 c.c. jar, partly submerged in one of the tanks in the General Laboratory on August 28th, was still alive on October 18th,

51 days later, and, soon after the close of the special experiment just described, a new series was started with the vessels submerged up to the neck in the same manner. An improvement in the results soon became apparent, and from this time the experiments were continued under these altered conditions, either in one of the tanks or in a small extemporised reservoir of water.

In the first experiment, with 6 *Temora*, in a 2-litre jar of water, with *Chlorodendron* as food, one specimen only was alive on the 19th day, and this did not live for more than a few days afterwards. These *Temora*, however, had been left standing for 7 days previously, in a beaker in Position A before the experiment was started, and the result was therefore of doubtful value.

The other experiments related chiefly to *Pseudocalanus elongatus* and *Calanus finmarchicus*. The water used was in all cases "outside" water, treated with one-third Miquel-Allen solution and filtered through a Berkefeld filter. In the majority of the experiments the food was *Nitzschia;* in a few cases *Chlorodendron* was used. Exact data for averages are wanting, and the results can only be considered in their main details. In many cases the observations were unfortunately interrupted before the complete records had been obtained. The results may be summarised as follows :—

Pseudocalanus elongatus. In 2-litre beakers, 3 experiments, each with 15 specimens (November 11th to 28th), showed on the 44th, 50th, and 51st days, severally, about 23 survivors. In one of these experiments, the water having been changed on the 44th day, four were still living on the 72nd day. In another a change of water on the 51st day led to bacterial infection, with fatal results to all the specimens very soon afterwards. In the third, one specimen was still living on the 121st day.

In an uncompleted experiment with 20 specimens (December 20th) a few were still living on the 50th day.

Two experiments (Nos. 174 and 175), which failed through injury caused in connection with an air-supply, are referred to below.

Nauplii were obtained in all the experiments with *Pseudocalanus*, their presence and growth being observed over periods which varied from 40 to 63 days in the different experiments, omitting the two experiments last referred to. Data concerning individual life periods are not available, but several were recorded as reaching the adult form and, in a few cases, apparently the full growth, the age at which the adult stage was reached being approximately between 35 and 40 days.

In the experiment in which the loss of the specimens was attributed to bacterial infection, bright carmine patches appeared colouring the dead bodies of the specimens, other objects at the bottom of the vessel being suffused with the same colour. Mr. Harold Drew kindly tried to cultivate the Bacteria on peptone agar, but no growth was obtained.

The circumstances of the failure of the two experiments (November 30th) in connection with the use of an air-supply are as follows :—

Each experiment concerned 20 specimens.

(No. 174.) Till the 14th day, several were seen very active, and on this day from 20 to 30 nauplii were observed. On the 15th day, all the nauplii and nearly all the adults were dead. On the 19th day, only one of the adults remained alive, showing little movement, on the bottom of the vessel.

(No. 175.) On the 14th day, about a dozen adults and a few nauplii were seen. No subsequent records were made till the 19th day, when nearly all were dead. On the following day a few nauplii still survived, but these died soon afterwards.

In these two experiments the vessels had been provided with an air jet, forced through the water by connection with the air-pressure system of the Laboratory, during the 24 hours between the 13th and 14th days. When on the 14th day the air-supply was taken off, and the vessels removed from the tank for examination, they remained exposed for about half an hour to the much higher air temperature of the Laboratory. The rise in the temperature of the water thus caused was not observed, but it seems possible that the air-saturated water of the vessels thus parting rapidly with air in solution, injury was caused to the blood system of the animals.

Calanus finmarchicus. In 2-litre beakers, submerged in the tank, 5 experiments (November 30th to January 13th) resulted, as far as the observations were carried, as follows :—

Experiments.	Specimens.	Max. Period of Life Recorded, days.	Average, days.
1	2	48	35 (completed)
1	5	27	19 „
1	3	64	41 (uncompleted)
2	3, 5	About 6 living on 45th day	„

Ova were obtained in the last two experiments, but were lost through an accident.

In 1-litre flasks submerged in a bath heated over a small bunsen flame to 16°–18°, and kept by a regulating thermometer at this approximate

temperature, five experiments (January 13th to 29th) showed the following results up to the time when the observations were interrupted :—

No.	Date.	Specimens.	Adults.	Remarks.
195	Jan. 13th	3	All living on 12th day (and apparently on 26th day).	Many Nauplii seen between 6th and 26th days.
198	„ 18th	3	All living on 20th day.	One Nauplius on 4th day. None seen on 20th day.
200	„ 24th	3	Two „ „ 16th day.	One egg seen on 15th day.
201	„ „	4	All dead on 5th day.	Water infected by Bacteria forming long white strands.
202	„ 29th	3	Two living on 30th day.	About 7 ova seen on 11th day.

Omitting the experiment which failed through bacterial infection, the mortality was small at the time when the observations were interrupted, two deaths only having been recorded among the twelve specimens over a period averaging at least 20 days and probably 23 days, in the different experiments.

Ova were obtained in all these experiments, and nauplii were recorded in two of them, many occurring in one over a period of 20 days.

Acartia sp.* In a 1-litre flask, submerged in the artificially heated bath, a single experiment was made (December 20th) with 5 specimens. On the 40th day three of these were living. Nauplii were first observed on the 23rd day, about a dozen were seen on the 25th and 32nd days, and a few only on the 40th day.

A Comparison of the Results obtained in Position C with those obtained in Positions A and B.

The experiments with *Pseudocalanus* having all been made in Position C, the results obtained with this species must be treated with some reserve when comparing them with those obtained for other species in Positions A and B, and it is better to consider them only as confirming the evidence of the experiments with *Calanus* and the single experiment with *Acartia*.

For *Acartia*, the only experiment in Position A gave the high maximum of 100 days, and an average of 60 days for the 6 specimens. In the uncompleted experiment in Position C, 3 out of the 5 specimens were still living on the 40th day. The combined life period of the young

* Probably *A. Clausi*. The species was not certainly determined.

was in the former case 43 days, and in the latter 17 days when the last record was made. It is only noticeable that in Position C the fertility of the parents was distinctly higher than in Position A. It seems probable that the species is hardy as compared with others and less susceptible to injury from changeable conditions (cf. p. 561).

For *Calanus*, the comparative results are as follows :—

POSITION A.

(1) Finger-bowls.	Max. for	5	experiments	(34	specimens),	40	days.	Avg.	12	days.
(2) 1-litre flasks.	„	5	„	(19	„),	84	„	„	22	„
(3) Special expt.	„	1	„	(5	„),	28	„	„	21	„

Average for 11 experiments, 17 „

POSITION C.

(1) 2-litre beakers. Max. for 2 completed exps. (7 specimens), 48 days. Avg. 27 days. Of 3 uncompleted experiments, one with 3 specimens showed at the time of the last record an average of 41 days ; the other two, with 8 specimens, showed on the 45th day an average of 40 days.

The average for these 5 experiments then exceeded 35 days.

(2) 1-litre flasks. The 4 experiments (12 specimens) were very incomplete at the time of their interruption, only one death having occurred in each of two of them, on the 16th and 30th days respectively, or over a period averaging in the 4 experiments not less than 20 (or 23) days.

The 5th flask experiment is omitted from consideration here. The Bacteria by which the water became infected appear to be comparatively uncommon, and, if the general form of the strands produced by them can be relied on as characteristic, they were only twice observed, each time with fatal results to the animals.

Disregarding the last experiment, it may reasonably be estimated that the average for the 4 experiments with *Calanus* in 1-litre flasks would not have been *less* than that shown by the 5 others in Position C at the close of the observations, viz., 35 days.

In regard to experiments in Positions A and B generally, the early falling off of specimens is noticeable in nearly all the results, thus :—

For *Temora*, the average of 9 experiments in finger-bowls was not more than about 5 days ; that of 2 experiments in 1-litre flasks was about the same ; in 2 experiments in 11-litre bell-jars, few survived the first fortnight.

With *Anomalocera*, the 2 experiments with 9 specimens in finger-bowls showed an average of 2 days only, with a maximum of 4 days.

With *Nauplii*, especially those of *Balanus*, *Temora*, and *Calanus*, introduced direct from the townettings into finger-bowls, the mortality

was very high, none living for more than about 15 days, and the average for 8 experiments probably not exceeding 2 days. The few, on the other hand, obtained in the course of the experiment with *Acartia*, lived for a considerable time. In a few experiments in Position A with mixed plankton kept in its natural proportions, in the water that contained it, from 1 to 3 nauplii were observed alive in 3 different experiments in 1-litre flasks, after 11, 11, and 17 days severally ; their continuance in these cases being possibly due to the absence of the initial change of water that was made in the ordinary experiments. On more than one occasion, when nauplii were transferred from townettings to water of a different (higher) temperature, they were seen to be temporarily stunned by the change, and to fall to the bottom of the vessel, though usually recovering within some 5 or 10 minutes afterwards.

Young Calanoids generally, included with some mixed plankton in an 11-litre bell-jar of Berkefeld water in Position B, showed a comparatively high maximum in this larger volume of water, several, including nauplii, surviving on the 33rd and a few on the 42nd day.

There remain for consideration the experiments in Position C with the species *Pseudocalanus elongatus*, for which unfortunately there are no comparative data in the other positions. Of the 6 experiments which have been referred to, 2 may be omitted in which a sudden failure was attributable to the use of an air-supply. In 3 of the remaining 4 experiments, about 50% of the total number of specimens were alive on the 50th day, some being afterwards recorded considerably later ; in the 4th probably 30% were alive on the 50th day. Young, which were obtained in all the experiments, were recorded in these four over periods ranging from 40 to 63 days in duration, one or more in each case reaching the adult stage.

General Remarks.

While it is not improbable that other adverse causes, in addition to that of changeable temperature, contributed in some measure to the generally unsuccessful results of experiments in Positions A and B, it is difficult to trace them with any consistency, or to attribute the failure of the animals to any single chief cause other than the fluctuations of temperature occurring in vessels which were directly exposed to air changes.

Experiments with some of the common putrefactive Bacteria, cultivated on peptone, in no way bore out a supposition that the presence of such Bacteria, and their fouling effects on the water, had exercised any important influence on the progress of the experiments. The possibility

of infection by Bacteria of a different nature, such, for example, as the two forms referred to (pp. 565, 566), must of course be considered. But such forms as these were rarely observed, nor did the very irregular rate of mortality among individuals in an experiment, or in different experiments, suggest that bacterial action was primarily accountable for the death of the specimens.

Food-growth again, was in many cases poor and uncertain in experiments in Position A, but as the food-supply was with few exceptions renewed at frequent intervals, it seems unlikely that the animals were much affected by any such deficiency. It was often observed, too, that when food-growth was vigorous the animals died off independently of this, or even earlier than in experiments in which the growth was poor or stationary.

A noticeable feature occurs in connection with the special experiment in Position A (p. 562), in which, apart from temperature, apparently ideal conditions were provided, and a healthy growing food culture was carried in the changing water-supply through the vessel in which the animals were contained. This vessel was a 1·5-litre flask, and it is remarkable that the average life of the 5 *Calanus* it contained was very nearly the same, 21 days, as that for the 19 specimens of the 5 experiments with this species in 1-litre flasks in the same room, 22 days. In the 5 experiments with 34 specimens in finger-bowls, in which the volume of water was no more than 300–350 c.c., the low average of 12 days is presumably attributable to the changes communicated by the air temperature being more rapid than in the case of the larger vessels. If an instantaneous change of temperature, probably of 4° or 5° (p. 568), can so affect nauplii as to stun them for 5 or 10 minutes, or if one, apparently of salinity only, can be fatal, as in the case of the 2 *Calanus* referred to (p. 562), it is reasonable to suppose that the daily fluctuations of air temperature to which uncovered vessels are exposed are liable to produce conditions that must sooner or later prove fatal to animals so sensitive to such changes.

The removal of the experiments to Position C was especially prompted, as it was observed, by the survival of a *Calanus* for 51 days in a 2-litre jar submerged in one of the tanks. This specimen was then found to have the hairs of the antennæ and caudal rami much encrusted with fixed Diatoms and other accretion, and probably succumbed owing to these causes about a week later. This jar contained a sample of water only, with the plankton naturally present in it, and therefore very few individuals at the outset, nor was any addition made to the food. Yet on

the 29th day there were seen alive in it, besides the adult *Calanus*, a few small ones, and one or two *Temora*, the latter being a species for which very low averages had been obtained elsewhere.

In the experiment carried out by Dr. Allen (p. 556), in which some *Calanus* were kept alive for not less than about 50 days, and in which two of the nauplii reached the adult stage, the flask used was kept standing in the water of one of the tanks. In the case of the 2 *Calanus* that were raised by Mr. Fuchs in an *Echinopluteus* culture, the jar containing these was not submerged, but was kept standing on one of the slate slabs under the tanks in the same room. Here these two specimens lived for 57 days, and subsequently in Position A for another 24 days, making a total period of 81 days. It is not known how far this result may have been exceptional, like such examples as that in which a specimen lived for 84 days in a 1-litre flask in Position A, but probably, under such conditions, the temperature changes in the water of a jar of 2000 c.c. would at most times be slight and gradual, and not such as seriously to affect the animals.

For the 5 experiments with *Calanus* in vessels submerged in the tanks the average, 35 days, is very incomplete, three of the experiments being uncompleted. For the 4 experiments in vessels submerged in the artificially heated bath, the low mortality at the time of their interruption suggested an average not lower than was indicated in the others, which at the close of the observations stood at rather more than double the average (17 days) obtained for the 11 experiments with this species in Position A.

As a series of preliminary experiments, the results with *Pseudocalanus* may, on the whole, be regarded as fairly satisfactory, the small proportion of nauplii which were brought through to the adult form being probably due to minor imperfections only in the conditions, possibly in the food-supply which it should not be difficult to adjust.

The results of the experiments in Position C are not as conclusive as might be wished, but their difference as a whole and in detail from the others is so marked as to leave little doubt that the preservation of an even temperature is of the first importance in experiments with pelagic Copepoda, and probably indispensable to success with the majority of pelagic plankton species.

On Diatom Growth in the Experiments.

In nearly all the experiments in Position C with *Calanus finmarchicus* considerable difficulty was encountered in controlling the growth of the

food-supply (*Nitzschia*). Notes as to exact dates are incomplete, but the rapidity of growth seems to have become especially apparent during the second week, the *Nitzschia* then becoming so thick as soon afterwards to necessitate the pouring off and renewal of the water. This was very pronounced in the flasks submerged in the bath heated to about 18°. Under the latter conditions, a flask containing only *Nitzschia* was recorded on the 12th day merely as "growing well," and another which was taken over for use in an experiment on the 15th day without comment was presumably in the same condition. In all of 4 flasks, however, which contained *Calanus* at this time—3 specimens in each—the growth became very thick on the 11th or 12th day, and soon afterwards so dense that it was very difficult to discern the specimens. In the same bath with these flasks was the one containing 5 *Acartia*, in which the specimens did well and produced several nauplii, yet in this case the growth was on the 40th day so slight that the *Nitzschia* was then renewed. Similarly, in all the experiments with *Pseudocalanus* (4 with *Nitzschia*) no pronounced growth of the Diatom occurred during the long period for which this species was kept.

While this overgrowth of food in experiments with *Calanus* was a serious hindrance and probably interfered considerably with the preservation of healthy conditions, the fact has a greater importance in its bearing on Diatom growth. Further investigations are needed before any very definite conclusions can be drawn from these limited data, but the facts suggest the presence of a strong fertilising action directly or indirectly traceable to the excretory products of *Calanus finmarchicus*, which, though probably occurring also in other species, seems not to occur in *Pseudocalanus*, or, judging from one experiment, in *Acartia*.

The water used in all these experiments was "outside" water, sometimes sterilised, always with the addition of one-third Miquel-Allen solution, that is to say, in the proportions of 2 c.c. of Solution A and 1 c.c. of Solution B to 3 litres of sea-water, the water being then filtered through a Berkefeld filter. How far the action arises independently of Miquel is not yet clear. In two later experiments, each with 5 specimens, in 2 litres of unfiltered sterilised "outside" water only, a similar intense growth was obtained. In consequence of this, it was decided to suspend the use of Miquel, and using only filtered unsterilised "outside" water, to reduce the number of specimens. In experiments made under these latter conditions, with 1 or 2 *Calanus* in 2 litres of water, the growth has been more often slight or moderate, though sometimes so strong

as to necessitate partial screening from the light. The intense growth obtained in one-third Miquel water occurred in experiments either with 3 *Calanus* per litre, or with from 2 to 5 *Calanus* per 2 litres. During the transition, which was a gradual one, from one-fourth Miquel to pure " outside " water, a thick growth was still obtained in an experiment with 1 *Calanus* in 2 litres, when it was estimated that a trace only of Miquel remained in the water.

The exact bearing which these facts may have on the problems of Diatom growth which are under investigation by Dr. Allen* will, it is hoped, become more apparent as the experiments are continued. That the action of the *Calanus* excreta is such as greatly to intensify the growth in the presence of the Miquel salts, even when the latter are used in much reduced proportions, there seems to be no doubt. Whether it is quite an independent one is at present somewhat uncertain.†

The Influence of some Bacteria on the Experiments, and their Destruction.

In order to ascertain the possible influence of some of the common Bacteria as contributing to the unsuccessful results of the earlier experiments, some special experiments were carried out in which Bacteria were encouraged to grow in large numbers in the water. As a food basis a stock solution of peptone, of 5 grams per litre in strength, was prepared in diluted Berkefeld water, and this was used in very small quantities.

In some peptone-agar cultures which Mr. Drew kindly made for me, from some infected water, two forms of Bacteria were obtained: one producing large spreading, roughly circular, white colonies, from 1 to 5 millimetres in diameter; the other forming small compact, often almond-shaped, yellowish-white colonies, usually about half a millimetre in greatest measurement.

Three 1-litre flasks of diluted Berkefeld water were infected with both of these forms, peptone being added in the percentages of ·001, ·002, and ·01, severally. On the following day the water in all the flasks was clouded with Bacteria.

In the first of these experiments (·001% solution) the cloudiness continued unchanged on the 58th day. On the 68th day, it had nearly disappeared, and the peptone being then renewed in the same proportions, the bacterial growth was restored, and continued on the 90th day subsequently.

* Cf. *Journ. Mar. Biol. Assoc.*, N.S., Vol. VIII., p. 421; Vol. X., p. 417.

† The most recent experiments support the view that the action is an independent one.—L. R. C.

In the second experiment (·002% solution) the cloudiness still continued on the 68th day, and the peptone being then renewed, there was no falling off in the Bacteria on the 90th day afterwards.

In the third experiment (·01% solution) the cloudiness was unchanged on the 47th day, and the water was then inoculated with 20 c.c. of a culture of a Ciliate, *Euplotes* sp. On the 9th day subsequently the water was found to be cleared of Bacteria, the *Euplotes* being present in very large numbers, but owing to my temporary absence in the interval it was not known at what period exactly the water became cleared. This experiment is of interest as exemplifying the destructive action of a Ciliate on a Bacteria culture of long standing.

In all experiments in which Bacteria were grown on peptone, or on the macerating remains of dead plankton, the same action occurred on the part of Infusoria, either naturally present or introduced into the water. Those purposely introduced were from mixed cultures only, in which one or more species were especially prominent. Such a culture was that of *Euplotes*, which was kept for a long period in a flask in Position A. Another large species, apparently a *Strombidium*, was usually obtained in large numbers in " outside " water in which Bacteria were grown, but some difficulty was encountered in retaining this indefinitely as an active culture and often, after a varying period of multiplication, it was lost sight of or died, being then usually superseded by a culture of smaller forms.

Experiments were made partly in sterilised, partly in unsterilised water. Of those here to be considered, 12 were made in 1-litre flasks in Position A, and 2 were made in 11-litre bell-jars in Position B. Peptone was used in proportions varying from ·001% to ·0001%, usually in the former percentage, the Bacteria growth being induced by it in some cases once only, in others as many as six times in the same experiment.

The period occupied by Infusoria in clearing the water varied somewhat in the different experiments, apparently also in proportion to the strength of the peptone. Not always exactly observed, the period ranged in 15 exact records, from 3 to 8 days, the average being 6 days, from the time when the peptone was added, the Bacteria usually assuming a very strong growth within 24 hours later.

In some experiments in which this cycle of events was repeated a few times, a point was reached when the culture became " sick " and stagnant, the Bacteria growth being feeble, and the Infusoria falling off.

But in most cases the same process was repeated as far as the experiments were carried.

In experiments with sterilised water, the Infusorian mostly employed for inoculation was of the form which was referred to *Strombidium*, including probably two, if not three, distinct species. This Ciliate, though often lost sight of and superseded by smaller forms, was retained in some experiments for a long period. In one case it continued fairly numerous as late as the 67th day, after having cleared the water of four successive cultures of Bacteria which were grown on peptone introduced on the 1st, 13th, 39th, and 49th days, severally.

Following the destruction of a strong Bacteria culture by Infusoria, there arises commonly, if not invariably, a more or less heavy deposit of flocculent white patches in the water. The nature of this deposit, possibly the excretory product of the Infusoria, was not ascertained. In one experiment which had been five times impregnated with peptone within a period of 29 days, a sixth impregnation of the water decanted off to a clean flask on the 34th day did not produce any distinct Bacteria growth, or any recurrence of the Infusoria, the water remaining sickly in appearance. But a similar addition of peptone to the original flask with its deposit, which had been refilled with clean sterilised "outside" water, produced a strong Bacteria growth, the Infusoria continuing fairly numerous for some 3 weeks later. In the former case conditions had apparently arisen in the water, such as to resist further Bacteria growth, the Infusoria being consequently deprived of their food-supply.

These observations, though passing beyond the range of the subject of this paper, seem to deserve notice, as emphasizing the intimate relationship existing between Infusoria and Bacteria in the sea, and the destructive action of the former on the latter in experiments. This bactericidal action may be peculiar to certain species, or again may not in these be an essential feature of their natural existence: *Euplotes*, for example, which is rapidly destructive of Bacteria, and will apparently thrive on them alone indefinitely, was at first found to be feeding largely on the spores of *Chlorodendron*. One point seems certain, that in so far as such Infusoria may occur in experiments, their presence is not in itself to be regarded as nocuous, but rather, on the contrary, as an indication of the presence of unhealthy conditions which they are directly engaged in counteracting.

As regards the influence of these common forms of Bacteria on the experiments with the zooplankton, specimens of Calanoida and other species, more especially small or young forms, were kept alive on several

occasions in the presence of these cultures for a considerable period, in one case through 4 successive growths of Bacteria, extending over some 6 weeks, the maximum life recorded—strangely, in this last-mentioned experiment—being 48 days. Some notes concerning a few of these experiments are appended :—

1-litre Flasks.

(No. 141.) In sterilised " outside " water, impregnated once with peptone, on the 1st day, and cleared of Bacteria on the 9th day by *Euplotes*.

Of about 6 Calanoids which were introduced on the 13th day, 3 (*Acartia*) were alive and active 34 days later. The maximum life period was not recorded.

(No. 140.) In sterilised " outside " water, similarly impregnated once with peptone, and cleared of Bacteria on the 8th day by a mixed culture of Infusoria.

Of about 12 Calanoids introduced on the 14th day, about 6 were alive after 7 days, 2 after 10 days, 1 after 20 days. The last was not alive on the 31st day.

(No. 122.) In unsterilised " outside " water, impregnated twice with peptone, on the 1st and 21st days, and cleared by contained Infusoria on the 5th and sometime prior to the 30th day, respectively.

Of the Calanoids contained in the water at the outset, 2 or 3 adult *Temora* were alive on the 30th day, and 1 on the 33rd day.

The water was aerated for a time on the 21st and 23rd days.

(No. 121.) In unsterilised " outside " water, impregnated four times with peptone, on the 1st, 28th, 33rd, and 38th days, severally, and cleared by contained Infusoria about 5 days later in each case.

Of several small forms in the contained zooplankton, 1 *Balanus* nauplius was recorded alive as late as the 21st day ; a few Calanoids were alive on the 28th day ; and 2 Calanoids were alive on the 48th day. The water was decanted off into a clean flask on the 8th day.

11-litre Bell-jars.

(No. 145.) In unsterilised " outside " water, impregnated with peptone on the 1st day only, and cleared by the contained Infusoria on the 7th day.

20 or 30 small Calanoids were alive on the 10th day, about 4 on the 29th day. None were observed on the 42nd day.

(No. 144.) In unsterilised " outside " water, impregnated with

peptone on the 1st day, and again in smaller quantities on 5 days successively, from the 8th to the 12th day.

5 small Calanoids were observed alive on the 42nd day.

In both of these last-mentioned experiments the water became extremely foul on the 3rd day especially. In the second it was siphoned off and back into the bell-jar on that day, for aeration. In the first, it was not disturbed.

In these extreme cases, in which the Bacteria were grown, sometimes repeatedly, in enormous numbers, the specimens were directly exposed to the chemical changes produced in the water, apart from the intervals when it was cleared, for about 4 or 5 days or longer as often as the Bacteria growth was renewed. In No. 121, for example, at least 2 Calanoids survived, after nearly 7 weeks, an aggregate period of intense Bacteria growth amounting to about 16 days. And in most cases the water was not aerated or disturbed. From those results and from others obtained in similar experiments, it seems evident that the influence of common Bacteria of this character, occurring in comparatively small numbers in the ordinary experiments, must be so slight as to be almost negligible ; while the occurrence of Infusoria in the water can only be regarded as counteractive to them, and probably as beneficial in the presence of any unhealthy conditions that arise.

In all of these experiments no food was given other than was already present in those in which the water was unsterilised. Apparently the specimens were feeding on the Infusoria, and judging from the appearance of the excreta this seemed to be the case.

So far as they have been observed, the Bacteria which can be of serious harm to Copepoda in such experiments seem to be of infrequent occurrence in the water employed. Two forms only have been definitely recorded, to both of which allusion has already been made: the one forming irregular white slimy strands through the water (p. 566); the other giving a carmine-coloured tinge to objects attacked or invested (p. 565). Each of these has been twice observed, and both have proved in each case quickly fatal to all specimens that were contained in the infected vessel, though an endeavour to cultivate the second form has twice failed.

Twin Gastrulæ and Bipinnariæ of *Luidia sarsi*, Düben, and Koren.

By

James F. Gemmill, M.A., M.D., D.Sc.

With Figures Pls. I–III (Figs. 1–21).

EARLY in June of this year (1914) I received from the Plymouth Marine Laboratory through the kindness of Dr. E. J. Allen, F.R.S., several Thermos flasks containing quantities of a culture of *Luidia* in the early blastula stage. This culture was made for me by Mr. James Gray, King's College, Cambridge, to whom, and to Dr. Allen, I desire herewith to express my indebtedness. The larvæ were little the worse of the journey to Glasgow, but it seemed to me that they showed even greater irregularities of form than might have been expected from Mortensen's (13) description of blastula formation in our species. However, in the end, abundance of perfectly typical young bipinnariæ* were secured from the contents of the various flasks. The abnormal larvæ became gradually fewer through death, and those which survived could be isolated without much trouble, since they exhibited less capacity for keeping near the surface of the water than their healthier brethren. A great many of the early malformations were of the nature of double or twin formation, and it soon became evident that the teratological type in question, namely, double monstrosity, was about to receive a more varied expression, and to attain a more advanced stage in development, than it had ever before been my good fortune to find in any starfish culture.

In the accompanying illustrations two series of abnormal larvæ are figured, one at the gastrula stage (Figs. 1–11), and the other at that of the early bipinnaria (13–21). As a description is appended to each figure, only questions of general interest need be dealt with here.

Classification. In the systematic teratology of vertebrates, Double

* Two points in normal development may be noted here. (1) There does not appear to be an auricularia stage in the formation of the bipinnaria, the preoral and postoral bands being separated from one another antero-dorsally by a distinct interval at the time when they are first recognisably differentiated in this field (see 7, p. 232). Indeed, the relatively great width of the interval in question would by itself enable us to distinguish the larva of *Luidia* from those of *Asterias rubens*, *A. glacialis*, and *Porania pulvillus* during the first fortnight of bipinnarial life. (2) The small structure arising posteriorly from endoderm and interpreted by me as a rudimentary posterior enterocoelic growth in *Asterias rubens*, *A. glacialis*, and *Porania pulvillus* does not appear to be formed in *Luidia* (see 7, p. 233).

Monstrosities are conveniently divided up into Anadidymi, Katadidymi, Anakatadidymi, Mesodidymi (5 ; 14 ; 6, p. 3). To these a small group falls to be added containing the few recorded examples of simple longitudinal or parallel union (6, pp. 4, 29), which I venture to suggest may suitably be termed Paradidymi. The Anadidymi are, of course, forms with the anterior end more or less double, and the posterior end single ; in the Katadidymi these conditions are reversed. The Anakatadidymi show anterior and posterior doubling, but are single in their middle regions, while the converse relations are characteristic of the Mesodidymi. In the Paradidymi doubling occurs in an equal or sub-equal degree throughout the whole of the longitudinal axis of the twins.

In fishes and other vertebrates, the notochord, the vertebral column, the central nervous system and the alimentary canal, serve as our principal guides in judging to which group a particular double monster should be assigned. In double bipinnariæ, on the other hand, we have to depend entirely on the alimentary canal, inasmuch as the only other easily recognisable longitudinal structure, namely, the posterior ciliated band, owing to its superficial position, in most cases shows a greatly lessened amount of doubling through the working of "regulation" processes. Nevertheless, if the alimentary canal be taken as a guide, it is remarkable how readily the various types of duplex bipinnariæ fall into the same kinds of groups as double-monster fishes. Thus Figs. 13 and 14 illustrate longitudinal or parallel union and are therefore Paradidymi ; Figs. 16 and 17 belong to the Anadidymi ; Figs. 18 and 19 to the Katadidymi ; Fig. 20 is Anakatadidymous, and Fig. 21 Mesodidymous in type. Probably, further search among the abnormal bipinnariæ would have revealed a still fuller and more representative series. There remains to make mention of Fig. 15, which illustrates what may be called tangential union, and would no doubt have included the bipinnaria from the larva shown in Fig. 7 had survival been allowed. The twin embryonic axes, as represented here by the alimentary canals, are independent of, and widely divergent from, one another, but there is superficial union of the lateral or frontal body-walls. Among monster fishes we have no exact counterpart of this type, since, owing to the manner in which the twin embryonic axes develop, practically the only alternative to axial union is an Anakatadidymus effected through the intermediary of the yolk-sac. However, in the amniotic vertebrates, and particularly in the mammals, numerous instances occur in which, without axial union being present, the twin organisms are united to one another by paraxial or superficial structures.

The twin bipinnariæ of *Luidia* are not directly comparable with the double Echinus-rudiments noted by Metschnikoff (11) and described in detail by MacBride (10), since the latter appear late in development, and their formation is a consequence of the abnormal persistence and differentiation of one particular organ, viz. a right hydrocoele. The same thing is true of the changes characteristic of double hydrocoele in the developing *Asterias* larva (7, p. 275). As regards structure, suggestive analogies can be drawn between our bipinnariæ and the abnormal medusæ described by Allmann (1) and Browne (2). In normal embryology perhaps the most interesting parallel is to be found in the development of the Annelid *Lumbricus trapezoides* Dugès, in which a double gastrula, giving rise to two complete earthworms, is produced by fission of the segmenting cell-mass (9). The converse process, namely, *fusion* of two ova, has been shown to be possible before (16 *Ascaris*) and after (16 *Ascaris*, 3 *Sphærechinus*) fertilisation, and also during the blastula stage (12 *Sphærechinus*). In general, such fusion tends to produce double monstrosities resembling our bipinnariæ, but sometimes a perfectly single organism of larger than normal size is the result (16 ; 3).

Causation. E. Haeckel (8, 1869) discovered that the segmented egg of a Siphonophore (*Crystallodes*), if artificially divided, could give rise to several partial embryos, and E. B. Wilson (15, 1893) found that during the early stages of segmentation in *Amphioxus* each of the component cells, if separated from the rest, could develop into a perfect gastrula, while imperfectly double gastrulæ occurred abundantly in cultures which had been subjected to shaking during the two-celled stage. A series of such gastrulæ is shown in 15, Pl. XXXIV, Figs. 66–73, while in Pl. XXXVII, some of the partially double stages which led up to them (four-celled, eight-celled, blastulæ) are also illustrated. As is well known, similar or allied phenomena have been demonstrated to occur in the development of many other ova, and there is now an extensive body of literature dealing with experiments on the subject. Without going into details for other groups, we may note that the ova of Asteroids were early found to react to experiment in much the same way as those of *Amphioxus*, and, what is more remarkable, it was ascertained by Driesch (3) that as late as the blastula stage either half of a developing ovum (*Asterias glacialis*, *Astropecten*) bisected transversely or longitudinally could give rise to a bipinnaria. Thus in Asteroids it appears that single cells in the earliest stages or cell masses at a later stage can, if isolated, produce whole larvæ. On the other hand, if the cells or cell masses in

question are incompletely separated from one another, partial doubling or twin formation may result.

Usually in starfish ova, doubling of this kind is associated with disturbances so profound that differentiation ceases in the gastrula stage. In my own experience great numbers of partially double blastulæ have appeared in different cultures of *Asterias rubens*, *A. glacialis*, and *Porania pulvillus*, but none of these was observed to reach even the early bipinnarial stages, and so far as I know such stages have not been figured or described. Possibly the ova of *Luidia* possess unusually great potentialities of duplex development, but we may, perhaps, conjecture that the long-continued shaking which the cultures would suffer during their journey (the Thermos flasks were left only three-quarters full for reasons connected with aeration) effected a physiological separation of masses of cells during the formation of the blastula, and at the same time diminished their vitality less than do the more abrupt experimental methods commonly employed in laboratory work.

Mode of Formation. Among Fishes the first noticeable feature in the genesis of double monstrosities is that two centres of gastrulation arise on the margin of the blastoderm. Next, the resulting embryonic axes are either brought together so as to unite posteriorly, producing the anadidymous type, or else remaining separate they give rise to anakatadidymous union of the embryos by means of the yolk-sac. The katadidymous condition is extremely rare, and, indeed, probably never occurs in perfect form. In the birds and mammals the larger proportion of double monsters arises in connection with two centres of embryo formation, but Katadidymus is not uncommon, being caused in most cases by fission of the posterior end of a developing embryonic axis. In fishes, birds, and mammals, since growth of the axis takes place almost entirely from before backwards, true anterior fission either does not occur or is extremely limited in extent. On the whole, we see that throughout the vertebrates the important feature in the production of double monstrosities is the presence of two foci of embryo formation, and that in the simplest group, the fishes, these foci are, to begin with, centres of gastrulation. As regards the Asteroids, a glance at the series of illustrations to this paper will show that here also the formation of two centres of gastrulation precedes bipinnarial twinning. Two more or less separate archentera are produced, and various other structures are partially or completely doubled. In the end the two archentera may remain separate from one another (Figs. 1–4, gastrulæ ; Figs. 13–15, bipinnariæ), but if the foci of gastrulation are

very close together, the infolding process may amalgamate them, giving rise to an archenteron bifid in front and single behind (Fig. 5, gastrula ; Fig. 16, bipinnaria). Again, in the case of a markedly bi-lobed blastula an originally single invagination may, during inward growth, divide into two branches (Fig. 6, gastrula ; Fig. 17, bipinnaria), but we must often leave the question open whether there has been anterior fission or posterior fusion of archentera (Figs. 7, 8, gastrulæ). It is evident, further, that anterior fusion of the archentera can take place (Figs 9–11, gastrulæ ; Fig. 19, bipinnaria). In Fig. 20 fusion of the expanded stomachal regions of the archentera is exhibited by a specimen with " back-to-back " union. Fig. 18, on the other hand, illustrates a case of " face-to-face " union in which the derivatives of two entirely separate archentera share a common buccal cavity. In Fig. 21 (Mesodidymus) the buccal cavity and rectum are single, while the œsophagus and stomach are doubled and there is a composite enterocoelic cavity between them. Fig. 7 shows triplicity in a modified form—the only instance of triplicity observed.

An examination of the various abnormal bipinnariæ figured will show that each archenteron tends to produce a pair of enterocoeles. In most cases all four persist (Figs. 13–15, 17, 18, 20). Sometimes two from different pairs (right of left pair and left of right pair) are united together (Figs. 19, 21). More rarely these two have either never been formed or have disappeared at a very early stage (Fig. 16).

As regards the ciliated bands we note that their preoral and postoral portions never become mixed—that is to say, the preoral portion of one " twin " always unites with the preoral of the other, and the postoral with the postoral. The general arrangement of these bands, and of the larval fields they enclose, makes it patent that quite remarkable powers of developmental " regulation " or " making the best of things " must in many cases have been at work.

SUMMARY.

The various types of twin *Luidia* larvæ may be classified according to the same system as Double Monstrosities among vertebrates, the alimentary canal of the larvæ being taken as their representative axial structure.

The causation depends on early partial separation of cells or of cell masses, accompanied by a minimal interference with the vitality of the whole.

Doubling (partial or complete) of the gastrula invagination is the great step on which the differentiation of twin bipinnariæ depends.

This differentiation shows very markedly the working of "regulation" processes in the course of which, when union of structures occurs, the union is always between structures of homologous origin. Thus preoral and postoral bands, enterocoeles, and particular regions of the alimentary canal, unite each with its own counterpart.

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DESCRIPTION OF FIGURES.

LETTERING EMPLOYED.

b.cav.	Buccal cavity.
bl.	Blastopore (anus of larva).
entc.	Enterocoele.
entc'.	Region of archenteron which produces the enterocoele.
entc.l.	Left enterocoele.
entc.r.	Right enterocoele.
m.o.	Mouth opening.
oes.	Œsophagus.
oes'.	Region of archenteron which produces the œsophagus.
po.cil.bd.	Postoral ciliated band.
pr.cil.bd.	Preoral ciliated band.
rect.	Rectum.
stom.	Stomach.
stom'.	Region of archenteron which gives rise to the stomach.

PLATE I.

FIGS. 1–4.—Examples in which the archentera from two foci of gastrulation have remained separate. In Fig. 1 the blastopores are near one another and the archentera are parallel and equally developed. Compare the bipinnarial stage shown in Fig. 13. In Fig. 2 the blastopores are again near one another, the archentera being unequal; compare the bipinnarial stage shown in Fig. 14, though in the latter the inequality has manifested itself later and been less pronounced. In Fig. 3 the blastopores are a considerable distance away from one another and the archentera are markedly unequal; compare also Fig. 7. In Fig. 4 the foci of gastrulation have appeared on opposite sides of the larva.

FIGS. 5–8.—Examples in which the blastopore being single, the archentera are bifid anteriorly. In Fig. 5 the doubling only affects the anterior or enterocoelic-œsophageal part of the archenteron; cf. the bipinnariæ shown in Figs. 16 and 17. In Fig. 6 the doubling reaches as far back as the commencement of the stomach; cf. anterior portion of the bipinnaria shown in Fig. 20. In Fig. 7 there is doubling to a like degree and in addition there is a small, entirely independent archenteron with its own blastoporic opening on one side; the larva thus exhibits a modified form of triplicity and is the only triple monster obtained. For parallel instances in Fishes see 6, pp. 33, 35. In Fig. 8 the doubling extends as far back as the stomachal region; cf. posterior half of the bipinnaria shown in Fig. 20.

FIGS. 9–11.—Examples in which there are two separate blastopores, but the archentera are united in front to a greater or less degree. In Fig. 9 the archentera are equal and fused only at their extreme anterior ends; cf. the bipinnaria shown in Fig. 19. In Fig. 10 there is the same condition, but the archentera are unequal. In Fig. 11 the union reaches back to the stomachal region.

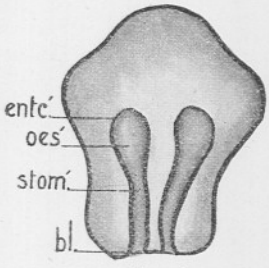


FIG. 1.

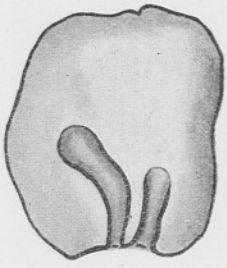


FIG. 2.

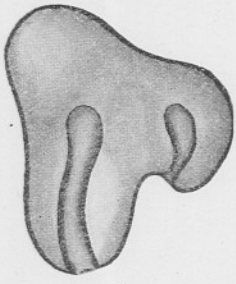


FIG. 3.

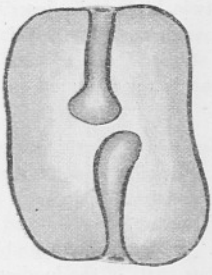


FIG. 4.

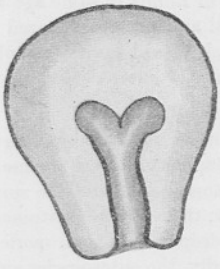
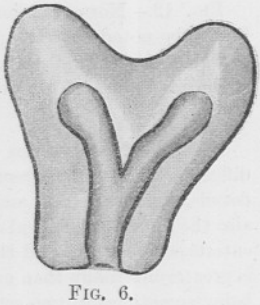


FIG. 5.



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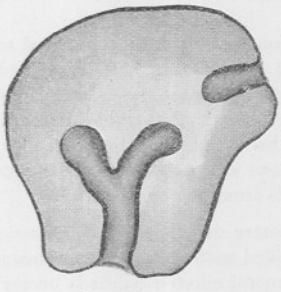


FIG. 7.

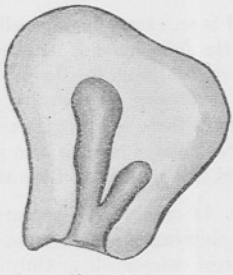


FIG. 8.

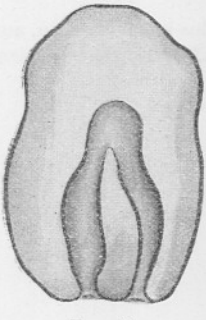


FIG. 9.

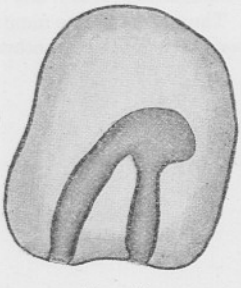


FIG. 10.

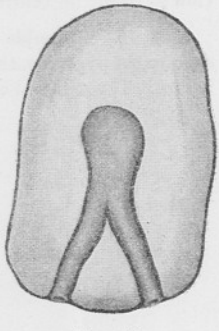


FIG. 11.

PLATE II.

(*For lettering see p.* 584.)

FIG. 12.—Normal bipinnaria of Luidia of same age as the twin bipinnariæ described. It will be noted that the preoral and postoral ciliated bands are completely developed and that in the alimentary canal, buccal cavity, œsophagus, stomach, and rectum can all be made out. There is a pair of enterocoeles, the left one being provided with a hydropore.

FIGS. 13–21.—A series of double monster bipinnariæ about six days old, showing different kinds and degrees of duplicity. Here we must pay attention to a number of details, e.g. the preoral and postoral bands and the surface areas which they mark out, also the mouth and buccal cavity, the œsophagus, stomach, and rectum, the right and left enterocoelic cavities and the hydropore and hydroporic canal. In general the doubling is greater internally than externally, the enterocoeles and various parts of the food-canal being sometimes in two sets without a corresponding degree of division being exhibited on the surface of the body.

FIG. 13 is an example of parallel lateral union, as seen from the dorsal aspect. The whole of the food-canal is doubled, the mouth and anus in both cases looking in the same direction. Each food-canal has its own pair of enterocoeles, the left one in both instances developing a hydropore and hydroporic canal. The whole bipinnaria is broader than normal; there is a single preoral ciliated band enclosing the widened frontal field; the postoral ciliated band is also single, but shows a deep backwardly directed sinus on the ventral side marking off the twin anal fields from one another.

In FIG. 14 one set of structures is much better developed than its neighbour, the latter not showing mouth or anus, though provided with œsophagus, stomach, intestine, and a pair of enterocoeles. Only one of the preoral ciliated bands is properly differentiated, viz. that in connection with the frontal end of the better developed twin. The view is from the ventral aspect.

FIG. 15.—A double monster bipinnaria in which one of the twins is smaller than, and set at right angles to, the other. The smaller has no mouth and its frontal field is deficient in size. The postoral ciliated bands run into one another.

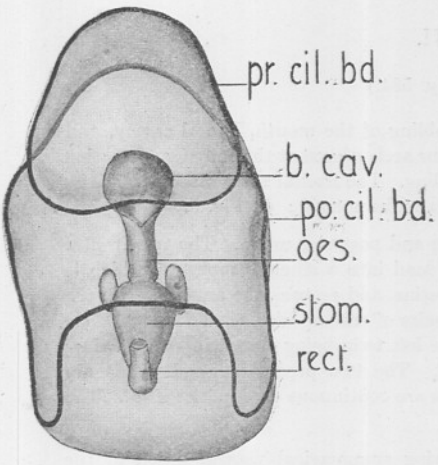


FIG. 12.

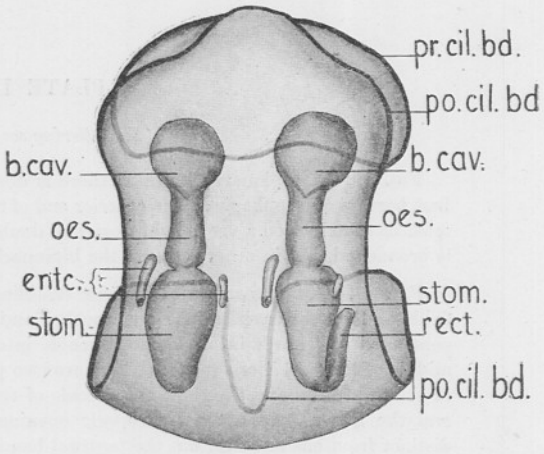


FIG. 13.

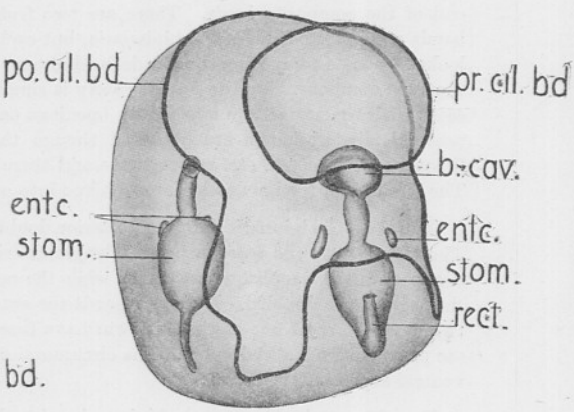


FIG. 14.

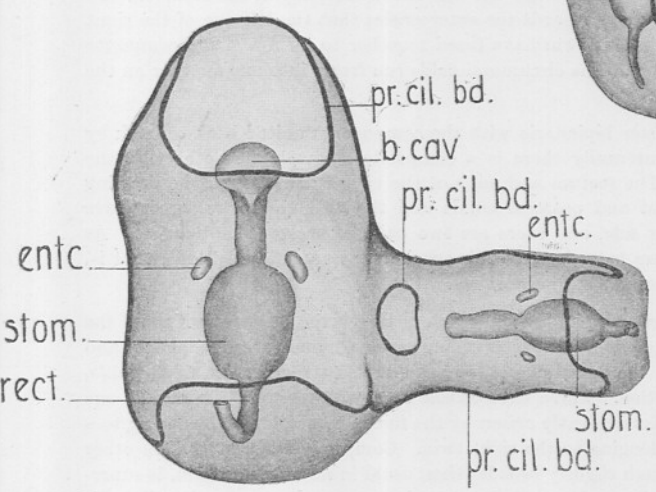


FIG. 15.

PLATE III.

(*For lettering see p.* 584.)

FIG. 16.—A bipinnaria in which there is doubling of the mouth, buccal cavity, and first portion of œsophagus. The anterior end of the archenteron at the end of gastrulation must have exhibited a very slight degree of doubling. The frontal extremity of the larva is broadened, but in other respects the bipinnaria looks normal; cf. Fig. 5.

FIG. 17.—A bipinnaria with anterior doubling and posterior union. The two frontal fields and buccal cavities face one another and lead into a single œsophagus which is continued backwards into a single stomach, intestine, and rectum, the anus being in the middle of the posterior surface. There are two pairs of enterocoeles, the left enterocoele of the right twin and the right enterocoele of the left twin being shown in the drawing, and the first-named has a hydroporic opening. The two preoral ciliated bands are distinct from one another, but the postoral bands are continuous on opposite sides. The circumoral food-collecting areas are also united.

FIG. 18.—A double monster bipinnaria showing symmetrical ventral union of the twin components, the fusion being somewhat greater at the anterior than at the posterior end of the composite larva. There are two frontal areas bounded by preoral ciliated bands on opposite sides of the bipinnaria, but each frontal area and ciliated band is to be looked upon as composite, that is, derived in part from one and in part from the other of the twin components. The buccal cavity is single, but also composite, and it communicates with the surface by two mouth openings on opposite sides of the larva. The two postoral ciliated bands are ununited though they approach one another posteriorly. Œsophagus, stomach, etc. are separate and there are two pairs of enterocoelic pouches. The circumoral food-collecting areas merge into one another.

FIG. 19.—A bipinnaria showing posterior doubling of the principal internal structures. The view is from the dorsal aspect. The preoral ciliated band, the buccal cavity, and the first part of the œsophagus are single, while the rest of the œsophagus, the stomach, and the rectum are doubled. Note as regards the enterocoeles that the left one of the right twin and the right one of the left twin have fused together to form a single composite sac provided with a hydropore. The circumoral fields run freely into one another on the ventral aspect of the larva.

FIG. 20.—A double monster bipinnaria with the components united back-to-back by their dorsal body-walls. Internally there is a composite stomach, but otherwise the food-canals are separate. The rectum and anus of the twin to the left of the drawing were lost. The two preoral and postoral bands and the two circumoral areas have remained separate on either side, and there are two pairs of enterocoelic pouches. As regards internal structure we may describe this specimen as anakatadidymous, that is, showing duplicity both anteriorly and posteriorly.

FIG. 21.—A double monster bipinnaria in which although the buccal cavity and the rectum are single, there is doubling of the intervening regions, namely, the œsophagus and stomach. The view is from the dorsal aspect, and the duplex structures lie side by side, and look in the same direction. Three enterocoelic sacs are present. The middle one possesses a hydropore and has evidently arisen by the fusion of a right sac belonging to a left twin with a left sac belonging to the right twin. Compare with Fig. 19. In other respects the bipinnaria, though slightly broader than usual in its middle region, is superficially almost normal. As far as internal structure is concerned we may describe this bipinnaria as exhibiting the mesodidymous condition.

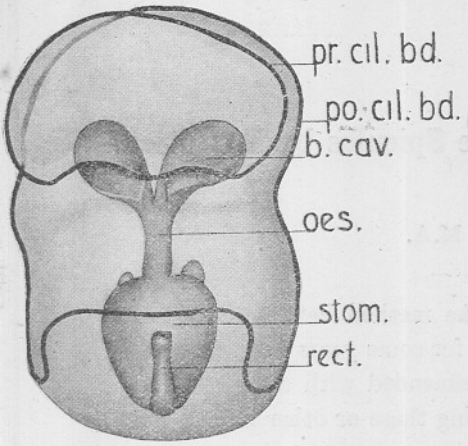


FIG. 16.

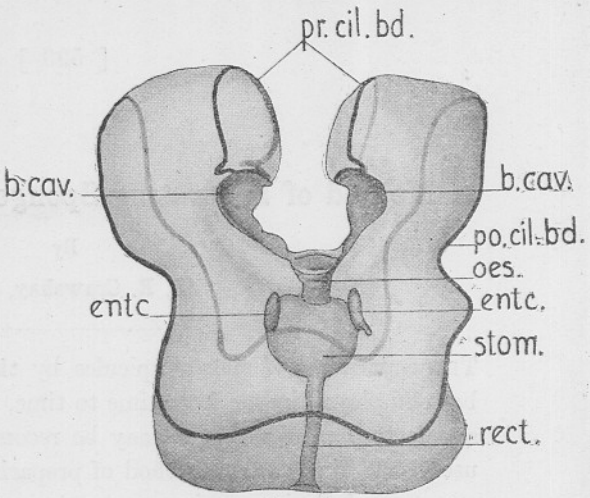
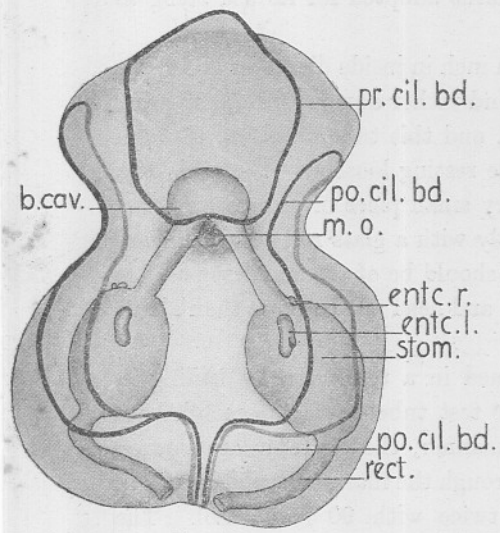


FIG. 17.



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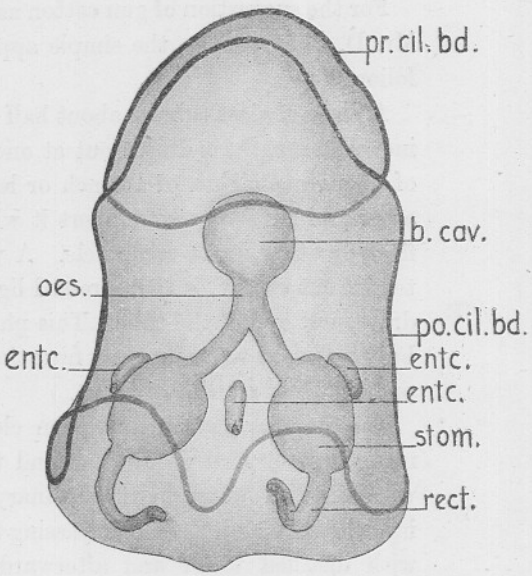

FIG. 19.

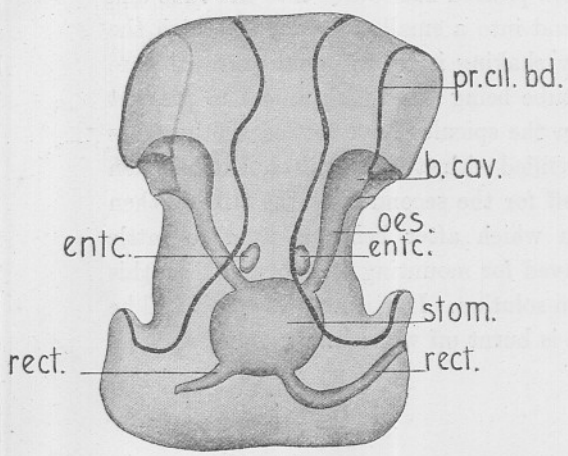

FIG. 20.

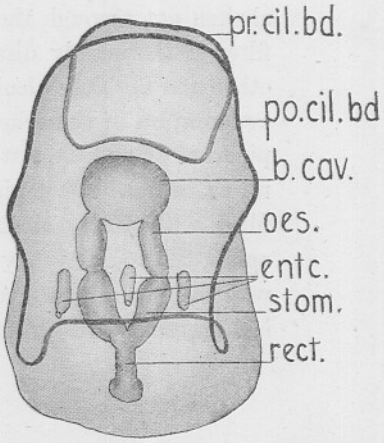

FIG. 21.

A Method of Separating Sponge Spicules by Filtration.

By

L. R. Crawshay, M.A.

THE separation of sponge spicules by the method here described has been employed by me from time to time, for some years past, with such satisfactory results that it may be recommended with confidence as a useful and time-saving method of preparing these or other minute hard structures for microscopic examination.

For the suggestion of gun cotton as a filtering medium I am indebted to Mr. D. J. Matthews, the simple apparatus adopted for its use being as follows :—

A piece of glass tubing, about half an inch in inside diameter and eight inches in length, is drawn out at one end rather abruptly to an opening of about one-eighth of an inch or less, and this tube is passed through a cork which serves to support it while resting loosely in the neck of a flask or other waste receptacle. A very small piece of gun cotton, first teased out evenly, is then pressed lightly with a glass rod into the lower drawn-out end of the tube. This plug should be of the smallest possible bulk sufficient to ensure easy filtration, and need not be more than about one-eighth of an inch in depth.

The spicules having first been cleaned in a test tube by boiling in nitric acid or Eau de Javelle, and the test tube having been filled up with distilled water in the ordinary manner, the contents are poured into the tube and, the liquid passing through the filter, the tube is refilled with distilled water and afterwards twice with 90 % alcohol. The filter carrying the spicules is then pressed backwards into the tube and shaken out through the broad end into a small test tube in which the filter is thoroughly dissolved by shaking it up in equal parts of pure ether and absolute alcohol, the tube being fitted with a cork to prevent evaporation of the ether. When the spicules have settled the liquid is pipetted off and the test tube is refilled with ether and alcohol and shaken up as before. After pipetting off for the second time the tube is then filled with 90 % alcohol, from which after being allowed to settle again, the spicules may be removed for mounting on the slide. In this way the gun cotton is removed in solution. If it is not, a deposit will be left on the slide when the liquid is burnt off which will more often spoil

the preparation, and there is a danger too of the spicules being partly fused by the high burning temperature of the gun cotton.

The method has the advantage of much saving of time over that of allowing the spicules to settle naturally in a test tube through the process of cleaning and dehydration, and ensures a degree of completeness which is greater perhaps than either this or the centrifuge method. When a very small fragment only of a sponge is available, or where spicules are of very small size or scarce in the specimen, it is especially serviceable as retaining the whole of the spicules within a narrow compass, thus obviating loss of material. Filtration may be accelerated by means of a pressure pump if necessary, though it is better as far as possible to avoid this owing to any additional pressure tending to pack the spicules too closely on the filter or to break them. If through the filter being too lightly adjusted too rapid filtration should occur, any spicules that may have passed through can of course be recovered by refiltering the waste liquid, and in view of this it is best to observe always the same precaution in regard to cleanness for the flask as for any tubes or pipettes that are used. Any of the latter that have been used in contact with the dissolved gun cotton should be washed in the first instance in ether and alcohol to ensure thorough cleaning and the removal of spicules clinging to traces of the residue.

Though the method has been employed almost solely for the separation of sponge spicules, there seems no reason why it should not be found of equal service in the treatment of Diatom tests, the shields of Coccolithophoridæ, or any other minute structures which are uninjured by ether or alcohol.

Polychæta of Plymouth and the South Devon Coast, including a list of the Archiannelida.

By

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INTRODUCTION.

The present list of Polychætes is a revision of the list published in 1904, as part of the general list of the Plymouth Marine Invertebrate Fauna (*Journ. Mar. Biol. Assoc.*, vol. vii., 1904, p. 219). It is the result of work carried on in the intervals of other researches, as opportunity offered, and there are in all probability a good many gaps still to be filled.

To the Plymouth records I have added those obtained at Salcombe (*Journ. Mar. Biol. Assoc.*, vol. vi., 1900, p. 151) and at Exmouth (ditto, vol. vi., 1902, p. 295), a few records from the Teignmouth estuary, and Major Elwes' records from Torquay (*Journ. Mar. Biol. Assoc.*, vol. viii., 1908, p. 197, and 1909, p. 347 ; vol. ix., 1910, p. 59), the latter dealing only with Polychætes found on the shore. Mr. Crawshay's records, from the valuable series of dredgings S.S.W. of the Eddystone to fifty fathoms, have also been included (*Journ. Mar. Biol. Assoc.*, vol. ix., 1912, p. 339).

Apart from the Archiannelids there are comparatively few species in the list which I have not been able to examine myself. In all cases where no initials appear at the end of a paragraph the responsibility for the record is my own.

My thanks are due to Major Elwes for a number of mounted specimens of the Torquay species, which have been of great help, especially with the Syllidæ.

As regards nomenclature, after the name of each species, one or more references have been given to papers where a detailed description of the species intended is given. Whilst endeavouring as far as possible to make use of that name which will probably stand, elaborate discussions of nomenclature and synonymy have been in general avoided. The main object has been to make quite clear which form is intended. Considerable changes in the names used in the former list have been necessary, since our knowledge of the British Polychæte fauna has been greatly extended by the publication of several parts of Prof. McIntosh's

Monograph, and of important papers on Irish Polychætes by Mr. R. Southern. The character of the various dredging and trawling grounds in the Plymouth neighbourhood is fully described in the general account of the Plymouth Fauna (*Journ. Mar. Biol. Assoc.*, vol. vii., 1904, p. 159), where a chart of the area will also be found. Similar accounts of the Salcombe and Exmouth areas will be found in the respective reports.

The following list of the Plymouth grounds, with depth and general nature of the bottom, etc., may be useful for reference.

LIST OF PLYMOUTH COLLECTING GROUNDS.

Shore.

Rum Bay. This term is used to include the shore from Batten Breakwater to Jennycliff Bay. Shale rocks, with patches of gravel and sand. Some stony ground.

Drake's Island. Stony and rocky shore. Some patches of sand and a *zostera*-bed.

Mount Edgcumbe. At the mouth of the Hamoaze. Very similar to the rocky and stony ground on Drake's Island.

Rocks below Laboratory. Rocks of hard Plymouth limestone, with good rock-pools.

Dredging Grounds of Plymouth Sound.

Millbay Channel. 14–23 fms. Stones and mud. Free from growth of seaweeds.

Asia Shoal. 5–7 fms. Stony ground with some growth of red seaweeds.

Queen's Ground. 5–6 fms. The term is used to include the area from Queen's Ground Buoy to New Grounds Buoy and the ground around the latter, all situated at the western entrance to Plymouth Sound. The soil is shell gravel, with stones and shells. It is very free from mud and there is some growth of red seaweeds.

Duke Rock. 4–5 fms. Near the eastern entrance to Plymouth Sound. The bottom is rocky, with intervals of ground occupied by stones and shells.

The Cattewater. The inner Plymouth harbour, where the bottom is soft mud, which can be worked with a shrimp trawl. The trawlers often throw their refuse overboard here, and many of the outside species can survive for a time.

THE YEALM ESTUARY.

A sheltered estuary to the east of Plymouth, where a large body of pure sea-water extends for a considerable distance from the mouth, and the fauna is essentially marine.

OUTSIDE GROUNDS.

Shores.

Wembury Bay. A rocky shore, with intervals of sand. Some of the reefs give considerable shelter from the breakers, especially at the western side of the bay.

Reny Rocks. A reef of exposed, weed-covered rocks running from the Shagstone to the mainland.

Whitsand Bay. An exposed shore which consists chiefly of fine, shifting sand, with occasional rocky patches.

Dredging and Trawling Grounds.

Cawsand Bay. Depth 3–5 fms. An inshore, shallow, sheltered bay with a bottom of fine sand.

Whitsand Bay. Depth 4–8 fms. A shallow sandy bay, more exposed than Cawsand Bay.

Mewstone Ledge. Depth 10–15 fms. A ridge of soft red, conglomerate rock, free from growth of seaweed. The dredge breaks off portions of the rock.

Mewstone Shell Gravel and "Amphioxus" Ground. Depth 10–12 fms. Bottom of clean shell gravel.

Stoke Point Grounds. Depth 10–22 fms. Reefs of red conglomerate alternating with patches of gravel and sand.

Rame-Eddystone Grounds. Depth 25–30 fms. Trawling ground between Rame Head and the Eddystone. Bottom muddy gravel, with clean sand in places.

Looe-Eddystone Grounds. Depth 25–30 fms. An extension westwards towards Looe of the Rame-Eddystone Grounds. Bottom similar to that of the latter, but rougher.

Eddystone Grounds. Depth 28–35 fms. Bottom varied. They are fully described in this Journal, vol. v., p. 365.

EXPLANATION OF INITIALS.

The authorities for various records are indicated by their initials, a list of which is given below. Initials have reference only to the *paragraph* in which they stand. Where no initials are given at the end of any paragraph the records are by E. J. Allen :—

A.J.S.—A. J. Smith, Assistant at the Laboratory since 1895.
C.S.—Creswell Shearer.
E.J.A.—E. J. Allen.
E.J.B.—E. J. Bles.
F.W.G.—F. W. Gamble.
J.T.C.—J. T. Cunningham.
R.A.T.—R. A. Todd.
S.P.—S. Pace.
T.V.H.—T. V. Hodgson.
W.B.B.—W. B. Benham.
W.G.—Walter Garstang.

ARCHIANNELIDA.

TURBANELLA HYALINA Max Schultze : Muller's Archiv., 1853, p. 241.

PLYMOUTH. Found by Dr. C. Shearer on the glass of one of the Laboratory tanks, July 26th, 1909. Dr. Shearer states :—" This form is apparently most rare, having never been described since 1853. Apparently an Archiannelid with parapodia of a primitive kind. Usually placed in the Gastrotrichia."

DINOPHILUS TÆNIATUS Harmer : Journ. Mar. Biol. Assoc. N.S. vol. 1, p. 119.

PLYMOUTH. In rock-pools in the Sound far above low water, in March and April, not found in June (*Harmer, loc. cit.*). Found often in immense numbers in pools high up on the limestone rocks below the Laboratory and in front of West Hoe Terrace. Records of the occurrence of the species below the Laboratory were kept by Mr. A. J. Smith between 1906 and 1910. From these it appears that it was abundant from November to April, but absent or very scarce between May and October.

DINOPHILUS GYROCILIATUS Schmidt : *Shearer*, Quart. Journ. Micr. Sci. vol. 57, 1912, p. 337.

PLYMOUTH. From sandy dredgings from Cawsand Bay. Can also be obtained in scrapings from the piles in Millbay Docks. Lived well in small aquaria and became established in the Laboratory tanks (Shearer, *loc. cit.*, p. 342).

Breeds all the year round in the Laboratory Tanks (C.S.).

PROTODRILUS FLAVOCAPITATUS Uljanin : *Pierantoni*, Protodrilus. Fauna Flora Golf. Neapel. Mon. 31, 1908, p. 167.

PLYMOUTH. The first record of Protodrilus at Plymouth is by

Bles (Jour. M.B.A., vol. 2, 1892, p. 343) who reared it from townettings taken in September. He considers the species to be *P. Leuckartii* Hatschek (Arbeit. Zool. Inst. Wien., vol. 3, 1880, p. 79).

Adults have since been found on the shore in numbers by Orton (Nature, vol. 91, 1913, pp. 85 and 348) at eleven different points between Salcombe and Looe, under stones and gravel near high-water mark, where small fresh-water streams join the sea. Orton records this species as *P. flavocapitatus* Uljanin.

CTENODRILUS PARDALIS Claparède : Beobactungen über Anat. u. Entw. wirbellos. Thiere a. d. K. von Normandie, 1863, p. 25.

PLYMOUTH. Found in the Laboratory tanks and also in pools at high-tide level below the Laboratory by Dr. C. Shearer. Some years it is very abundant in the tanks, in other years it is absent (C.S.).

NERILLA ANTENNATA Schmidt : *Goodrich*, Quart. Journ. Micr. Sci. vol. 57, 1912, p. 397.

PLYMOUTH. First recorded by Miss F. Buchanan (Rep. Brit. Assoc. 1892, p. 358). It has since been found to occur frequently in the Laboratory tanks, and also in scrapings from piles in the Cattewater.

Breeds from February to June in the Laboratory Tanks (C.S.).

SACCOCIRRUS SP. : *Goodrich*, Quart. Journ. Micr. Sci. vol. 44, 1901, p. 413 ; and *Pierantoni*, Ann. Mus. Zool. Napoli, vol. 2, no. 18, 1907.

PLYMOUTH. Found by Orton in Cawsand Bay together with Protodrilus, amongst stones and gravel just below high-water mark where a small fresh-water stream joins the sea. He thinks the species different from *S. papillocercus* Bobretzky (Nature, vol. 91, 1913, p. 348).

POLYGORDIUS LACTEUS Schneider : *Hempelman*, Zeitsch. wiss. Zool. vol. 84, 1906, p. 527.

PLYMOUTH. Dredged in clean shell gravel off the Mewstone and near the west end of the Breakwater. In clean shell gravel near the Eddystone and off Bolt Head.

HISTRIOBDELLA HOMARI van Beneden : *Foettinger*, Archiv. Biologie, V. 1884, p. 435. *Shearer*, Quart. Journ. Micr. Sci. vol. 55, 1910, p. 287.

PLYMOUTH. Usually found on the eggs of lobsters taken by fishermen, but normally an inhabitant of the branchial chamber (C.S.).

Breeding during the summer months.

Breeding in September (C.S.).

POLYCHÆTA.

SYLLIDÆ.

EXOGONE GEMMIFERA Pagenstecher : *McIntosh*, Mon. Brit. Ann. II. 1, 1908, p. 151.

PLYMOUTH. Common on the shore amongst the roots of Laminaria and other weeds, in the Sound and on the coast outside. Frequent in dredgings from the Sound. It also occurs in dredgings from deeper water, e.g. 2 miles off Yealm Point in 15 fms. and off the Eddystone in 30–35 fms.

Breeding : A number of specimens found amongst Ascidians from the piles in Millbay Dock in June carried eggs and embryos in different stages of development.

TORQUAY. Not uncommon amongst sea-weeds from half-tide mark downwards (*Elwes*, Journ. M.B.A., vol. 8, 1908, p. 197).

SPHÆROSYLLIS HYSTRIX Claparède : *McIntosh*, Mon. Brit. Ann. II. 1, 1908, p. 157.

PLYMOUTH. Frequent in dredgings from the Sound ; occasional specimens amongst roots of weeds from the shore.

SPHÆROSYLLIS OVIGERA Langerhans : Wurmfauna v. Madeira, Zeitschr. Wiss. Zool. XXXII. 1879, p. 567.

PLYMOUTH. In the Sound near New Grounds Buoy. Several specimens have been taken.

The species seems to be quite distinct from *S. hystrix* as well as from *S. pirifera*, Claparède. The palps are very broad and the median tentacle is in a line with or more generally in front of the anterior eyes, as figured and described by Langerhans. The body is always coated thickly with sand and mud, which enables the specimens to be separated at once from the *S. hystrix* found in the same material. The body is covered with papillæ.

SPHÆROSYLLIS ERINACEUS Claparède, *var.* : *de St. Joseph*, Ann. Polych. Dinard ; Ann. Sci. Nat. Zool. 1886, p. 207.

PLYMOUTH. Common amongst roots of Laminaria from Rum Bay.

The specimens differ from the descriptions and figures of Claparède and de St. Joseph in having the two anal cirri large and much swollen at the base.

Breeding : A specimen obtained in June had four large eggs on each segment from Segt. 9 backwards. The eggs were carried on the dorsal side of the segment. On the segments anterior to Segt. 9, four round tubercles were present on each, in positions corresponding to those occupied by the eggs.

GRUBEA CLAVATA, Claparède: Beobactungen, p. 41. Pl. XIII. Figs. 28–29. *de St. Joseph*, Ann. Sci. Nat. Zool. I. 1886, p. 200.

PLYMOUTH. From Laminaria roots, Rum Bay shore.

TORQUAY. One example from Laminaria root, Oddicombe Beach (*Elwes*, Journ. M.B.A., vol. 8, 1908, p. 197).

GRUBEA LIMBATA Claparède: Ann. Chètop. Naples, p. 208. *Viguier*: Arch. Zool. Exp. II. 1884, p. 103.

PLYMOUTH. From Laminaria roots from the Breakwater and Reny Rocks. Dredged near the east end of the Breakwater in 4 to 5 fms.

Four specimens have been obtained altogether, one in June with long swimming bristles. The specimens agree in all respects with the descriptions of Claparède and Langerhans. The buccal segment is hidden by a raised collar similar to that seen in *Eusyllis*.

GRUBEA PUSILLA Dujardin: *Langerhans*, Zeitschr. Wiss. Zool. XXXII. 1879, p. 565. *de St. Joseph*, Ann. Sci. Nat. Zool. I. 1886, p. 203.

PLYMOUTH. Amongst the roots of Laminaria from Rum Bay.

Breeding: Two females with embryos on the parapodia were seen in March.

PIONOSYLLIS LAMELLIGERA de St. Joseph: Ann. Sci. Nat. Zool. I. 1886, p. 163.

PLYMOUTH. In dredgings from Duke Rock, New Grounds, between Knap and Panther Buoys, and Mewstone Ledge. Amongst Laminaria roots from Reny Rocks.

TORQUAY. Very common in Laminaria roots (*Elwes*, Journ. M.B.A., vol. 8, 1908, p. 198).

PIONOSYLLIS DIVARICATA Keferstein: *McIntosh*, Mon. Brit. Ann. II. 1, 1908, p. 164. *de St. Joseph*, Ann. Sci. Nat. Zool. I. 1886, p. 160 as *P. longocirrata*.

PLYMOUTH. One specimen from dredgings from New Grounds.

TORQUAY. Three or four specimens from Corbyn's Head (*Elwes*, Journ. M.B.A., vol. 8, 1908, p. 198).

EUSYLLIS TUBIFEX (Gosse): *McIntosh*, Mon. Brit. Ann. II. 1, 1908, p. 173. (Probably the same as *E. Blomstrandi*, Malmgren as described by *de St. Joseph*, Ann. Sci. Nat. Zool. I. 1886, p. 171. Cf. *Southern*, Clare Island Survey, Pt. 47, Proceed. Roy. Irish Acad. XXXI. 1914, p. 32.)

PLYMOUTH. Very common in the Sound from the shore and in dredgings. Often met with in dredgings from outside, e.g. Mewstone Ledge and Eddystone Grounds.

Breeding: Females with ova and swimming bristles recorded in February and March.

TORQUAY. Fairly common amongst weeds covered with Polyzoa and Sertularia (*Elwes*, Journ. M.B.A., vol. 8, 1908, p. 198).

Breeding: Females with ova, some with well developed swimming bristles, in April.

EUSYLLIS MONILICORNIS Malmgren: *de St. Joseph*, Ann. Sci. Nat. Zool. I. 1886, p. 169 (cf. *Langerhans*, Wurmfauna von Madeira, Zeits. Wiss. Zool. XXXII. 1879, p. 551).

PLYMOUTH. Single specimens have been taken on a number of occasions from dredgings in the Sound, at Duke Rock and Asia Shoal. One from Mewstone Ledge.

The species is clearly distinguished from *E. tubifex* (Gosse) by its more robust form, and by the character of the setæ, the end pieces of which are of two kinds in each typical foot, the one short and stout, the other long and slender. The hinder part of the head generally carries a conspicuous patch of dark brown or black pigment.

EUSYLLIS LAMELLIGERA Marion and Bobretzky: Annélides du Golfe de Marseille, Ann. Sci. Nat. 6e sér. II. p. 33. Pl. III. Fig. 9. *de St. Joseph*, Ann. Sci. Nat. Zool. I. 1886, p. 169.

PLYMOUTH. Two or three specimens have been obtained from dredgings from Mewstone Ledge and Eddystone Grounds.

Breeding: A female with nearly ripe eggs was taken in July.

A well defined species, which can easily be recognised by the enlarged leaf-like shape of the first pair of ventral cirri. It is well described by Marion and Bobretzky.

ODONTOSYLLIS CTENOSTOMA Claparède: *McIntosh*, Mon. Brit. Ann. II. 1, 1908, p. 182.

PLYMOUTH. Very abundant on the shores of the Sound and frequent in dredgings from the Sound.

Breeding: A specimen in the swimming stage, with long setæ, was recorded in May.

TORQUAY. The most abundant of all the species of Syllids (*Elwes*, Journ. M.B.A., vol. 8, 1908, p. 199).

ODONTOSYLLIS FULGURANS Audouin and Edwards: *McIntosh*, Mon. Brit. Ann. II. 1, 1908, p. 179.

PLYMOUTH. Dredged at Queen's Ground (New Grounds), Mewstone Ledge, off Stoke Point and on Rame Eddystone Grounds. Usually not more than one specimen on each occasion.

ODONTOSYLLIS GIBBA Claparède: *McIntosh*, Mon. Brit. Ann. II. 1, 1908, p. 183.

PLYMOUTH. Common in dredgings from Asia Shoal, Duke Rock, Queen's Ground and Millbay Channel.

TORQUAY. Several examples were found at Corbyn's Head (*Elwes*, Journ. M.B.A., vol. 8, 1908, p. 199).

TRYPANOSYLLIS ZEBRA (Grube): *McIntosh*, Mon. Brit. Ann. II. 1, 1908, p. 169.

PLYMOUTH. Frequent in dredgings from Millbay Channel and Asia Shoal. Occasionally from other parts of the Sound. Yealm dredging. On the shore at Wembury Bay in a mass of yellow sponge.

TORQUAY. Fairly numerous among Laminaria roots from the rocks between Babbacombe and Oddicombe beaches (*Elwes*, Journ. M.B.A., vol. 8, 1908, p. 200).

TRYPANOSYLLIS CAELIACA Claparède: *McIntosh*, Mon. Brit. Ann. II. 2, 1910, p. 240.

TORQUAY. Four or five specimens from Oddicombe Rocks (*Elwes*, Journ. M.B.A., vol. 8, 1908, p. 201).

EURYSYLLIS PARADOXA (Claparède): *McIntosh*, Mon. Brit. Ann. II. 2, 1910, p. 241.

PLYMOUTH. Occasional specimens from Asia Shoal dredgings and from dredgings on the rocky ground south of the Breakwater. One or two from Laminaria roots from the shore at Reny Rocks.

Breeding: A specimen with hinder segments swollen with genital products from Reny Rocks in July.

TORQUAY. From Oddicombe, Corbyn's Head and Livermead (*Elwes*, Journ. M.B.A., vol. 8, 1908, p. 201).

SYLLIS (TYPOSYLLIS) ARMILLARIS (Müller): *McIntosh*, Ann. Mag. Nat. Hist. Ser. 8. vol. xi, 1913, p. 83. *McIntosh*, Mon. Brit. Ann. II. 1, 1908, p. 188; ditto II. 2, 1910, p. 238.

PLYMOUTH. Eddystone Grounds (*Weldon*, Journ. M.B.A., vol. 5, 1899, p. 481). A number of specimens from 20 to 50 miles S.S.W. of Eddystone in 42–49 fms. (L.R.C.). Frequent on all dredging grounds in and around Plymouth Sound. Amongst Ascidians from Millbay Dock. Occasional specimens from the shore.

The species was included in former lists (Journ. M.B.A., vol. 7, 1904, p. 219) as *Typosyllis alternosetosa*, de St. Joseph.

TORQUAY. Fairly common. Recorded as *Typosyllis alternosetosa* (*Elwes*, Journ. M.B.A., vol. 8, 1908, p. 199).

SYLLIS (TYPOSYLLIS) PROLIFERA Krohn: *Langerhans*, Zeit. wiss. Zool. XXXII, 1879, p. 530. *Claparède*, Glanures Zoot. parmi les Annél. de Port-Vendres. 1864, p. 70 (530) as *Syllis Armandi*. *McIntosh*, Mon. Brit. Ann. II. 1, 1908, p. 167 as *Pionosyllis hyalina* Grube and possibly in part, p. 161 as *Pionosyllis prolifera* Krohn.

PLYMOUTH. Common everywhere amongst weeds, etc., on the shore, as well as in dredgings from shallow water especially in Plymouth Sound.

TORQUAY. One of the most numerous of the Torquay Syllids. A very variable species (*Elwes*, Journ. M.B.A., vol. 8, 1908, p. 199).

There is some difficulty in deciding the correct nomenclature and

synonymy of the three forms of Syllis which have been described by different authors under the names, *Syllis prolifera* Krohn, *S. variegata* Grube and *S. hyalina* Grube. After examining a considerable number of living specimens my own view is that two distinct species have been referred to under these names, which would most conveniently and probably according to the law of priority most correctly bear the names *S. prolifera* Krohn and *S. variegata* Grube. The name *S. hyalina* Grube has I think most frequently been applied to examples of *S. prolifera* (and possibly other species) which were not yet fully grown.* In *S. prolifera* Krohn the pharynx is comparatively short and stout, the single dorsal tooth is large and is usually situated at the hinder end of the first third of the pharynx. There is a considerable distance between the point of the tooth and the anterior edge of the pharynx.

The proventriculus is comparatively short and stout, being about the same length as the pharynx.

The end pieces of the bristles have very boldly bifid tips, the bifid character becoming more and more marked in the posterior segments, where the end pieces also become much shorter.

In the last few parapodia there is in each a single straight simple bristle dorsally, the tip of which is often with some difficulty seen to be bifid, and ventrally a single curved simple bristle with a boldly bifid tip exactly resembling the tip of the compound bristles.

The anterior segments contain a quantity of brown pigment on the dorsal surface. This pigment is in many specimens distributed fairly uniformly over the surface, but more generally it tends to accumulate along the posterior border of the segment forming a transverse brown bar. In other specimens again in addition to this posterior bar there is an accumulation of the pigment in the centre of the dorsal surface of the segment, a brown patch above each of the dorsal cirri, and a bar along the anterior border of the segment. The pattern thus formed tends to resemble that of *S. variegata*, but this pattern is not often found in *S. prolifera*, in which the uniform distribution of pigment on the dorsal surface with a posterior brown bar is the more characteristic condition.

The dorsal cirri are moniliform. They are distinctly long, as compared for example with *S. armillaris* or *S. gracilis*, and in well-grown worms have from 25 to 30 or even 40 articulations. They differ in length, being alternately long and short throughout the greater part of the body.

The *Pionosyllis hyalina* Grube described by McIntosh (Mon. Brit. Ann. II. 1, 1908, p. 166) is almost certainly this form in an immature condition, with the cirri not yet fully grown and thus having fewer articulations.

* It should be noted that the *S. hyalina* of Malaquin is the *S. alternosetosa* de St. Joseph, recorded in the present list as *S. armillaris* (Müller) (Rech. sur les Syllidiens, 1893, p. 96).

The corresponding characters of *S. variegata* are described below under that species.

SYLLIS (TYPOSYLLIS) VARIEGATA Grube: *Langerhans*, Zeit. wiss. Zool. XXXII, 1879, p. 532, *Marenzeller*, Sitzb. mathem.-naturw. Cl. LXIX. Bd. I. 1874, p. 441. *McIntosh*, Mon. Brit. Ann. II. 1, 1908, p. 161 as *Pionosyllis prolifera* (Krohn).

PLYMOUTH. Not uncommon in dredgings from Millbay Channel and Asia Shoal. Off Yealm Head. One large specimen from the shore at Wembury Bay amongst Laminaria roots.

South by west of Eddystone in 44–49 fms. (*Crawshay*, Journ. M.B.A., vol. 9, 1912, p. 340).

The distinction between *S. variegata* and *S. prolifera* will be seen on comparing the following characters. In *S. variegata* Grube the pharynx is long and slender, extending through as many as ten segments when a fully grown worm is alive and crawling. The single dorsal tooth is relatively smaller than in *S. prolifera* and lies close to the anterior margin of the pharynx.

The proventriculus is long and relatively narrower than in *S. prolifera*.

The end-pieces of the bristles are on the whole longer than those of *S. prolifera* and are much less boldly bifid at the tip. The long end-pieces are continued back to the posterior segments to a much greater degree than in *S. prolifera* and the bifid character does not to the same extent become more marked.

Simple bristles occur in the posterior parapodia as in the former species. Their bifid character is not easy to make out, but some of the bristles seem to show it under a high power of the microscope.

The pigment is brown and the transverse figure of eight pattern described by Grube and subsequent authors is very characteristic on the anterior segments. This pattern is liable to considerable modification, one extreme form of which is described and figured by McIntosh (p. 162, fig. 53). It will be seen that merely by thickening the different bars and dots figured by McIntosh until their ends touch the characteristic *variegata* pattern is produced. The largest specimen of *S. variegata* which I have examined resembles McIntosh's description in colour pattern as well as in all other respects.

The dorsal cirri are moniliform and long, in most cases longer than in *S. prolifera*. In a large specimen the median tentacle contained about 42 articulations, whilst the lateral contained 20. The dorsal cirri along most of the length of the body are alternately long and short; in the specimen referred to there were 43 articulations in the long cirri and 20 in the short ones. The short cirri are carried by the worm horizontally, whilst the long ones rise vertically and arch over the back, the ends being frequently coiled. The long and short cirri are of nearly uniform diameter throughout, thus differing from *Syllis Krohnii* Ehlers.

SYLLIS (TYPOSYLLIS) KROHNII Ehlers: *McIntosh*, Mon. Brit. Ann. II. 1, 1908, p. 192.

PLYMOUTH. Amongst Corallina from Rum Bay, and from under a stone at Wembury Bay.

Breeding: A specimen from Wembury Bay in March had a well-developed stolon with four red eyes.

TORQUAY. Amongst Corallina from Corbyn's Head (*Elwes*, Journ. M.B.A., vol. 8, 1908, p. 200).

SYLLIS (EHLERSIA) CORNUTA Rathke: *McIntosh*, Mon. Brit. Ann. II. 1, 1908, p. 200.

PLYMOUTH. Eddystone Grounds (*Weldon*, Journ. M.B.A., vol. 5, 1899, p. 481). Occasional specimens which I believe belong to this species have been obtained from dredgings from Duke Rock, Queen's Ground and Asia Shoal, but the identification is not quite certain.

SYLLIS GRACILIS Grube: *McIntosh*, Mon. Brit. Ann. II. 1, 1908, p. 203.

PLYMOUTH. Dredgings from Millbay Channel, Asia Shoal and Queen's Ground. Single specimens frequently met with. Rum Bay shore, from crevices of shale.

SYLLIS (HAPLOSYLLIS) SPONGICOLA Grube: *McIntosh*, Mon. Brit. Ann. II. 1, 1908, p. 197.

PLYMOUTH. Occasional specimens have been found in dredgings from Plymouth Sound (Millbay Channel, Winter Shoal, Cawsand Bay). A considerable number of specimens were obtained from a mass of slimy sponge dredged on the Mewstone Ledge.

SALCOMBE. In dredgings from the channel between Salstone and Snape's Point (Journ. M.B.A., vol. 6, 1900, p. 190).

TORQUAY. Fairly abundant (*Elwes*, Journ. M.B.A., vol. 8, 1908, p. 199).

AMBLYOSYLLIS LINEATA Grube: *McIntosh*, Mon. Brit. Ann. II. 1, 1908, p. 225. *de St. Joseph*, Ann. Sci. Nat. Zool. I. 1886, p. 187 as *Pterosyllis* (*Gattiola*) *spectabilis* Johnston.

PLYMOUTH. Common in dredgings from Millbay Channel: less numerous Queen's Ground, Mallard and Asia Shoal (E.J.A., R.A.T., T.V.H.): sometimes in large numbers in sponges from Millbay Ch. (W.G.). Occurs also amongst Laminaria roots from the shores of the Sound, in dredgings from outside the Breakwater, off Yealm Head and occasionally on Eddystone Grounds.

SALCOMBE. Dredged in the channel west of Salstone (Journ. M.B.A., vol. 6, 1900, p. 190).

TORQUAY. In weeds from rocks between Oddicombe and Babbacombe (*Elwes*, Journ. M.B.A., vol. 8, 1908, p. 199).

It seems probable that Claparède's *Pterosyllis formosa* is the species under consideration. Both McIntosh and de St. Joseph appear to take this view though neither adopts Claparède's name, which has priority.

AUTOLYTUS LONGIFERIENS de St. Joseph: Ann. Sci. Nat. Zool. vol. 1, 1886, p. 217. *McIntosh*, Mon. Brit. Ann. II. 2, 1910, p. 245. *Southern*, Proceed. R. Irish Acad. XXXI. 47, p. 39.

PLYMOUTH. Two specimens were dredged on rocky ground immediately south of the Breakwater in May, one from Duke Rock in June and one was found amongst roots of Laminaria from Rum Bay in June.

The male (*Polybostricus*) and female (*Sacconereis*) forms of this species were obtained in townets near the Eddystone in February. From one Sacconereis kept in the Laboratory the young hatched two weeks after the specimen was procured.

TORQUAY. Five or six specimens were obtained on the shore (*Elwes*, Journ. M.B.A., vol. 8, 1908, p. 202).

AUTOLYTUS RUBROPUNCTATUS (Grube): *Marion and Bobretzky*, Ann. Golfe Marseille, 1875, p. 44 as *Autolytus* (*Proceræa*) *ornatus*. *Southern*, Proceed. R. Irish Acad. XXXI. 47, 1914, p. 40.

PLYMOUTH. Frequent in dredgings from the Sound, Asia Shoal, Queen's Ground and Duke Rock. Frequent also on all the dredging and trawling grounds between Plymouth and the Eddystone and westwards to Looe.

Breeding: No specimens with stolons were found amongst a large number examined between January and June. At the beginning of July, one specimen was seen with a stolon just beginning to form. The observations were interrupted after that month.

Southern has pointed out that the description given by McIntosh (Mon. Brit. Ann. II. 1, p. 186) does not agree with that of other observers. The Plymouth specimens have no ventral cirrus and the setæ have the typical bifid end-pieces of the genus *Autolytus*. McIntosh's coloured figure is stated to be from a Plymouth example.

AUTOLYTUS PICTUS (Ehlers): *McIntosh*, Mon. Brit. Ann. II. 1, 1908, p. 211.

PLYMOUTH. Frequently met with in dredgings from all grounds in Plymouth Sound; especially common amongst *Alcyonidium* and sponges from Asia Shoal. Occasional specimens on all grounds between Plymouth and the Eddystone, especially on rough ground.

Breeding: Three specimens with the Polybostricus head just commencing to form were found in dredgings from Asia Shoal in April.

TORQUAY. Rather common on the shore (*Elwes*, Journ. M.B.A., vol. 8, 1908, p. 201).

AUTOLYTUS MACROPHTHALMA (Marenzeller): *de St. Joseph*, Ann. Sci. Nat. Zool. I. 1886, p. 226. *Southern*, Proc. R. Irish Acad. XXXI. 47, 1914, p. 41.

PLYMOUTH. Specimens have been obtained in dredgings from Millbay Pit, Asia Shoal, New Grounds, Tinker Buoy, and 1 mile off Rame Head.

TORQUAY. Two examples from the shore at Babbacombe (*Elwes*, Journ. M.B.A., vol. 8, 1908, p. 201).

AUTOLYTUS EHBIENSIS de St. Joseph: *McIntosh*, Mon. Brit. Ann. II. 2, 1910, p. 243. *de St. Joseph*, Ann. Sci. Nat. Zool. I. 1886, p. 228.

PLYMOUTH. From Laminaria roots and sea-weeds from the shore at Rum Bay, and amongst Ascidians, etc., from Millbay Dock. Dredged off Yealm Head and near the Eddystone.

Breeding: Specimens with chains of buds in January, in February and in April.

TORQUAY. Found in great abundance on *Fucus*, which was covered with *Sertularia pumila*, on the Breakwater at Babbacombe (*Elwes*, Journ. M.B.A., vol. 8, 1908, p. 201).

AUTOLYTUS PUNCTATUS de St. Joseph: Ann. Sci. Nat. Zool. I. 1886, p. 233.

PLYMOUTH. Not uncommon on Queen's Ground and on the Rame-Eddystone and Looe-Eddystone trawling grounds.

Breeding: Specimens with stolons were taken from May to July. The breeding season probably extends considerably beyond these months.

This species has only been recorded from Dinard by de St. Joseph, from Boulogne by Malaquin (Syllidiens, Lille, 1893, p. 80), and from the west of Ireland by Southern (Proceed. R. Irish Acad. XXXI. 47, 1914, p. 42). It is easily recognised from de St. Joseph's description.

AUTOLYTUS EDWARSI de St. Joseph: Ann. Sci. Nat. Zool. I. 1886, p. 235.

PLYMOUTH. This species is common in dredgings from Duke Rock and the rocky ground immediately south of the Breakwater. It appears to often live in tubes attached to the fronds and roots of Laminaria.

Breeding: Specimens with stolons were found from March to June and the breeding season probably extends beyond these months.

The species, which is well defined, has only been recorded by de St. Joseph from Dinard, by Malaquin (Syllidiens, Lille, 1893, p. 80) from Boulogne, and by Southern (Proceed. R. Irish Acad. XXXI. 47, 1914, p. 43) from the west of Ireland.

AUTOLYTUS PROLIFER (O. F. Müller): *de St. Joseph*, Ann. Sci. Nat. Zool. I. 1886, p. 238. *Langerhans*, Zeits. Wiss. Zool. XXXII. 1879, p. 575.

PLYMOUTH. Two specimens from Millbay Pit dredgings and one from dredgings from the rocky ground south of the Breakwater.

Breeding: Specimen in May had one stolon. In July a female had many eggs in the body segments.

The pharynx has ten large equal teeth, which according to Langerhans and de St. Joseph is characteristic of this species. The body

is more robust than that of *A. Edwarsi* or *A. punctatus* and the living worms were picked out as distinct from the other species found here, on account of their form and movements, before the pharynx was examined. I agree with Southern that many of the records of this species in the literature are unreliable.

AUTOLYTUS LUGENS de St. Joseph: Ann. Sci. Nat. Zool. I. 1886, p. 234.

PLYMOUTH. Three or four specimens in dredgings from Queen's Ground and Millbay Pit.

Breeding: In January and February the stolon was just beginning to form; in July a large stolon was well developed.

The specimens agreed with de St. Joseph's description. The massive black tentacles and dorsal cirri of the first segment were very conspicuous. The anal cirri had the same form, and the pharynx has 16 equal teeth. I have found no other record of the species except that by de St. Joseph, who took it at Dinard.

AUTOLYTUS INERMIS de St. Joseph: Ann. Sci. Nat. Zool. I. 1886, p. 237.

PLYMOUTH. Occasional specimens have been taken on the principal dredging grounds in the Sound, as well as on the trawling grounds between Plymouth and the Eddystone and Eddystone and Looe. The specimens all had the characteristic colour.

Breeding: With stolons in December, January, April, May and June. One specimen in August had no stolon.

TORQUAY. One specimen (*Elwes*, Journ. M.B.A., vol. 8, 1908, p. 202). Malaquin (Syllidiens, Lille, 1893, p. 76) makes a new genus, *Autolytides* for this species, in which the pharynx has a plain border, without teeth of any kind.

MYRIANIDA PINNIGERA (Montagu): *McIntosh*, Mon. Brit. Ann. II. 1, 1908, p. 229. *Malaquin*, Syllidiens, Lille, 1893, Plate I, etc., as *M. fasciata* Milne-Edwards.

PLYMOUTH. Frequently met with in Plymouth Sound (W.G.); dredgings from Millbay Channel, Asia and Queen's Ground (T.V.H., R.A.T., E.J.A.); amongst Ascidians and sponges from the piles at Millbay Dock (R.A.T., E.J.A.).

SALCOMBE. On the shore at the Salstone and dredged in the channel to the west of the Salstone (Journ. M.B.A., vol. 6, 1900, p. 190).

PROCERASTEA HALLEZIANA Malaquin: Recherches sur les Syllidiens, Lille, 1893, p. 81, Pl. XI. Figs. 1–14, Pl. VIII. Fig. 26.

PLYMOUTH. Six specimens were obtained from amongst Ascidians from a raft moored in Cawsand Bay, September 30th, 1914.

Breeding: The specimens bore no stolons, but in one specimen three of the middle segments were considerably enlarged.

HESIONIDÆ.

MAGALIA PERARMATA Marion and Bobretzky: Annél. Golfe Marseille, 1875, p. 54. *McIntosh*, Mon. Brit. Ann. II. 1, 1908, p. 136.

PLYMOUTH. Not uncommon in dredgings from Millbay Channel, Asia Shoal, Queen's Ground and Duke Rock. From trawl material, Rame-Eddystone ground. From scrapings from piles at Millbay Dock.

TORQUAY. Common among Laminaria roots (*Elwes*, Journ. M.B.A., vol. 8, 1908, p. 350).

OXYDROMUS PROPINQUUS Marion and Bobretzky: Annél. Golfe Marseille, 1875, p. 51, as *Gyptis propinqua. de St. Joseph*, Ann. Sci. Nat. Zool. V. 1887, p. 321.

PLYMOUTH. Not uncommon in dredgings from near New Grounds Buoy from January to April.

Breeding: Females with well-developed eggs, January to April.

OPHIODROMUS FLEXUOSUS Delle Chiaje: *McIntosh*, Mon. Brit. Ann. II. 1, 1908, p. 117.

PLYMOUTH. Three or four specimens have been obtained from the Looe-Eddystone trawling grounds.

CASTALIA PUNCTATA (O. F. Müller): *McIntosh*, Mon. Brit. Ann. II. 1, 1908, p. 121.

PLYMOUTH. Common in dredgings from Millbay Channel and Asia Shoal; occasionally from Duke Rock and Queen's Ground. A few specimens from rough grounds outside the Sound, e.g. 2 miles off Yealm Head and 2 miles S.W. by W. of Eddystone.

It was taken by Crawshay 17·5 miles S. 25° W. of the Eddystone in 42 fathoms (Journ. M.B.A., vol. 9, 1912, p. 340).

CASTALIA FUSCA (Johnston): *McIntosh*, Mon. Brit. Ann. II. 1, 1908, p. 127.

PLYMOUTH. On the shore under stones and amongst the roots of weeds from Drake's Island, Rum Bay and Mount Edgcumbe; from the piles at Millbay Dock. Amongst dredgings from Millbay Channel and Asia Shoal. Recorded in the previous list as *Kefersteinia cirrata* (Keferstein).

TORQUAY. Common under stones, especially at Meadfoot; also in Laminaria roots (*Elwes*, Journ. M.B.A., vol. 8, 1909, p. 350).

AMPHINOMIDÆ.

SPINTHER MINIACEUS Grube: *McIntosh*, Mon. Brit. Ann. I. 2, 1900, p. 232.

PLYMOUTH. Half a dozen specimens living on a sponge dredged at Duke Rock, February 6th, 1906.

Breeding: Ripe females, depositing eggs.

EUPHROSYNE FOLIOSA Audouin and Edwards: *McIntosh*, Mon. Brit. Ann. I. 2, 1900, p. 234.

PLYMOUTH. Occasional specimens in dredgings from Queen's Ground, Asia Shoal and Millbay Channel (T.V.H., R.A.T., E.J.A.). Eddystone Grounds.

One specimen 40 miles S. 24° W. of Eddystone in 49 fms. (*Crawshay*, Journ. M.B.A., vol. 9, 1912, p. 341).

EXMOUTH. One specimen dredged amongst sponges (Journ. M.B.A., vol. 6, 1902, p. 318).

APHRODITIDÆ.

APHRODITA ACULEATA Linn.: *McIntosh*, Mon. Brit. Ann. I. 2, 1900, p. 247.

PLYMOUTH. On most of the fine-sand grounds off Plymouth, between 20 and 30 fms. (T.V.H., R.A.T., E.J.A.) S.S.W. of the Eddystone to 42 fms. (*Crawshay*, Journ. M.B.A., vol. 9, 1912, p. 340).

SALCOMBE. One small specimen from Millbay Sands (Journ. M.B.A., vol. 6, 1900, p. 190).

TORQUAY. Thrown up on shore after heavy weather, especially at Anstey Cove and Tor Abbey Sands (*Elwes*, Journ. M.B.A., vol. 9, 1910, p. 59).

HERMIONE HYSTRIX (Savigny): *McIntosh*, Mon. Brit. Ann. I. 2, 1900, p. 264.

PLYMOUTH. Most frequently on gravel grounds in the neighbourhood of the Eddystone (*Hodgson*, Journ. M.B.A., vol. 6, 1900, p. 240): occasionally on similar ground in about 20 fms. (R.A.T., E.J.A.).

S.S.W. of the Eddystone to 50 fms. on rough ground (*Crawshay*, Journ. M.B.A., vol. 9, 1912, p. 340).

LEPIDONOTUS SQUAMATUS (Linn.): *McIntosh*, Mon. Brit. Ann. I. 2, 1900, p. 274.

PLYMOUTH. Under stones and amongst weeds, Hydroids, Polyzoa, etc.: from low-tide mark to 30 fms. and over, common and widely distributed (*Hodgson*, Journ. M.B.A., vol. 6, 1900, p. 240).

S.S.W. of the Eddystone to 42 fms. (*Crawshay*, Journ. M.B.A., vol. 9, 1912, p. 340).

SALCOMBE. Dredged in the channel between the Salstone and Snape's Point, as well as in the channel in Salcombe Harbour. It was also obtained under the Marine Hotel (*Hodgson*, Journ. M.B.A., vol. 6, 1900, p. 190).

TORQUAY. Two or three under stones on Babbacombe Beach (*Elwes*, Journ. M.B.A., vol. 9, 1910, p. 59).

LEPIDONOTUS CLAVA (Montagu): *McIntosh*, Mon. Brit. Ann. I. 2, 1900, p. 280.

PLYMOUTH. Everywhere on the shore under stones, especially

at extreme low water (*Hodgson*, Journ. M.B.A., vol. 6, 1900, p. 241): less frequently in dredgings from the Sound.

EXMOUTH. Not uncommon on the shore at Orcombe Rocks (Journ. M.B.A., vol. 6, 1902, p. 318).

TORQUAY. Occasionally found on all the beaches. Numerous specimens on a large buoy in Torquay Harbour (*Elwes*, Journ. M.B.A., vol. 9, 1910, p. 59).

GATTYANA CIRROSA (Pallas): *McIntosh*, Mon. Brit. Ann. I. 2, 1900, p. 285.

PLYMOUTH. In dredgings from the neighbourhood of the Eddystone (*Hodgson*, Journ. M.B.A., vol. 6, 1900, p. 242). Yealm Sand Bank and east shore, commensal in tubes of *Amphitrite Johnstoni*.

SALCOMBE. Found on the shore living in the tubes of *Amphitrite Johnstoni* on the Salstone, south of Halwell Point and near the mouth of Salcombe Harbour (under Marine Hotel) (*Hodgson*, Journ. M.B.A., vol. 6, 1900, p. 190).

EUNOA NODOSA (M. Sars): *McIntosh*, Mon. Brit. Ann. I. 2, 1900, p. 291.

One specimen from the stony ground off Prawle Point, in 30 fms. (*Weldon*, Journ. M.B.A., vol. 5, 1899, p. 478).

LAGISCA EXTENUATA (Grube): *Fauvel*, Résult. Camp. Sci. Monaco. Fas. XLVI. Annél. Polych. 1914, p. 62. *McIntosh*, Mon. Brit. Ann. I. 2, 1900, p. 298 as *L. floccosa* (Savigny) = *L. propinqua* Malmgren.

PLYMOUTH. Between tide-marks and in dredgings throughout the whole area to 30 fms. (*Hodgson*, Journ. M.B.A., vol. 6, 1900, p. 247 as *L. floccosa*. At many stations S.S.W. of the Eddystone to about 50 fms. (*Crawshay*, Journ. M.B.A., vol. 9, 1912, p. 340, as *L. floccosa*).

TORQUAY. Fairly common under stones (*Elwes*, Journ. M.B.A., vol. 9, 1910, p. 59).

NOTE. Two varieties of this species occur in the Plymouth district. (1) A littoral and inshore variety, in which the elytron bears on its edge a few minute scattered cilia only, whilst the surface is covered with small tubercles slightly conical in shape and of fairly uniform size (a few being slightly larger than the rest) and has a number of large, brown, globular papillæ near the posterior border. (2) A deeper water variety found on the dredging and trawling grounds from 20 to 50 fms., in which the elytra bear on their edges a continuous row of minute cilia, almost spherical in shape. The surface of the elytron is covered with small tubercles as in the littoral variety, but scattered over the surface both towards the centre and especially towards the exterior and posterior borders a number of the tubercles are greatly enlarged, so that they stand out as strong conical spines. Those near the posterior border are the largest and their ends may appear rounded and swollen, but

they do not attain the size of the large globular papillæ of the littoral form. This deeper water form approaches the *L. rarispina* of Malmgren, and was so entered in our previous lists. The spines do not, however, attain the length indicated in Malmgren's figures (Nordiska Hafs-Annulater, 1865. Tafl. VIII. figs. 2 and 2c).

With regard to the name of the species, Fauvel (*loc. cit.*) points out that Savigny's *L. floccosa* is described by its author as having sixteen pairs of elytra, and his description is too incomplete to fix even the genus to which it belongs. The first recognisable description of the present form is by Grube with the specific name *extenuata*. By this name it has been generally referred to in the literature or by its later synonym *L. propinqua* Malmgren.

The species referred to in previous lists by Hodgson and Elwes from Plymouth and Torquay (*loc. cit.*) as *L. extenuata* Grube, is I believe *L. Elisabethæ* McIntosh.

LAGISCA ELISABETHÆ McIntosh : Mon. Brit. Ann. I. 2, 1900, p. 303.

PLYMOUTH. On the shore at Wembury Bay and Rum Bay, not uncommon. Probably the form referred to by Hodgson (Journ. M.B.A., vol. 6, 1900, p. 247) as *L. extenuata* Grube.

TORQUAY. Very common in roots of Laminaria and under stones (*Elwes*, Journ. M.B.A., vol. 9, 1910, p. 59). Southern has examined specimens from Torquay sent by Major Elwes and states that they are certainly this form (Proceed. R. Irish Acad. XXXI. 47, 1914, p. 51).

HARMOTHOË IMBRICATA (Linn.) : *McIntosh*, Mon. Brit. Ann. I. 2, 1900, p. 314.

PLYMOUTH. Between tide-marks amongst Laminaria roots on the Breakwater : amongst Hydroids, Polyzoa, etc., on Eddystone Grounds (*Hodgson*, Journ. M.B.A., vol. 6, 1900, p. 245).

This form seems to be rare at Plymouth, and I have not succeeded in re-finding it.

HARMOTHOË SPINIFERA (Ehlers) : *McIntosh*, Mon. Brit. Ann. I. 2, 1900, p. 327.

PLYMOUTH. Amongst dredgings from Millbay Channel, Queen's Ground, Asia Shoal, etc., and Yealm River : common (T.V.H., R.A.T., E.J.A.).

SALCOMBE. Dredged in the channel west of the Salstone, and between the Salstone and Snape's Point (*Hodgson*, Journ. M.B.A., vol. 6, 1900, p. 190).

TORQUAY. One specimen only found (*Elwes*, Journ. M.B.A., vol. 9, 1910, p. 59).

HARMOTHOË LUNULATA (Delle Chiaje) : *McIntosh*, Mon. Brit. Ann. I. 2, 1900, p. 342.

PLYMOUTH. A not uncommon tidal form. Found among roots of Laminaria on the Breakwater, and occasionally under stones

near low water (*Hodgson*, Journ. M.B.A., vol. 6, 1900, p. 243). One specimen S.S.W. of Eddystone in 49 fms. (*Crawshay*, Journ. M.B.A., vol. 9, 1912, p. 341).

SALCOMBE. On the shore of the bay north of Pilworthy Point (*Hodgson*, Journ. M.B.A., vol. 6, 1900, p. 190).

HARMOTHOË SETOSISSIMA (Savigny): *McIntosh*, Mon. Brit. Ann. I. 2, 1900, p. 345.

PLYMOUTH. Occasionally found among Polyzoa (*Cellaria*) and *Chætopterus* tubes from the Eddystone Grounds (*Hodgson*, Journ. M.B.A., vol. 6, 1900, p. 244). S.S.W. of the Eddystone in 43–49 fms. (*Crawshay*, Journ. M.B.A., vol. 9, 1912, p. 341).

SALCOMBE. On the eastern shore of Salcombe Harbour (*Hodgson*, Journ. M.B.A., vol. 6, 1900, p. 190).

HARMOTHOË AREOLATA (Grube): *McIntosh*, Mon. Brit. Ann. I. 2, 1900, p. 349.

PLYMOUTH. Not uncommon on the Eddystone Grounds, where the dredge or trawl brings up masses of Polyzoa, Hydroids and *Chætopterus* tubes (*Hodgson*, Journ. M.B.A., vol. 6, 1900, p. 244).

HARMOTHOË FRASER-THOMSONI McIntosh: Mon. Brit. Ann. I. 2, 1900, p. 337.

PLYMOUTH. Two specimens S.S.W. of the Eddystone in 49–51 fms. (*Crawshay*, Journ. M.B.A., vol. 9, 1912, p. 341).

HARMOTHOË MARPHYSÆ McIntosh: Mon. Brit. Ann. I. 2, 1900, p. 339.

PLYMOUTH. Prof. McIntosh records this species from the galleries of *Marphysa sanguinea* from chinks in the rocks, Polperro (British Museum). It was found at Plymouth by Mr. R. A. Todd commensal with *Marphysa sanguinea* on the shore at Mount Edgcumbe.

A form which seems to resemble *H. marphysæ* more closely than any other described species has been met with in fine sand in the Yealm Estuary. In one case the sand contained *Amphitrite Johnstoni*, in another *Synapta inhærens*, and a definite association of the *Harmothoë* with the *Synapta* was actually observed in one instance.

EUARNE IMPAR (Johnston): *McIntosh*, Mon. Brit. Ann. I. 2, 1900, p. 353.

PLYMOUTH. Common between tide-marks and amongst dredgings throughout the Plymouth area (T.V.H., E.J.A.): Eddystone Grounds (T.V.H.). S.S.W. of Eddystone in 40–42 fms. (*Crawshay*, Journ. M.B.A., vol. 9, 1912, p. 341).

SALCOMBE. Dredged in the channel between the Salstone and the mouth of Salcombe Harbour (*Hodgson*, Journ. M.B.A., vol. 6, 1900, p. 190).

EXMOUTH. On the shore west of the mouth of Salthouse Lake (Journ. M.B.A., vol. 6, 1902, p. 318).

TORQUAY. Rare. Recorded by Gosse from Anstey's Cove (*Elwes*, Journ. M.B.A., vol. 9, 1910, p. 59).

SCALISETOSUS COMMUNIS (Delle Chiaje): *McIntosh*, Mon. Brit. Ann. I. 2, 1900, p. 372.

PLYMOUTH. On the shore at Mount Edgcumbe: amongst dredgings Millbay Channel and Asia Shoal (R.A.T., E.J.A.).

Fauvel considers that the name *S. pellucidus* (Ehlers) should be maintained for this species, as there is great doubt as to Delle Chiaje's species (Camp. Sci. Monaco, XLVI. 1914, p. 47).

SCALISETOSUS ASSIMILIS (McIntosh): *McIntosh*, Mon. Brit. Ann. I. 2, 1900, p. 377.

PLYMOUTH. Among spines of *Echinus esculentus* from Mewstone and Eddystone Grounds (T.V.H., R.A.T., E.J.A.).

MALMGRENIA CASTANEA, McIntosh: Mon. Brit. Ann. I. 2, 1900, p. 379.

PLYMOUTH. Commensal on the surface of *Spatangus purpureus*, near the mouth of the Echinoderm: not uncommon (T.V.H., E.J.A.).

HALOSYDNA GELATINOSA (M. Sars): *McIntosh*, Mon. Brit. Ann. I. 2, 1900, p. 384.

PLYMOUTH. Frequently met with on the shore under stones and amongst dredging and trawling material throughout the area, including the Eddystone Grounds.

One specimen taken by Crawshay S.S.W. of the Eddystone in 49 fms. (Journ. M.B.A., vol. 9, 1912, p. 341).

TORQUAY. One specimen under a stone at Babbacombe Beach (*Elwes*, Journ. M.B.A., vol. 9, 1910, p. 60).

POLYNOE SCOLOPENDRINA Savigny *Auct.*: *McIntosh*, Mon. Brit. Ann. I. 2, 1900, p. 389. *Marenzeller*, Zur Kenntniss der adriatischen Anneliden. Sitzb. math-nat. Cl. Wien. 69, 1874, p. 420 as *P. Johnstoni*.

PLYMOUTH. Commensal in tubes of *Polymnia nebulosa* on the shore at Mount Edgcumbe. In dredgings from Asia Shoal.

Eddystone Grounds (*Hodgson*, Journ. M.B.A., vol. 6, 1900, p. 249).

The specimens commensal with *Polymnia nebulosa* are large (6 to 7 centimetres long) and the colour tends, especially in spirit, to dark olive green. Those from dredgings in the Sound are smaller (2–3 cm.) and the colour is light brown. The elytra of the two sides nearly or even quite meet in the middle line in both cases. The dorsal bristle bundles are well developed. Three rows of dorsal tubercles on the posterior segments are very marked.

POLYNOE CRASSIPALPA Marenzeller: Zur Kenntniss der adriatischen Anneliden. Sitzb. math-nat. Cl. Wien. 69, 1874, p. 412.

PLYMOUTH. Occasional specimens are met with in dredgings from Plymouth Sound.

When the two are seen side by side there can be no doubt that

Marenzeller was right in separating this form from the *P. scolopendrina* Savigny of Johnston and other authors. In *P. crassipalpa* the body is much more slender and the dorsum is more strongly pigmented, the dark brown colour being arranged in a characteristic pattern. The posterior part of the ventral surface is also strongly pigmented. The elytra are small, to quote Savigny "separated by an interval equal to their breadth, the two rows thus leaving all the middle of the back uncovered; but the elytra of each row mutually overlap a little" (Syst. des Annélides, p. 25). This character and the complete absence of tubercles on the uncovered, posterior part of the dorsum give the species a quite characteristic appearance to the naked eye or under a low power lens. The bristles of the dorsal bundle in the typical foot are few, two or three only in one specimen examined by me, six in Marenzeller's specimens, and spinous rows are little developed on them. The ventral bristles as well as other details of the worm are well described by Marenzeller. The latter author, however, in my opinion, attaches undue importance in distinguishing the species of this genus to the relative lengths of the median tentacle, palps and tentacular cirri, especially as these have apparently been noted both by himself and by other authors only on preserved specimens. The palps especially seem to be subject to considerable and very variable degrees of contraction under the influence of preservatives. In a well preserved specimen which shows little sign of contraction I find the median tentacle just a little longer than the palps, and the dorsal tentacular cirri about the same length as the median tentacle. The palps taper gradually to a point and are not shaped as in Marenzeller's figure, which seems to have been drawn from a specimen in which they were much contracted.

Although I have not much doubt that Savigny's description applies to the present species it is impossible to be quite certain on the point, and it therefore seems better to use *P. scolopendrina* for the other form, which has been known under that name for half a century, and to call the present one *P. crassipalpa*, the name under which it was first clearly described by Marenzeller.

LEPIDASTHENIA ARGUS Hodgson: Journ. M.B.A., vol. 6, 1900, p. 250.

SALCOMBE. Found in the tubes of *Amphitrite Edwardsi*, on the shore between Salcombe town and Sandhill Point (under Marine Hotel) (T.V.H.).

The species has since been taken on many occasions in the same locality and under the same conditions as originally described by Hodgson. It has never been found elsewhere.

ACHOLOË ASTERICOLA (Delle Chiaje): *McIntosh*, Mon. Brit. Ann. I. 2, 1900, p. 397.

In the ambulacral groove of *Astropecten irregularis*: common (T.V.H., R.A.T., E.J.A.).

STHENELAIS BOA (Johnston): *McIntosh*, Mon. Brit. Ann. I. 2, 1900, p. 408.

PLYMOUTH. Common in sand between tide-marks, Rum Bay, Drake's Island, Mount Edgcumbe, Wembury Bay, Yealm River (T.V.H., R.A.T., E.J.A.): occasionally amongst dredgings from Millbay Channel and Asia Shoal (T.V.H., E.J.A.): Mewstone Grounds (T.V.H.).

SALCOMBE. On the Salstone and near the mouth of the harbour, between the Ferry House and Millbay; never numerous. Dredged in the channel between Salstone and Snape's Point (Journ. M.B.A., vol. 6, 1900, p. 191).

EXMOUTH. One specimen in the channel; never met with on the shore (Journ. M.B.A., vol. 6, 1902, p. 318).

TORQUAY. Not uncommon in the sand at Tor Abbey Sands (*Elwes*, Journ. M.B.A., vol. 9, 1900, p. 60).

STHENELAIS LIMICOLA, Ehlers: *McIntosh*, Mon. Brit. Ann. I. 2, 1900, p. 417.

PLYMOUTH. One specimen in a coarse townet attached to the Otter-trawl, 5 miles W.S.W. of Rame Head. One specimen dug in the sand bank in the upper part of the Yealm River.

SIGALION MATHILDÆ Audouin and Edwards: *McIntosh*, Mon. Brit. Ann. I. 2, 1900, p. 427.

TEIGNMOUTH. One specimen obtained in the sand below Shaldon Bridge.

PHOLOË MINUTA (Fabricius): *McIntosh*, Mon. Brit. Ann. I. 2, 1900, p. 437.

PLYMOUTH. Common amongst dredging and trawling material over the whole Plymouth area, including Eddystone Grounds. Especially abundant in Millbay Channel and on Asia Shoal.

TORQUAY. The most numerous of all the Torquay Aphroditidæ, inhabiting especially the Laminarian zone (*Elwes*, Journ. M.B.A., vol. 9, 1910, p. 60).

PHYLLODOCIDÆ.

NOTOPHYLLUM FOLIOSUM (Sars): *McIntosh*, Mon. Brit. Ann. II. 1, 1908, p. 46.

PLYMOUTH. Frequent in dredgings from all the grounds in the Sound, and often met with on all the dredging and trawling grounds outside, including the Eddystone Grounds.

In the previous list this species was wrongly named *Eulalia obtecta* Ehlers.

TORQUAY. One from Livermead (*Elwes*, Journ. M.B.A., vol. 8, 1909, p. 349).

EULALIA BILINEATA (Johnston) : *McIntosh*, Mon. Brit. Ann. II. 1, 1908, p. 51.

PLYMOUTH. Frequent amongst dredgings from the Sound, especially from Millbay Channel and Asia Shoal. Dredged off Yealm Head. Amongst roots of Laminaria from Cawsand Bay.

EULALIA AUREA Gravier : Recherches sur les Phyllodociens, Bull. Sci. France et Belg. XXIX. 1896, p. 309.

PLYMOUTH. Common on all the dredging grounds in Plymouth Sound. Occasional specimens are met with on most of the grounds near shore, e.g. off Yealm Head.

McIntosh (Mon. Brit. Ann. II. 1, 1908, p. 60) regards *E. aurea* as a variety of *E. viridis*. The general shape of the animal, the character of its movements, its size when mature and its usual habitat seem to mark it clearly from that form. The most striking difference is, however, the distinctive colour and colour pattern of each of the forms, which is very constant. In most respects *E. aurea* seems nearer to *E. bilineata* than to *E. viridis*.

Breeding : With eggs January to July (R.A.T., E.J.A.).

TORQUAY. On the shore, but not above the Laminarian zone (*Elwes*, Journ. M.B.A., vol. 8, 1909, p. 348).

EULALIA ORNATA de St. Joseph : Ann. Sci. Nat. Zool. V. 1888, p. 291.

PLYMOUTH. In dredgings from the Sound, especially Millbay Channel and Asia Shoal. Much less frequent than *E. aurea*.

McIntosh (Mon. Brit. Ann. II. 1, 1908, p. 59) regards this form also as a variety of *E. viridis*. The well-marked colour pattern, its general shape and the character of its movements appear to me to justify doubts as to this conclusion.

TORQUAY. Fairly common, but not above the Laminarian zone (*Elwes*, Journ. M.B.A., vol. 8, 1909, p. 347).

EULALIA VIRIDIS (O. F. Müller) : *McIntosh*, Mon. Brit. Ann. II. 1, 1908, p. 55.

PLYMOUTH. Common on rocky shores in the Sound and on the coast. Its usual home seems to be amongst shore sea-weeds, to which the large gelatinous masses of green eggs are attached. It is, however, occasionally taken in dredgings from the Sound, especially in an immature state, and specimens have even been taken on the Eddystone Grounds.

Breeding : Eggs in January and February ; abundant in May and June. None found at end of July or in August (A.J.S.).

SALCOMBE. From dredgings between Salstone and Snape's Point (Journ. M.B.A., vol. 6, 1900, p. 193).

EXMOUTH. Two specimens were obtained from Orcombe Rocks, at the mouth of the estuary (Journ. M.B.A., vol. 6, 1902, p. 320).

TORQUAY. Particularly abundant where the limestone rocks

have been much eaten away from about half-tide mark downwards. It appears to like crawling about the damp rocks out of the water when the tide is low (*Elwes*, Journ. M.B.A., vol. 8, 1909, p. 347).

EULALIA TRIPUNCTATA McIntosh: Mon. Brit. Ann. II. 1, 1908, p. 63. *de St. Joseph*, Ann. Sci. Nat. Zool. V. 1888, p. 285, as *E. Claparedii*.

PLYMOUTH. Not infrequent in dredgings from Millbay Channel, Asia Shoal and occasionally Queen's Ground and Duke Rock. Found also on the outer grounds, e.g. off Yealm Head. Cawsand Bay, among Laminaria roots from the shore. Recorded in the former list as *E. Claparèdi*.

Breeding: May, eggs brick-red.

EULALIA PUNCTIFERA (Grube): *McIntosh*, Mon. Brit. Ann. II. 1, 1908, p. 53 as *Eulalia nebulosa*, Montagu.

PLYMOUTH. In dredgings from Millbay Channel, Asia Shoal and Yealm; on the shore at Mount Edgcumbe and in the Yealm Estuary.

SALCOMBE. Dredged in the channel between the Salstone and Snape's Point (Journ. M.B.A., vol. 6, 1900, p. 193).

TORQUAY. One specimen from Corbyn's Head (*Elwes*, Journ. M.B.A., vol. 8, 1909, p. 348).

EULALIA (PTEROCIRRUS) MACROCEROS (Grube): *McIntosh*, Mon. Brit. Ann. II. 1, 1908, p. 60.

PLYMOUTH. Occasional specimens from dredging grounds in the Sound. A number also taken in dredging from 2 miles off Yealm Head.

EULALIA (EUMIDA) SANGUINEA Oersted: *McIntosh*, Mon. Brit. Ann. II. 1, 1908, p. 66.

PLYMOUTH. Common and generally distributed in dredging material throughout the area, especially in inshore waters. Frequent amongst Laminaria roots from the shore.

Breeding: May to July; eggs green, occasionally reddish.

The species shows considerable variety both of form and colour, and it seems probable that McIntosh has included under this name several forms which may prove to be distinct species.

One variety with alternate green and white bands on the dorsum (*Eulalia* Sp. B. *McIntosh*, *l.c.*, p. 68), when seen alive appears to be specially distinct. Southern (Proceed. R. Irish Acad. XXXI. 47, 1914, p. 66) has also found this variety on the west coast of Ireland.

In the former list the present species was entered under the name of *Eulalia pallida* Claparède, with a reference to de St. Joseph's description.

TORQUAY. Common among Laminaria roots (*Elwes*, Journ. M.B.A., vol. 8, 1909, p. 348).

PHYLLODOCE LAMELLIGERA (Gmelin): *McIntosh*, Mon. Brit. Ann. II. 1, 1908, p. 76.

Between tide-marks Drake's Island: Breakwater: in dredgings from Millbay Channel, Asia Shoal, Duke Rock (T.V.H., E.J.A.).

Recorded in the former list as *P. laminosa*, Savigny.

TORQUAY. One light coloured individual under a stone at Hope's Nose, and another of normal colouring at Meadfoot (*Elwes*, Journ. M.B.A., vol. 8, 1909, p. 349).

PHYLLODOCE PARETTI (Blainville): *McIntosh*, Mon. Brit. Ann. II. 1, 1908, p. 82.

PLYMOUTH. Occasional specimens in dredgings from the Mewstone Ledge (E.J.A.): off Stoke Point (S.P.).

TORQUAY. The head and about twenty segments of one from Corbyn's Head (*Elwes*, Journ. M.B.A., vol. 8, 1909, p. 349).

PHYLLODOCE MACULATA (Linn.): *McIntosh*, Mon. Brit. Ann. II. 1, 1908, p. 89.

PLYMOUTH. Common in dredgings from the Sound and inshore waters, being sometimes present in very large numbers. It seems to be much more abundant during the summer months than in winter. Large specimens which seem to be the same species were found in fine clean sand at Wembury Bay.

Breeding. January, February (W.G.): April to July. Eggs orange-brown or green (E.J.A.).

EXMOUTH. A form recorded as *P. teres* Malmgren from fine clean sand at Exmouth and from similar ground at Teignmouth I am now inclined to regard as the common *P. maculata* (Journ. M.B.A., vol. 6, 1902, p. 319).

TORQUAY. Common between tide-marks. Found amongst rocks and weeds, and also in the sand (*Elwes*, Journ. M.B.A., vol. 8, 1909, p. 348).

PHYLLODOCE RUBIGINOSA de St. Joseph: *McIntosh*, Mon. Brit. Ann. II. 1, 1908, p. 92.

PLYMOUTH. Frequent in dredgings from Millbay Channel, Asia Shoal and other parts of the Sound. Amongst dredge and trawl material from near the Eddystone.

Crawshay obtained several specimens S.S.W. of the Eddystone in 46–49 fms. (Journ. M.B.A., vol. 9, 1912, p. 341).

ETEONE PICTA Quatrefages: *McIntosh*, Mon. Brit. Ann. II. 1, 1908, p. 100.

PLYMOUTH. Occasional specimens from dredgings, Millbay Channel, Asia Shoal, Queen's Ground, Barn Pool. Some large specimens were found amongst roots of Laminaria from the shore at Cawsand Bay, and it was also taken on the shore at Wembury Bay.

TORQUAY. Small ones not uncommon amongst Laminaria roots (*Elwes*, Journ. M.B.A., vol. 8, 1909, p. 349).

ETEONE PUSILLA Oersted (*nec* Malmgren): *Oersted*, Ann. Dann. Consp. 1843, p. 30. *Michaelsen*, Poly. deutsch. Meere., Wiss. Meeresunters. II, 1897, p. 37.

EXMOUTH. In clean fine sand in the estuary (Journ. M.B.A., vol. 6, 1902, p. 319–320). Specimens 17 to 18 mm. long, one of 17·5 mm. having 94 pairs of parapodia.

TEIGNMOUTH. In clean fine sand in the estuary.

The head exactly resembles Oersted's figure. The anal cirri are large and swollen. They vary from cylindrical with a rounded end to slightly pear-shaped in preserved specimens, and very slight contraction in the preserving fluid would justify Oersted's description "papillis caudalibus subglobosis." They are altogether different from those figured by Malmgren, and from his description "cirri anales lineare-fusiformes elongati" (Nord. Hafs. Ann., 1865, p. 102, Tab. XV. Fig. 37).

MYSTIDES LIMBATA de St. Joseph: Ann. Sci. Nat. Zool. V. 1887, p. 310.

PLYMOUTH. Dredged off the Mewstone in 15–16 fms. Female with dark green eggs in May (J.T.C.).

Not uncommon in dredgings from Asia Shoal and Queen's Ground (New Grounds). In dredgings from Yealm River.

A small median tentacle, as in *Eulalia*, is very distinct in some specimens when alive, but in the majority of specimens it is difficult, if not impossible to make out. In all other respects the form agrees with de St. Joseph's description.

TOMOPTERIDÆ.

TOMOPTERIS HELGOLANDICA Greef: *Apstein*, Alciopiden und Tomopteriden der Plankton-Expedition, Kiel, 1900.

PLYMOUTH. Not uncommon in townettings from the Channel.

NEREIDÆ.

MICRONEREIS VARIEGATA Claparède: *McIntosh*, Mon. Brit. Ann. II. 2, 1910, p. 261. *Regnard*, Mém. Soc. Zool. de France, XXVI. 1913, p. 91.

PLYMOUTH. Amongst weeds and Corallina from the shore at Rum Bay. From weeds dredged in Cawsand Bay.

TORQUAY. Amongst red algæ and Lithothamnion from the rocks between Oddicombe and Babbacombe beaches (*Elwes*, Journ. M.B.A., vol. 8, 1909, p. 350).

LEPTONEREIS GLAUCA Claparède: *Ramsay*, Journ. M.B.A. vol. 10, 1914, p. 244.

PLYMOUTH. From the piles of the wharf at Millbay Docks. Fairly numerous. Heteronereid males in February, females filled with ova in March (*Ramsay, l.c.*).

TORQUAY. One male Heteronereid in February at Oddicombe (*Elwes*, Journ. M.B.A., vol. 8, 1909, p. 351 as *L. Vaillanti*).

NEREIS PELAGICA Linnæus: *McIntosh*, Mon. Brit. Ann. II. 2, 1910, p. 267.

PLYMOUTH. Frequent amongst weeds on rocky shores and from dredgings in all parts of the Sound; also Wembury Bay and Yealm River (T.V.H., E.J.A.).

EXMOUTH. Dredged amongst masses of sponge (*Halichondria panicea*) in the main channel (Journ. M.B.A., vol. 6, 1902, p. 318).

TORQUAY. Extremely common in the roots of Laminaria. Heteronereids in January and February (*Elwes*, Journ. M.B.A., vol. 8, 1909, p. 351).

NEREIS ZONATA Malmgren: *Fauvel*, Résult. Camp. Sci. Monaco, Fas. XLVI. Annél. Polych. 1914, p. 177.

PLYMOUTH. Common on the dredging and trawling grounds off Plymouth in depths of from 20–40 fms. Recorded previously as *N. procera* Ehlers (Journ. M.B.A., vol. 5, 1899, p. 481).

Dredged by Crawshay S.S.W. of the Eddystone in depths of 42–49 fms. (Journ. M.B.A., vol. 9, 1912, p. 342 as *N. pelagica*).

It seems to me probable that this is the species which Johnston calls *Nereis fimbriata* O. F. Müller. He states that it inhabits the "coralline region," and he obtained it not only at Berwick Bay but also from Polperro (Cat. Worms. Brit. Mus. 1865, pp. 155 and 341).

NEREIS (PERINEREIS) CULTRIFERA Grube: *McIntosh*, Mon. Brit. Ann. II. 2, 1910, p. 280.

PLYMOUTH. Common on the shores all around the Sound, Wembury Bay, Yealm Estuary, especially in muddy gravel. Young specimens frequent in dredgings.

SALCOMBE. Common all round the estuary excepting in very fine mud. Most common where soil is gravel mixed with sand and mud (Journ. M.B.A., vol. 6, 1900, p. 192).

EXMOUTH. One specimen only was found at Orcombe Rocks, quite at the mouth of the estuary (Journ. M.B.A., vol. 6, 1902, p. 318).

TORQUAY. Under stones, not very common, on the edge of the submerged forest at Tor Abbey Sands (*Elwes*, Journ. M.B.A., vol. 8, 1909, p. 352).

NEREIS (PERINEREIS) MARIONI Audouin and Edwards: *McIntosh*, Mon. Brit. Ann. II. 2, 1910, p. 295.

PLYMOUTH. McIntosh (*loc. cit.*) records this species from Plymouth, probably in material sent from the Laboratory. I have not yet found it myself.

NEREIS (PRAXITHEA) SCHMARDÆI Quatrefages: *McIntosh*, Mon. Brit. Ann. II. 2, 1910, p. 291. *de St. Joseph*, Ann. Sci. Nat. Zool. V. 1888, p. 263, and XX. 1895, p. 215 as *N. irrorata* Malmgren.

PLYMOUTH. Not uncommon in coarse sand and gravel between tide-marks, Drake's Island, Mount Edgcumbe, Jennycliff (rare), Wembury Bay, Yealm Estuary south shore. Small specimens amongst dredgings from Queen's Ground and Asia Shoal. Recorded in previous list as *N. irrorata*.

SALCOMBE. Common in muddy gravel under the Marine Hotel. Also found on the east side of the harbour, and one specimen in Kingsbridge Estuary south of Halwell Point (Journ. M.B.A., vol. 6, 1900, p. 191, as N. irrorata).

EXMOUTH. One specimen from Orcombe rocks at the mouth of the estuary (Journ. M.B.A., vol. 6, 1902, p. 319, as N. irrorata).

TORQUAY. Occasionally under stones at Petit Tor Bay and Babbacombe Beach; amongst roots of Zostera at Corbyn's Head (*Elwes*, Journ. M.B.A., vol. 8, 1909, p. 352).

NEREIS (PLATYNEREIS) DUMERILII Audouin and Edwards: *McIntosh*, Mon. Brit. Ann. II. 2, 1910, p. 302.

PLYMOUTH. Small specimens are common on all the dredging grounds of the Sound, the largest specimens coming from Queen's Ground. In dredgings from Yealm River. Occasional specimens are obtained from the shores of the Sound and from Millbay Docks.

TORQUAY. Small individuals very common amongst algæ from rock pools (*Elwes*, Journ. M.B.A., vol. 8, 1909, p. 351).

NEREIS (HEDISTE) DIVERSICOLOR O. F. Müller: *McIntosh*, Mon. Brit. Ann. II. 2, 1910, p. 312.

PLYMOUTH. Common in the mud flats of the Tamar and Plym estuaries, seldom in the Sound; found only where the density of the water is low.

SALCOMBE. Numerous only in a small gully traversed by a stream of fresh water which runs into Southpool Lake. Occasional specimens found in other parts of the harbour (Journ. M.B.A., vol. 6, 1900, p. 193).

EXMOUTH. Very common in the upper parts of the estuary where the density of the water is low (Journ. M.B.A., vol. 6, 1902, p. 319).

NEREIS (EUNEREIS) LONGISSIMA Johnston: *McIntosh*, Mon. Brit. Ann. II. 2, 1910, p. 325.

PLYMOUTH. Occasional specimens in fine sand between tide-marks on Drake's Island and Mount Edgcumbe shore. Recorded by Cunningham from a mud-bank in the Cattewater near Oreston.

The Heteronereis stage is sometimes very numerous swimming in the Cattewater, the largest numbers being reported from near

Laira Bridge. It has also been reported as numerous in the Hamoaze. It generally swims at night.

SALCOMBE. In fine muddy sand, especially abundant south of Garston Point and on the south side of the bay immediately below Halwell Point (Journ. M.B.A., vol. 6, 1900, p. 192, where further details as to its habitat and habits are given).

EXMOUTH. One specimen on Bullhill Bank and one from the mud north of Salthouse Lake (Journ. M.B.A., vol. 6, 1902, p. 319).

NEREIS (NEREILEPAS) FUCATA Savigny: *McIntosh*, Mon. Brit. Ann. II. 2, 1910, p. 336.

PLYMOUTH. In shells of *Buccinum undatum* inhabited by *Eupagurus Bernhardus:* Mewstone Grounds, Rame-Eddystone, Looe-Eddystone and Eddystone Grounds.

Found by Crawshay at two positions S.S.W. of Eddystone in 42–47 fms., associated with *Anapagurus lævis* (Journ. M.B.A., vol. 9, 1912, p. 342).

S. Pace records a specimen from Yealm River.

Breeding. May (W.G.).

SALCOMBE. From a Hermit Crab on Millbay Sands (Journ. M.B.A., vol. 6, 1900, p. 193).

EXMOUTH. In a shell inhabited by *E. Bernhardus* at Orcombe Rocks (Journ. M.B.A., vol. 6, 1902, p. 318).

TORQUAY. In whelk shells thrown up on shore (*Elwes*, Journ. M.B.A., vol. 8, 1909, p. 351).

NEPHTHYDIDÆ.

NEPHTHYS CÆCA (O. F. Müller): *McIntosh*, Mon. Brit. Ann. II. 1, 1908, p. 8.

PLYMOUTH. Large specimens on sandy shores, especially Drake's Island, Rum Bay and Yealm Sand-bank (T.V.H., R.A.T., E.J.A.).

SALCOMBE. Only on the banks near the mouth of the harbour, being most numerous on the eastern side (Journ. M.B.A., vol. 6, 1900, p. 193).

EXMOUTH. Several large specimens from Bullhill Bank (Journ. M.B.A., vol. 6, 1902, p. 319).

NEPHTHYS HOMBERGI Lamarck: *McIntosh*, Mon. Brit. Ann. II. 1, 1908, p. 17.

PLYMOUTH. Shore between tide-marks especially in sand, Drake's Island, Rum Bay, Jennycliff Bay, Bovisand, Wembury Bay, Whitsand Bay, Yealm River (R.A.T., E.J.A.): dredged on Mewstone *Amphioxus* Ground (R.A.T.) and Eddystone Grounds (T.V.H.).

SALCOMBE. One of the commonest shore Polychætes in Sal-

combe Estuary. On all grounds except finest mud (Journ. M.B.A., vol. 6, 1900, p. 193).

EXMOUTH. Common in sand and muddy sand all over the estuary (Journ. M.B.A., vol. 6, 1902, p. 319).

TORQUAY. Common in sand at Tor Abbey Sands and Livermead. In dirty, muddy sand in the inner harbour of Torquay (*Elwes*, Journ. M.B.A., vol. 8, 1909, p. 350).

NEPHTHYS CIRROSA Ehlers: *McIntosh*, Mon. Brit. Ann. II. 1, 1908, p. 36.

PLYMOUTH. In sand between tide-marks, Drake's Island and Yealm Estuary.

EXMOUTH. In considerable numbers on grounds where the soil was fine clean sand, but did not occur in any other localities (Journ. M.B.A., vol. 6, 1902, p. 319).

TORQUAY. In clean sand in company with *N. Hombergi*, but not quite so numerous (*Elwes*, Journ. M.B.A., vol. 8, 1909, p. 350).

EUNICIDÆ.

STAUROCEPHALUS RUBROVITTATUS Grube: *McIntosh*, Mon. Brit. Ann. II. 2, 1910, p. 353.

PLYMOUTH. Frequent in dredgings from Millbay Channel, Queen's Ground, Asia Shoal, Duke Rock. Also taken 2 miles off Yealm Head.

TORQUAY. One specimen at an unusually low spring tide at Corbyn's Head (*Elwes*, Journ. M.B.A., vol. 9, 1910, p. 61).

STAUROCEPHALUS CILIATUS (Keferstein): Ehlers, Borstenwürmer, 1868, p. 424.

PLYMOUTH. Recorded once from Queen's Ground dredging. No further specimens have been obtained since the one entered in the former list. The specimen has four eyes, an anterior pair of large eyes and a posterior pair of small ones, as described by Ehlers and Keferstein. In this respect it differs from the *S. ciliatus* of McIntosh (Mon. Brit. Ann. II. 2, 1910, p. 359), which is described as having two eyes, black, large and distinct.

STAUROCEPHALUS PALLIDUS Langerhans: Zeit. wiss. Zool. XXXIII. 1879, p. 300. *McIntosh*, Mon. Brit. Ann. II. 2, 1910, p. 362 and p. 363.

PLYMOUTH. Recorded once from Asia Shoal dredging. In the former list it was stated that the species "resembles *S. ciliatus* Kef., excepting for absence of eyes." This should have read "excepting for the absence of the posterior pair of eyes." The specimen, as McIntosh (*l.c.* p. 362) who examined it points out, has two very distinct eyes situated near the base of the tentacles. As regards the

eyes, therefore, the specimen does not differ from the *S. ciliatus* with two eyes described by McIntosh; it does differ, however, from the *S. ciliatus* described by Keferstein and Ehlers, which has four eyes. It agrees with *S. pallidus* Langerhans, which has two eyes. The correct synonymy of the two species, if indeed they are really distinct, can only be settled by further research.

OPHRYOTROCHA PUERILIS Claparède and Mecznikow: *McIntosh*, Mon. Brit. Ann. II. 2, 1910, p. 364.

PLYMOUTH. Frequently met with in dredgings from the Sound, especially from Asia Shoal. Sometimes very numerous in dredgings from the Cattewater. Often common in the Laboratory tanks.

Breeding: August (W.G.). Spawned in tanks, May (A.J.S.).

TORQUAY. Frequent on the sides of glass vessels containing roots and pieces of rock. A small aquarium was found to be swarming with this species (Elwes, Journ. M.B.A., vol. 9, 1910, p. 61).

LUMBRICONEREIS FRAGILIS O. F. Müller: *McIntosh*, Mon. Brit. Ann. II. 2, 1900, p. 372.

PLYMOUTH. Two specimens (both incomplete) from a depth of 47–49 fms. S.S.W. of the Eddystone are provisionally referred to this species by Crawshay (Journ. M.B.A., vol. 9, 1912, p. 342).

Southern (Proceed. R. Irish Acad. XXXI. 47, 1914, p. 85) thinks that *L. fragilis* O. F. Müller and *L. impatiens* Claparède may prove to be identical.

LUMBRICONEREIS LATREILLI Audouin and Edwards: *McIntosh*, Mon. Brit. Ann. II. 2, 1910, p. 376.

PLYMOUTH. Shores of the Sound between tide-marks (Drake's Island, Mount Edgcumbe, Rum Bay); amongst dredgings from Millbay Channel, Asia Shoal, Queen's Ground, Yealm River and Eddystone Grounds.

SALCOMBE. A number of specimens on the west side of the harbour under the Marine Hotel. A few were found in other parts of the estuary (Journ. M.B.A., vol. 6, 1900, p. 191).

TORQUAY. Three or four in rather coarse gravel on Babbacombe Beach (Journ. M.B.A., vol. 9, 1910, p. 61).

LUMBRICONEREIS IMPATIENS Claparède: *McIntosh*, Mon. Brit. Ann. II. 2, 1910, p. 379.

PLYMOUTH. Occurs in dredge and trawl material from the Rame-Eddystone, Looe-Eddystone and Mewstone Grounds, especially from gravel; very abundant on Queen's Ground in the spring of 1903.

ARABELLA (MACLOVIA) IRICOLOR (Montagu): *McIntosh*, Mon. Brit. Ann. II. 2, 1910, p. 395.

PLYMOUTH. Occasional specimens at low-water mark on the shores of the Sound and Wembury Bay.

Salcombe. In muddy gravel on the west side of the Salstone and in sand near the mouth of the harbour. Interesting as being the locality in which Montagu chiefly collected (Journ. M.B.A., vol. 6, 1900, p. 191).

Onuphis britannica McIntosh : Mon. Brit. Ann. II. 2, 1910, p. 404.

Plymouth. On coarse shell-gravel grounds, in depths from 20 to 30 fms. off the Mewstone, off Stoke Point, South of Rame Head and off the Eddystone (E.J.A., R.A.T.).

Recorded in the former list as *O. conchilega* M. Sars.

Crawshay found it at several positions S.S.W. of the Eddystone in depths of 42–44 fms. (Journ. M.B.A., vol. 9, 1912, p. 342, as *O. conchilega*).

Hyalinœcia sicula Quatrefages : *McIntosh*, Mon. Brit. Ann. II. 2, p. 417 (=*H. bilineata* Baird).

Plymouth. Dredged from shell-gravel ground off Yealm Head.

Hyalinœcia tubicola (O. F. Müller) : *McIntosh*, Mon. Brit. Ann. II. 2, 1910, p. 419.

Plymouth. Common on muddy-gravel grounds from 20 to 30 fms. : off the Mewstone, Rame-Eddystone and Eddystone Grounds (E.J.A., R.A.T.).

Common and widely distributed on the area S.S.W. of the Eddystone at depths of 40–52 fms. (*Crawshay*, Journ. M.B.A., vol. 9, 1912, p. 342).

Eunice harassi Audouin and Edwards : *Fauvel*, Résult. Camp. Sci. Monaco, Fas. XLVI. Annél. Polych., 1914, p. 134. *McIntosh*, Mon. Brit. Ann. II. 2, 1910, p. 425 as *E. fasciata* Risso.

Plymouth. On the shore, Drake's Island, Rum Bay, Breakwater (R.A.T., E.J.A.) : Wembury Bay (E.J.A.). In dredgings from Duke Rock (W.G., T.V.H.) : Queen's Ground, Asia Shoal, Millbay Channel (R.A.T., E.J.A.) : south of Breakwater Fort (W.G.) : Rame-Eddystone Grounds.

Crawshay obtained three specimens S.S.W. of the Eddystone in 40–42 fms. (Journ. M.B.A., vol. 9, 1912, p. 342).

The synonymy of this species has recently been revised by Fauvel. He gives reasons for considering that the *E. Harassii* described by Claparède and Ehlers and probably also *E. fasciata* Risso are not the present species but *E. torquata* Quatrefages.

Eunice vittata Delle Chiaje : *McIntosh*, Mon. Brit. Ann. II. 2, 1910, p. 431.

Plymouth. McIntosh (*loc. cit.*) gives Plymouth as a locality on the authority of C. S. Bate, and Polperro on that of W. Baird. One specimen was dredged by Crawshay 16 miles S. 25° W. of the Eddystone in 42 fms. (Journ. M.B.A., vol. 9, 1912, p. 342).

Marphysa sanguinea (Montagu) : *McIntosh*, Mon. Brit. Ann. II. 2, 1910, p. 442.

PLYMOUTH. Frequent on the shore in crevices of rock, especially on the bridge between Drake's Island and Mount Edgcumbe; also Rum Bay, Wembury Bay and Yealm Estuary (W.G., T.V.H., R.A.T., E.J.A.).

SALCOMBE. A few specimens were found in different parts of the harbour. Interesting as being the locality in which Montagu chiefly collected (Journ. M.B.A., vol. 6, 1900, p. 191).

EXMOUTH. One specimen from Orcombe Rocks (Journ. M.B.A., vol. 6, 1902, p. 318).

MARPHYSA BELLI (Audouin and Edwards): *McIntosh*, Mon. Brit. Ann. II. 2, 1910, p. 448.

PLYMOUTH. On the shore between tide-marks, N. side of Drake's Island and Rum Bay: very common in the *Zostera* beds at the mouth of the Yealm River.

SALCOMBE. Specimens were obtained on the Salstone and near the mouth of Salcombe Harbour (under Marine Hotel) (Journ. M.B.A., vol. 6, 1900, p. 191).

NEMATONEREIS UNICORNIS (Grube): *McIntosh*, Mon. Brit. Ann. II. 2, 1910, p. 453.

PLYMOUTH. Between tide-marks, N. side of Drake's Island, Mount Edgcumbe and Yealm Sand-bank. Amongst dredgings from Queen's Ground, Asia Shoal and Millbay Channel.

TORQUAY. Fairly common in the limestone rocks at Babbacombe (*Elwes*, Journ. M.B.A., vol. 9, 1910, p. 61).

LYSIDICE PUNCTATA (Risso): *McIntosh*, Mon. Brit. Ann. II. 2, 1910, p. 456.

PLYMOUTH. Frequent in Plymouth Sound, on the shore between tide-marks (Rum Bay, Drake's Island), and in dredgings (Asia Shoal, Millbay Channel, Queen's Ground). On the shore at Wembury Bay and Reny Rocks. Dredged in Yealm River. Recorded in former list as *L. ninetta* Aud. and Edw.

TORQUAY. Small specimens 30 to 50 mm. long, extremely common amongst Laminarian roots and limestone rocks (*Elwes*, Journ. M.B.A., vol. 9, 1910, p. 60 as *L. ninetta*).

SPHÆRODORIDÆ.

EPHESIA GRACILIS Rathke: *McIntosh*, Mon. Brit. Ann. III. 1, 1915, p. 47.

PLYMOUTH. Frequently met with from all dredging grounds in the Sound and outside to the Eddystone Grounds. Most common Millbay Channel and Asia Shoal. Also found on the shore between tide-marks, Drake's Island and Mount Edgcumbe.

Single specimens dredged on a number of grounds S.S.W. of

the Eddystone in 42–47 fms. by Crawshay (Journ. M.B.A., vol. 9, 1912, p. 343).

TORQUAY. Two or three from Meadfoot Beach (*Elwes*, Journ. M.B.A., vol. 9, 1910, p. 61).

EPHESIA PERIPATUS Claparède : *McIntosh*, Mon. Brit. Ann. III. 1, 1915, p. 50.

TORQUAY. Two specimens from Corbyn's Head (*Elwes*, Journ. M.B.A., vol. 9, 1910, p. 61).

SPHÆRODORUM MINUTUM (Webster and Benedict) : *Southern*, Proceed. Roy. Irish Acad. XXXI. 47, 1914, p. 90.

PLYMOUTH. Amongst Laminaria roots from Rum Bay ; a number of specimens. From material trawled in the Cattewater.

GLYCERIDÆ.

GONIADA MACULATA Oersted : *McIntosh*, Mon. Brit. Ann. II. 2, 1910, p. 462.

PLYMOUTH. Occasional specimens from the shores of the Sound. Dredged in fine mud in the Sound.

SALCOMBE. A few specimens from the shore near the mouth of the harbour on both sides. (Journ. M.B.A., vol. 6, 1900, p. 194).

GLYCERA LAPIDUM Quatrefages : *McIntosh*, Mon. Brit. Ann. II. 2, 1910, p. 477.

PLYMOUTH. Between tide-marks Wembury Bay and Drake's Island (in shell gravel) : dredged in shell gravel off the Mewstone and near Queen's Ground, not uncommon.

SALCOMBE. The species recorded as *Glycera capitata* dredged between the Salstone and Snape's Point is probably this form (Journ. M.B.A., vol. 6, 1900, p. 194).

TORQUAY. One specimen in the inner harbour of Torquay and one on the Babbacombe Beach (*Elwes*, Journ. M.B.A., vol. 9, 1910, p. 60).

GLYCERA SIPHONOSTOMA Delle Chiaje : *McIntosh*, Mon. Brit. Ann. II. 2, p. 482 (=*G. gigantea* Quatrefages).

PLYMOUTH. Between tide-marks, Drake's Island (W.G., R.A.T.). Mewstone *Amphioxus* ground.

Recorded in the former list as *Glycera gigantea* Quatrefages.

GLYCERA ALBA Blainville : *McIntosh*, Mon. Brit. Ann. II. 2, p. 486 (=*G. convoluta* Keferstein).

PLYMOUTH. The most common Glycera of the inshore waters. Between tide-marks Drake's Island, Jennycliff Bay, Yealm Estuary. In dredgings from Millbay Channel, Rame-Eddystone and Eddystone Grounds.

Recorded in the former list is *G. convoluta* Keferstein.

SALCOMBE. Nowhere abundant. Two or three specimens from the shore in Salcombe Harbour (Journ. M.B.A., vol. 6, 1900, p. 194, as *G. convoluta*).

EXMOUTH. Found occasionally on Bullhill Bank and on the gravel between Powderham and Starcross (Journ. M.B.A., vol. 6, 1902, p. 319, as *G. convoluta*).

TORQUAY. Fairly numerous in Tor Abbey Sands and at Livermead (*Elwes*, Journ. M.B.A., vol. 9, 1910, p. 60, as *G. convoluta*).

GLYCERA GOËSI Malmgren: *McIntosh*, Mon. Brit. Ann. II. 2, 1910, p. 491 (=*G. Mesnili* de St. Joseph).

PLYMOUTH. On the shore at Drake's Island, and in other parts of the Sound. Not uncommon. Dredged off Stoke Point and near the Eddystone.

This is the *G. Mesnili* of de St. Joseph. McIntosh considers it the same as *G. Goësi* of Malmgren, but this seems to me open to doubt, if Malmgren's figure of the gill is correct. Fauvel (Résult. Camp. Sci. Monaco, 1914, p. 203) adopts the synonym *G. Rouxii* Audouin and Edwards.

ARICIIDÆ.

ARICIA CUVIERI Audouin and Edwards: *McIntosh*, Mon. Brit. Ann. II. 2, 1910, p. 497.

PLYMOUTH. Occasional specimens dredged off the Mewstone.

ARICIA LATREILLI Audouin and Edwards: *McIntosh*, Mon. Brit. Ann. II. 2, 1910, p. 502.

EXMOUTH. Large specimens were moderately plentiful in the hard sand on the south of the Pole Sands (Journ. M.B.A., vol. 6, 1902, p. 321).

TORQUAY. In the sand at Tor Abbey Sands (*Elwes*, Journ. M.B.A., vol. 9, 1910, p. 61).

SCOLOPLOS ARMIGER (O. F. Müller): *McIntosh*, Mon. Brit. Ann. II. 2, 1910, p. 510.

PLYMOUTH. In dirty sand and between layers of shale at Rat Island (Hamoaze) (W.G.). In sand at Drake's Island, Rum Bay and the Yealm Estuary.

SALCOMBE. A few specimens were found in the *Zostera* banks near the mouth of the harbour, on both the east and west sides (Journ. M.B.A., vol. 6, 1900, p. 194).

EXMOUTH. Not uncommon in sand on all the banks in the upper part of the estuary (Journ. M.B.A., vol. 6, 1902, p. 321).

SPIONIDÆ.

NERINE FOLIOSA (Audouin and Edwards): *McIntosh*, Mon. Brit. Ann. III. 1, 1915, p. 142.

PLYMOUTH. Wembury Bay (T.V.H.). In sand between tide-marks on the east side of Drake's Island, on the eastern side of the Sound, on Kingsand Beach (Cawsand Bay), Yealm Sand-bank, occasional specimens at each locality.

Recorded in the former list as *N. coniocephala* Johnston.

SALCOMBE. One specimen from the shore on the east side of the harbour (Journ. M.B.A., vol. 6, 1900, p. 194, as *N. coniocephala*).

TEIGNMOUTH. In sand in the estuary.

EXMOUTH. Several specimens were obtained in the sand west of Salthouse Lake and in the hard clayey mud to the north of it (Journ. M.B.A., vol. 6, 1902, p. 320, as *N. coniocephala*).

NERINE CIRRATULUS (Delle Chiaje): *McIntosh*, Mon. Brit. Ann. III. 1, 1915, p. 148.

PLYMOUTH. In fine gravel between tide-marks on the eastern side of Plymouth Sound, occasional specimens only.

SALCOMBE. One specimen was obtained on the shore on the west side of the harbour, under the Marine Hotel (Journ. M.B.A., vol. 6, 1910, p. 194).

EXMOUTH. Bullhill Bank and Cocklesands (Journ. M.B.A., vol. 6, 1902, p. 321).

TORQUAY. Tor Abbey Sands; not numerous (*Elwes*, Journ. M.B.A., vol. 9, 1910, p. 62).

SCOLECOLEPIS VULGARIS (Johnston): *McIntosh*, Mon. Brit. Ann. III. 1, 1915, p. 156 (=*S. Girardi* Quatrefages).

PLYMOUTH. Occasional specimens only from Rum Bay.

Recorded in the former list as *Scolelepis Giardi* (de Quatrefages), a misprint for *S. Girardi*.

TORQUAY. At the west end of Tor Abbey Sands; rare (*Elwes*, Journ. M.B.A., vol. 9, 1910, p. 62).

There is considerable difficulty as to the proper names to give to this and the following species. I have in this list followed *McIntosh's* monograph, though I feel some doubt as to whether the synonymy adopted by him is correct. Mesnil (Bull. Sci. France et Belg. XXIX. 1896) and de St. Joseph (Ann. Sci. Nat. Zool. XVII. 1894, p. 77) were both unable to satisfy themselves of the identity of *S. vulgaris* (Johnston) with *S. Girardi* (Quatrefages). Johnston no doubt had before him the common British species, inhabiting "the shore between tide-marks, ascending tidal rivers as far as the water is made brackish." Speaking of *N. coniocephala* he says, "This species inhabits our shores at low-water mark, and is seldom found with the preceding

(i.e. *N. vulgaris*), *which loves a station higher up*" (Cat. Brit. Mus. 1865, pp. 200 and 201). In the south-west of England this account of the habitat applies not to *S. Girardi*, but to *S. fuliginosa*, which is the common shore and estuarine form, occurring in very large numbers, whereas isolated specimens of *S. Girardi* are only very occasionally found. On the west coast of Ireland, Southern (Proceed. R. Irish Acad. XXXI. 47, 1914, p. 96) found *S. vulgaris* of McIntosh (=*S. Girardi* of Mesnil) generally living in sand, rarely in Laminaria roots, and it was never abundant. *S. fuliginosa* was common locally in Blacksod Bay, but not widely distributed. Mesnil (*loc. cit.* p. 146) thinks it probable that the *S. vulgaris* of Cunningham and Ramage, which was abundant in the Firth of Forth, is *S. fuliginosa*, and that *S. fuliginosa* is the common species at Heligoland.

Scolecolepis fuliginosa (Claparède): *McIntosh*, Mon. Brit. Ann. III. 1, 1915, p. 160.

Plymouth. Very numerous in places in black mud at Rum Bay, Wembury Bay and Yealm Estuary.

Recorded in former list as "*Scolelepis vulgaris* Johnston (probably the same as *S. fuliginosa* Claparède, *var. macrochæta major* of Mesnil)."

Salcombe. One small one dredged between Salstone and Snape's Point (Journ. M.B.A., vol. 6, 1900, p. 194, as *Nerine vulgaris* Johnston).

Torquay. Very numerous at west end of Tor Abbey Sands and at Livermead. In December numbers were found coiled up together under stones (*Elwes*, Journ. M.B.A., vol. 9, 1910, p. 62)

Scolecolepis (Laonice) cirrata (Sars): *McIntosh*, Mon. Brit. Ann. III. 1, 1915, p. 164.

Plymouth. McIntosh (*loc. cit.*) gives Plymouth as a locality on the authority of Spence Bate and Brooking Rowe. I have not seen any specimens from this neighbourhood.

Spiophanes bombyx (Claparède): *McIntosh*, Mon. Brit. Ann. III. 1, 1915, p. 182.

Torquay. A few specimens at the east end of Tor Abbey Sands (*Elwes*, Journ. M.B.A., vol. 9, 1910, p. 62).

Aonides oxycephala (Sars): *McIntosh*, Mon. Brit. Ann. III. 1, 1915, p. 186.

Plymouth. In the *Zostera* bed at low-water mark, eastern shore of Yealm mouth, very numerous. Yealm Sand-bank, occasional specimens. Rum Bay and Wembury Bay in crevices of shale. In sand at Wembury Bay.

Torquay. Numerous in rather foul mud under stones at Livermead (*Elwes*, Journ. M.B.A., vol. 9, 1910, p. 62).

Teignmouth. From sand in the estuary.

Spio filicornis Fabricius : *McIntosh*, Mon. Brit. Ann. III. 1, 1915, p. 172.

Plymouth. In fine, clean sand at Wembury Bay, at low tide.

The head of the living worm was conical, the point being used in attempts to burrow. The point could be bent downwards into the shape of a hook.

Pygospio elegans Claparède : *McIntosh*, Mon. Brit. Ann. III. 1, 1915, p. 189.

Plymouth. Forming tubes in very fine sand near the mouth of the Yealm River.

Breeding : March.

Exmouth. In the clean hard sand of the estuary. Not found on the more exposed Pole Sands (Journ. M.B.A., vol. 6, 1902, p. 320).

Teignmouth. Abundant in sand below Shaldon Bridge.

Pygospio seticornis (Oersted) : *Mesnil*, Bull. Sci. France et Belg. XXX. 1897, p. 85 ; *Cunningham and Ramage*, Trans. Roy. Soc. Edinburgh, XXXIII. 1888, p. 640.

Salcombe. Abundant on the shore under the Marine Hotel, forming long, slender tubes or galleries of mucus covered with sand grains (Journ. M.B.A., vol. 6, 1900, p. 194).

Exmouth. In clean hard sand in the estuary (Journ. M.B.A., vol. 6, 1902, p. 320).

The gills on the second setigerous segment are still very conspicuous and unmistakable in some of the preserved specimens which have recently been re-examined. Mesnil (*loc. cit.*) thinks that this form is not the *Spio seticornis* of Fabricius. Excepting for the presence of the gills on the second setigerous segment the species very closely resembles *Pygospio elegans* of Claparède.

Polydora ciliata (Johnston) : *McIntosh*, Mon. Brit. Ann. III. 1, 1915, p. 198.

Plymouth. Boring in limestone of the Breakwater and in limestone dredged in Millbay Channel. Boring in shells of Purpura and Littorina from Yealm Sand-bank. Frequently found in oyster shells.

Torquay. Very numerous in the small pools in the limestone boulders on the shore (*Elwes*, Journ. M.B.A., vol. 9, 1910, p. 62).

Polydora flava Claparède : *McIntosh*, Mon. Brit. Ann. III. 1, 1915, p. 205.

Plymouth. At Rum Bay and Rat Island (Hamoaze), common in crevices of shale (W.G.). In holes in limestone below the Laboratory and in dredgings from Yealm River.

Breeding : February (W.G.).

Torquay. Numerous on rocks and in pools (*Elwes*, Journ. M.B.A., vol. 9, 1910, p. 62).

Polydora caeca (Oersted) : *Mesnil*, Bull. Sci. France et Belg. XXIX. 1896, p. 191.

PLYMOUTH. Eddystone Grounds (T.V.H.). On the shore at Rum Bay in crevices of shale.

POLYDORA HOPLURA Claparède: *McIntosh*, Mon. Brit. Ann. III. 1, 1915, p. 212.

PLYMOUTH. Boring in limestone of the Plymouth Breakwater.

MAGELONA PAPILLICORNIS Fr. Müller: *McIntosh*, Mon. Brit. Ann. III. 1, 1915, p. 223.

PLYMOUTH. In fine sand near low-water mark at Jennycliff Bay, under Batten Castle, on the south shore of Yealm Estuary, and in Wembury Bay.

Larvæ in townets in July and August (E.J.A.); in September (E.J.B.).

TORQUAY. One example at a very low spring tide on Tor Abbey Sands (*Elwes*, Journ. M.B.A., vol. 9, 1910, p. 62).

DISOMIDÆ.

POECILOCHÆTUS SERPENS Allen: Quart. Journ. Micr. Sci. vol. XLVIII. 1904, p. 79.

PLYMOUTH. In sand at low tide south of Batten Castle; larvæ not uncommon in the plankton during the summer months.

Adults have since been found by Southern in sand on the shore of Lough Swilly (Proceed. Roy. Irish Acad. XXXI. 47, 1914, p. 105).

CHÆTOPTERIDÆ.

CHÆTOPTERUS VARIOPEDATUS (Renier): *McIntosh*, Mon. Brit. Ann. III. 1, 1915, p. 120.

PLYMOUTH. Common in muddy gravel on the Eddystone Grounds, Rame-Eddystone and Looe-Eddystone Grounds (E.J.A.); occasional specimens Duke Rock (T.V.H.); Asia Shoal (R.A.T.), Millbay Channel (R.A.T., E.J.A.) and Mewstone *Echinoderm* Ground (R.A.T.): Stoke Point Grounds (S.P.). A few specimens at a number of positions S.S.W. of the Eddystone in depths of 40–51 fms. were taken by Crawshay (Journ. M.B.A., vol. 9, 1912, p. 343).

Larvæ in townettings July to October (W.G.).

Breeding. Ripe eggs and sperm in July (A.J.S., E.J.A.).

SALCOMBE. Found on the shore at extreme low water on the west side of the Salstone and on the *zostera* bank near the mouth of the harbour on the western side. (Journ. M.B.A., vol. 6, 1900, p. 195).

PHYLLOCHÆTOPTERUS ANGLICA Potts: Proceed. Zool. Soc. London, 1914, p. 984.

PLYMOUTH. From material brought in by trawlers from some locality to the south of the Eddystone (*Potts, loc. cit.*).

AMMOCHARIDÆ.

Owenia fusiformis Delle Chiaje: *McIntosh*, Mon. Brit. Ann. III. 1, 1915, p. 356.

Plymouth. In fine sand near low-water mark at Jennycliff Bay and under Batten Castle.

Salcombe. In clean fine sand at Millbay (Journ. M.B.A., vol. 6, 1900, p. 195).

Teignmouth. In sand below Shaldon Bridge on the east side.

Torquay. Very numerous in Tor Abbey Sands (*Elwes*, Journ. M.B.A., vol. 9, 1910, p. 62).

CIRRATULIDÆ.

Cirratulus (Audouinia) tentaculatus (Montagu): *McIntosh*, Mon. Brit. Ann. III. 1, 1915, p. 242.

Plymouth. Common in gravel and sand just below high-water mark on all shores both inside and outside the Sound, excepting on open sandy beaches. Occasional small specimens dredged in shallow water amongst the roots of weeds.

Salcombe. Very common all over the estuary above half-tide mark, wherever the soil contains much mud mixed either with gravel or sand (Journ. M.B.A., vol. 6, 1900, p. 194).

Exmouth. One specimen only was obtained from Orcombe Rocks quite at the mouth of the estuary. The entire absence of the species from the estuary itself is noteworthy (Journ. M.B.A., vol. 6, 1902, p. 320).

Torquay. Numerous at Meadfoot, Hope's Nose and Tor Abbey Sands in rather foul mud (*Elwes*, Journ. M.B.A., vol. 9, 1910, p. 63).

Cirratulus cirratus (O. F. Müller): *McIntosh*, Mon. Brit. Ann. III. 1, 1915, p. 249.

Plymouth. McIntosh (*loc. cit.* p. 250) gives Plymouth as a locality on the authority of Spence Bate and Brooking Rowe. I have obtained a number of specimens from crevices in the shale at Rum Bay, and from the shore below the Laboratory. Small specimens have been obtained from dredgings in the Cattewater and from scrapings of the piles in Millbay Dock.

Cirratulus norvegicus (Quatrefages): *Southern*, Proceed. Roy. Irish Acad. XXXI. 47, 1914, p. 107.

Plymouth. A specimen was obtained from crevices in the shale at Rum Bay. Mr. Southern has kindly confirmed the identification.

Dodecaceria concharum, Oersted: *McIntosh*, Mon. Brit. Ann. III. 1, 1915, p. 255.

Plymouth. Boring in limestone on Plymouth Breakwater,

abundant ; also in limestone below the Laboratory and from Millbay Channel.

TORQUAY. Very numerous in the limestone boulders at Babbacombe (*Elwes*, Journ. M.B.A., vol. 9, 1910, p. 63).

HETEROCIRRUS VIRIDIS (Langerhans) : *McIntosh*, Mon. Brit. Ann. III. 1, 1915, p. 261.

TORQUAY. Found occasionally in small pools in limestone rocks at Babbacombe (*Elwes*, Journ. M.B.A., vol. 9, 1910, p. 63).

HETEROCIRRUS CAPUT-ESOCIS de St. Joseph : *McIntosh*, Mon. Brit. Ann. III. 1, 1915, p. 263.

TORQUAY. Two or three found in small pools in limestone rocks at Babbacombe (*Elwes*, Journ. M.B.A., vol. 9, 1910, p. 63).

TEREBELLIDÆ.

AMPHITRITE GRACILIS GRUBE : *de St. Joseph*, Ann. Sci. Nat. Zool. XVII. 1894, p. 198.

PLYMOUTH. Common in sand between tide-marks and between layers of shale in Rum Bay and at Mount Edgcumbe, Yealm Sandbank and Wembury Bay. Dredged at Millbay Channel and Eddystone Grounds.

AMPHITRITE JOHNSTONI Malmgren : *de St. Joseph*, Ann. Sci. Nat. Zool. V. 1898, p. 421.

PLYMOUTH. In sand and gravel near low-water mark along the southern shore of the Yealm River ; most common on the east shore where the stream divides (R.A.T., E.J.A.). Occasional specimens from Rum Bay.

SALCOMBE. Very abundant on the Salstone, especially on the north-east and south-east sides. Occasionally met with on the shore in all parts of the Kingsbridge Estuary and Salcombe Harbour, being abundant on the western shore near the mouth of the harbour (under Marine Hotel) (Journ. M.B.A., vol. 6, 1900, p. 195).

AMPHITRITE EDWARDSI Quatrefages : *de St. Joseph*, Ann. Sci. Nat. Zool. XVII. 1894, p. 186.

SALCOMBE. In the *Zostera* banks near the mouth of Salcombe Harbour, being especially abundant on the western side (under Marine Hotel). In the latter locality *A. Johnstoni* is also found, but is more abundant at a somewhat lower tidal level. *A. Edwardsi* was never found in the Kingsbridge Estuary, where *A. Johnstoni* was common.

The burrows of *A. Edwardsi* were generally occupied by the Polynoid *Lepidasthenia argus* (Journ. M.B.A., vol. 6, 1900, p. 196).

TEREBELLA (LEPRÆA) LAPIDARIA Linn. : *de St. Joseph*, Ann. Sci. Nat. Zool. XVII. 1894, p. 202.

PLYMOUTH. Common in crevices of shale at Rum Bay (R.A.T., E.J.A.).

POLYMNIA NEBULOSA (Montagu): *de St. Joseph*, Ann. Sci. Nat. Zool. XVII. 1894, p. 219.

PLYMOUTH. Very common between tide-marks at Mount Edgcumbe (R.A.T., E.J.A.): occasional specimens on the shore at Rum Bay and in dredgings from Millbay Channel, Asia Shoal, Queen's Ground and Yealm River (R.A.T., E.J.A.): Eddystone Grounds (T.V.H.).

Dredged by Crawshay at a number of stations S.S.W. of the Eddystone in 40–50 fms. (Journ. M.B.A., vol. 9, 1912, p. 343).

SALCOMBE. Dredged in the channel west of the Salstone (Journ. M.B.A., vol. 6, 1900, p. 197).

EXMOUTH. A few specimens from Exmouth Dock and from dredging material from the sponge ground below the pier (Journ. M.B.A., vol. 6, 1902, p. 321).

TORQUAY. Occasional specimens at Corbyn's Head and in rocks between Oddicombe and Babbacombe beaches (*Elwes*, Journ. M.B.A., vol. 9, 1910, p. 63).

POLYMNIA NESIDENSIS (Delle Chiaje): *de St. Joseph*, Ann. Sci. Nat. Zool. XVII. 1894, p. 225.

PLYMOUTH. Between tide-marks at Rum Bay, Mount Edgcumbe, Wembury Bay: dredged at Asia Shoal, Yealm River and Cawsand Bay.

One specimen dredged S.S.W. of the Eddystone by Crawshay at a depth of 49 fms. (Journ. M.B.A., vol. 9, 1912, p. 343).

TORQUAY. Very common in Laminaria roots, etc. (*Elwes*, Journ. M.B.A., vol. 9, 1910, p. 63).

LANICE CONCHILEGA (Pallas): *de St. Joseph*, Ann. Sci. Nat. Zool. XVII. 1894, p. 211.

PLYMOUTH. Common on sandy shores inside and outside the Sound; occasionally dredged on Queen's Ground; Eddystone Grounds (T.V.H., R.A.T., E.J.A.).

Empty tubes were dredged by Crawshay S.S.W. of the Eddystone at depths from 42 to 49 fms. (Journ. M.B.A., vol. 9, 1912, p. 343).

SALCOMBE. Extremely abundant in patches of clean sand near the mouth of the harbour on both sides, and in sheltered parts of sandy bays outside the harbour. Found only occasionally in the upper parts of the estuary (Journ. M.B.A., vol. 6, 1900, p. 196).

EXMOUTH. Very common on the banks in the estuary, where there was a large proportion of gravel mixed with clean sand (Journ. M.B.A., vol. 6, 1902, p. 321).

TORQUAY. Numerous on Tor Abbey Sands, especially at the east end (*Elwes*, Journ. M.B.A., vol. 9, 1910, p. 63).

NICOLEA VENUSTULA (Montagu) ? *de St. Joseph*, Ann. Sci. Nat. Zool. XVII. 1894, p. 207. *Marenzeller*, Sitzb. Kg. Akad. der. Wiss. zu Wien, Bd. 89, 1884, p. 195.

ENGLISH CHANNEL. Seven specimens obtained 32 miles S. of Start Point (40–43 fms.).

Dredged by Crawshay at a number of stations S.S.W. of the Eddystone at depths of 42–50 fms. (*Crawshay*, Journ. M.B.A., vol. 9, 1912, p. 343).

These specimens from the deeper water of the Channel all have 17 bundles of bristles on each side.

The difference between this and the next species (*Nicolea zostericola* (Oersted) Malmgren) is discussed by de St. Joseph and by Crawshay (*loc. cit.* p. 344). *N. venustula* as described by de St. Joseph has 17 setigerous segments, whereas *N. zostericola* as described by Malmgren has 15 only.

McIntosh (Ann. Mag. Nat. Hist., vol. 15, 1915, p. 20) describes *N. venustula* as having 15 bristle-bundles on each side, which would make the form described by him agree with *N. zostericola*.

Fauvel (Résult. Camp. Scient. Monaco, Fasc. XLVI. Annél. Polych. 1914, p. 299) has found both the form with 15 setigerous segments and that with 17 such segments. He considers them as the same species and adopts the name *N. venustula* (Montagu).

NICOLEA ZOSTERICOLA (Oersted): *Malmgren*, Nordiska Hafs-Annulater, Öfer. K. Vet. Akad. Förh., 1865, p. 381.

PLYMOUTH. Common between tide-marks on Reny Rocks; less frequent on the north side of Drake's Island. Also obtained from dredgings in Yealm River.

This species has 15 bundles of bristles on each side, and so far has only been recognised from the shore and shallow inshore waters. For comparison with *N. venustula* see note to that species.

THELEPUS CINCINNATUS (Fabricius): *Marenzeller*, Adriat. Annel. Sitzb. K. Akad. der Wiss. zu Wien, Bd. 89, 1884, p. 205.

PLYMOUTH. Common on the trawling grounds in the neighbourhood of the Eddystone (20 to 40 fms.).

Obtained by Crawshay at a number of stations S.S.W. of the Eddystone in depths of 40 to 50 fms. (Journ. M.B.A., vol. 9, 1912, p. 344).

If the number of pairs of gills (gills on two segments) is taken as the main character of the species, rather than the shape of the uncini, which seems variable, the species most commonly met with is *T. cincinnatus*, and not *T. setosus*, Quatrefages, as entered in the former list. It is probable that *T. setosus* also occurs in small numbers, but the matter requires re-investigation.

SALCOMBE. It is doubtful whether the species found at Salcombe should be assigned to *T. setosus* or to *T. cincinnatus* (Journ. M.B.A., vol. 6, 1900, p. 197).

POLYCIRRUS CALIENDRUM Claparède : *de St. Joseph*, Ann. Sci. Nat. Zool. XVII. 1894, p. 237.

PLYMOUTH. Common in dredgings from all parts of the Sound, especially in Millbay Channel. Dredged also in Yealm River. Occasional specimens amongst weeds and Laminaria roots from the shore.

In the former list two species *P. aurantiacus* Grube and *P. caliendrum* Claparède were recorded. The specimens included under the former name were those which are generally of large size and of a bright scarlet red colour. They have, however, three large pairs of nephridia and three small pairs as in *P. caliendrum*. The typical specimens of *P. caliendrum*, which were referred to in the former list, are of various shades of yellow, some being quite pale. They have six pairs of nephridia arranged as in the bright red form. I am inclined to agree with Southern's suggestion (Proceed. R. Irish Acad. XXXI. 47, 1914, p. 127) that *P. aurantiacus* and *P. caliendrum* may be identical, in which case the name *P. aurantiacus* Grube should have precedence. *McIntosh's* recent description of *P. aurantiacus* Grube (Ann. Mag. Nat. Hist. XV. 1915, p. 33) would appear to apply to the species now under discussion, and he speaks of a red variety.

SALCOMBE. Both varieties dredged between Salstone and Snape's Point (Journ. M.B.A., vol. 6, 1900, p. 197).

POLYCIRRUS HÆMATODES (Claparède) : *de St. Joseph*, Ann. Sci. Nat. Zool. XVII. 1894, p. 241.

PLYMOUTH. Not uncommon in dredgings from the Sound, especially from Millbay Channel and Asia Shoal. It is much less numerous than *P. caliendrum*.

LOIMIA MEDUSA (Savigny) : *Malmgren*, Nord. Hafs-Annul. 1865, p. 380, Pl. XXV ; Ann. Polych. 1867, p. 217, Pl. XIV.

PLYMOUTH. Amongst shell gravel near low-water mark on the north side of Drake's Island ; from the shore in Yealm River. Tubes dredged on Queen's Ground.

TEREBELLIDES STRŒMI, Sars : *Malmgren*, Nord. Hafs-Annul. 1865, p. 396.

PLYMOUTH. One specimen dredged four miles S.W. by S. of Rame Head.

AMPHARETIDÆ.

MELINNA ADRIATICA Marenzeller : Adriatische Anneliden. Sitzb. Akad. Wien, Bd. 69, 1874, p. 472.

PLYMOUTH. Very common in soft mud in Plymouth Sound. Found both on the shore at low water and also by dredging.

SALCOMBE. In fine mud in the upper parts of Salcombe and Kingsbridge Estuary in very great abundance. Probably the *Sabella curta* of Montagu (Journ. M.B.A., vol. 6, 1900, p. 197).

EXMOUTH. Only a few scattered specimens were found in the estuary (Journ. M.B.A., vol. 6, 1902, p. 322).

TORQUAY. Two at extreme low water at Livermead amongst *Zostera* roots (*Elwes*, Journ. M.B.A., vol. 9, 1910, p. 64).

AMPHICTEIS GUNNERI Sars: *Fauvel*, Résult. Camp. Sci. Monaco, Fas. XLVI. Annél. Polych. 1914, p. 281.

PLYMOUTH. One specimen dredged four miles S.W. by S. of Rame Head.

Recorded in the former list as *A. curvipalea* Claparède, which Fauvel has shown to be identical with *A. Gunneri* Sars.

AMPHICTENIDÆ.

PECTINARIA (LAGIS) KORENI Malmgren: *de St. Joseph*, Ann. Sci. Nat. Zool. V. 1898, p. 405.

PLYMOUTH. Common in sand near low-water mark south of Batten Castle.

SALCOMBE. Two specimens recorded as *P. belgica* from the shore may be this species (Journ. M.B.A., vol. 6, 1900, p. 198).

PECTINARIA (AMPHICTENE) AURICOMA (Müller): *Malmgren*, Nord. Hafs-Annulat. 1865, p. 357.

PLYMOUTH. Eddystone Grounds (T.V.H.).

PECTINARIA (PETTA) PUSILLA Malmgren: Nord. Hafs-Annul. 1865, p. 361. *Fauvel*, Résult. Camp. Sci. Monaco, Fasc. XLVI. Annél. Polych. 1914, p. 279.

PLYMOUTH. Two specimens dredged by Crawshay S.S.W. of the Eddystone in 42 fms. (Journ. M.B.A., vol. 9, 1912, p. 346).

CAPITELLIDÆ.

NOTOMASTUS LATERICEUS Sars: *McIntosh*, Mon. Brit. Ann. III. 1, 1915, p. 276.

PLYMOUTH. On the shore in black, muddy sand near low-water mark in the upper parts of the Yealm Estuary. Occasional specimens from the shore at Rum Bay and Wembury Bay.

SALCOMBE. One of the commonest Polychætes of the shores of the estuary. Especially abundant and large in the fine mud in the upper parts of the estuary (Journ. M.B.A., vol. 6, 1900, p. 194).

TORQUAY. Under stones, Corbyn's Head and Livermead (*Elwes*, Journ. M.B.A., vol. 9, 1910, p. 64).

NOTOMASTUS RUBICUNDUS Keferstein: *Eisig*, Die Capitelliden des Golfes von Neapel, 1887, p. 863.

PLYMOUTH. In fine clean sand on the north and south shores

of the Yealm Estuary, near the mouth. In fine clean sand at Wembury Bay.

Prof. McIntosh considers that these are young *N. latericeus*. The appearance of the living worms is, however, quite distinct, and both the habits and the habitat of the two forms are different. *N. latericeus* burrows by constantly protruding the proboscis and when examined alive it is continually performing this movement. In the case of *N. rubicundus*, although many specimens have been watched, I have never yet seen the proboscis protruded.

Capitella capitata (Fabricius): *McIntosh*, Mon. Brit. Ann. III. 1, 1915, p. 280.

Plymouth. Common in black mud from between tide-marks, Wembury Bay and Rum Bay.

Heteromastus filiformis Claparède: *Eisig*, Die Capitelliden des Golfes von Neapel, 1887, p. 839.

Exmouth. A few specimens in the sand west of Salthouse Lake (Journ. M.B.A., vol. 6, 1902, p. 320).

OPHELIIDÆ.

Ophelia bicornis Savigny: *de St. Joseph*, Ann. Sci. Nat. Zool. V. 1898, p. 380.

Exmouth. Very abundant in clean sand on the Pole Sands. Occasionally met with on other sand-banks (Journ. M.B.A., vol. 6, 1902, p. 321).

A considerable number of specimens have recently been examined and they have been compared with typical specimens of *O. limacina* Rathke from the North Sea. The distinguishing characters described by de St. Joseph are remarkably constant and there is no doubt that the two species are quite distinct. The list of synonyms of *O. limacina* given by McIntosh (Mon. III. 1, 1915, p. 10) therefore requires revision in the sense indicated by de St. Joseph. In the first region of the body of *O. bicornis* there are 9 setigerous segments, then follow 15 setigerous segments bearing gills or dorsal processes, and behind these five setigerous segments without gills, and one achetous anal segment. A constant character of the species not mentioned by de St. Joseph is a lateral, vertical, glandular fold of skin, which lies immediately in front of the 9th parapodium. The lips of the parapodia are much less strongly developed than in *O. limacina* and all the bristles are much shorter, more slender and inconspicuous. The lateral rows of pores immediately above the gills described by de St. Joseph in *Ophelia neglecta* Schneider, which are very conspicuous in the large specimens of *O. limacina* (cf. de St. Joseph, p. 379) are entirely absent in *O. bicornis*.

Ammotrypane aulogaster Rathke: *McIntosh*, Mon. Brit. Ann. III. 1, 1915, p. 15.

PLYMOUTH. Occasionally dredged in the Sound, and on the Mewstone shell gravel.

POLYOPHTHALMUS PICTUS Dujardin : *McIntosh*, Mon. Brit. Ann. III. 1, 1915, p. 21.

PLYMOUTH. On the shore between tide-marks Wembury Bay (A.J.S.) ; occasionally found on all rocky shores amongst the weed and coralline of tide pools.

TORQUAY. Common amongst Corallines, etc., in rock pools (*Elwes*, Journ. M.B.A., vol. 9, 1910, p. 64).

MALDANIDÆ.

MICROMALDANE ORNITHOCHÆTA Mesnil : Bull. Sci. France et Belg. XXX. 1897, p. 146. *Southern*, Proceed. R. Irish Acad. XXXI. 47, 1914, p. 134.

PLYMOUTH. Found once on the shore at Rum Bay.

NICOMACHE LUMBRICALIS (Fabricius) *var.* : *Arwidsson*, Zool. Jahrb. Abt. Systematik. Suppl. 9, Hft. 1, 1907, p. 86.

PLYMOUTH. One specimen was obtained amongst trawled material from the Rame-Eddystone Ground.

The specimen is in three pieces, but no portion seems to be missing. Its total length would be about 260 mm. There are 21 setigerous segments and *three* pre-anal achetous segments. The anal funnel resembles Arwidsson's figure. The anterior border of the head has not a broad, hemispherical outline, but is produced into a slight but distinct blunt projecting process. This is not the *Nicomache maculata* Arwidsson, which is the only British *Nicomache* recorded in recent publications by McIntosh and Southern.

CÆSICIRRUS NEGLECTUS Arwidsson : Proceed. Roy. Irish Acad. XXIX. B. 6, 1911, p. 217.

PLYMOUTH. In sand and amongst roots of *Zostera* at the mouth of the Yealm Estuary.

SALCOMBE. Common in the *Zostera* beds near the mouth of the estuary.

HETEROCLYMENE ROBUSTA Arwidsson : Zool. Jahrb. Abt. Systematik. Suppl. 9, Hft. 1, 1907, p. 227.

PLYMOUTH. Occasionally met with amongst trawled material from the Rame-Eddystone Grounds.

ARENICOLIDÆ.

ARENICOLA MARINA Linnaeus : *McIntosh*, Mon. Brit. Ann. III. 1, 1915, p. 59.

PLYMOUTH. In fine sand between tide-marks at Rum Bay,

Drake's Island, Mount Edgcumbe, Wembury Bay and Yealm River (T.V.H., R.A.T., E.J.A.).

Post-larval stages of *Arenicola* in townettings in February (W.G., W.B.B.) and March (E.J.A.).

SALCOMBE. Common in all parts of the harbour in sand or muddy sand (Journ. M.B.A., vol. 6, 1900, p. 195).

EXMOUTH. Very abundant in sand and gravel in the estuary (Journ. M.B.A., vol. 6, 1902, p. 321).

TORQUAY. Common on Tor Abbey Sands (*Elwes*, Journ. M.B.A., vol. 9, 1910, p. 64).

ARENICOLA ECAUDATA Johnston: *McIntosh*, Mon. Brit. Ann. III. 1, 1915, p. 72.

PLYMOUTH. With *A. branchialis* near the bases of rocks in a deposit composed of sand and small stones (F.W.G.); Rum Bay, in sand and gravel around the rocks below the Laboratory (R.A.T.); Wembury Bay (R.A.T., E.J.A.); Drake's Island (T.V.H.).

TORQUAY. Under stones in gravel at Hope's Nose and Babbacombe Beach (*Elwes*, Journ. M.B.A., vol. 9, 1910, p. 64).

ARENICOLA BRANCHIALIS Audouin and Edwards: *McIntosh*, Mon. Brit. Ann. III. 1, 1915, p. 78. *Ashworth*, Cat. Chætopoda Brit. Museum I. 1912, p. 141.

PLYMOUTH. With *A. ecaudata* near the bases of rocks in a deposit composed of sand and small stones (F.W.G.); Rum Bay, Wembury Bay, Drake's Island.

Recorded in the former list as *A. Grubei* Claparède.

SALCOMBE. One specimen only found in muddy gravel on the west side of the Salstone (Journ. M.B.A., vol. 6, 1900, p. 195 as *A. Grubii*).

SCALIBREGMIDÆ.

SCALIBREGMA INFLATUM Rathke: *McIntosh*, Mon. Brit. Ann. III. 1, 1915, p. 34.

PLYMOUTH. In muddy gravel at low water on the southern shore of the Yealm River, just below the junction of the two rivers; two specimens 10/9/00. No further specimens of this species have been taken.

SCLEROCHEILUS MINUTUS Grube: *McIntosh*, Mon. Brit. Ann. III. 1, 1915, p. 43.

PLYMOUTH. This species was formerly frequently taken in Millbay Channel dredgings, and occasionally in dredgings from Asia Shoal and off the Mewstone. During the last two or three years no specimens have been found in spite of special search for it.

CHLORHÆMIDÆ.

STYLARIOIDES (TROPHONIA) PLUMOSA (O. F. Müller): *McIntosh*, Mon. Brit. Ann. III. 1, 1915, p. 231.

PLYMOUTH. In dredgings from Millbay Channel and Asia Shoal, occasional specimens. Also dredged off Stoke Point.

FLABELLIGERA (SIPHONOSTOMA) AFFINIS Sars: *McIntosh*, Mon. Brit. Ann. III. 1, 1915, p. 107.

PLYMOUTH. Between tide-marks at Drake's Island (R.A.T., T.V.H., E.J.A.); Reny Rocks (R.A.T., E.J.A.); under Rame Head (T.V.H.); Wembury Bay (E.J.A., A.J.S.); in dredgings from Millbay Channel, Queen's Ground (R.A.T., T.V.H.); Mewstone Grounds (E.J.A., R.A.T.); on *Echinus acutus* (R.A.T.).

TORQUAY. Under stones at Corbyn's head (*Elwes*, Journ. M.B.A., vol. 9, 1910, p. 64).

SABELLIDÆ.

SABELLA PAVONINA (Savigny): *de St. Joseph*, Ann. Sci. Nat. Zool. XVII. 1894, p. 267.

PLYMOUTH. Common on the shore in Yealm River and also found in Yealm dredgings. Common on the shore in the Cattewater, near the entrance to Hooe Lake. Looe-Eddystone, Rame-Eddystone and Eddystone Grounds, common amongst hydroids and Cellaria.

Dredged by Crawshay S.S.W. of the Eddystone at a number of positions in depths of 40 to 51 fms. (Journ. M.B.A., vol. 9, 1912, p. 346).

Specimens from the deeper water are all small with the tube of very fine mud, compact and light coloured. Those on the shore attain a large size and the tube is much coarser.

Breeding: August and September (C.S.).

SALCOMBE. Very abundant on the shore at the Salstone, and on the mud in Kingsbridge Estuary south of Garston Point. Absent from the banks near the mouth of Salcombe Harbour (Journ. M.B.A., vol. 6, 1900, p. 198). These estuarine specimens were of large size.

TORQUAY. Large specimens from the inner harbour. (*Elwes*, Journ. M.B.A., vol. 9, 1910, p. 65).

BRANCHIOMMA VESICULOSUM (Montagu): *de St. Joseph*, Ann. Sci. Nat. Zool. XVII. 1894, p. 300.

PLYMOUTH. Occasional specimens on the shore, Yealm sand-bank and Rum Bay (R.A.T.): Drake's Island, south shore of Yealm near the mouth, Barn Pool, and shore south of Batten Castle.

SALCOMBE. In Salcombe Estuary where the soil is composed of gravel, abundant. It is found at a higher tidal level than *Sabella pavonina* and *Myxicola infundibulum*. Most numerous on the

Salstone and in the upper parts of Salcombe Harbour (Journ. M.B.A., vol. 6, 1900, p. 199).

Dasychone bombyx (Dalyell): *de St. Joseph*, Ann. Sci. Nat. Zool. XVII. 1894, p. 309.

Plymouth. Amongst Laminaria roots from the shores of the Sound and amongst Ascidians from Millbay Dock. Occurs on all the dredging grounds in the Sound, and outside to Eddystone Grounds.

Dredged by Crawshay at a number of positions S.S.W. of the Eddystone in depths of 40–49 fms. (Journ. M.B.A., vol. 9, 1912, p. 346).

Potamilla reniformis (O. F. Müller): *de St. Joseph*, Ann. Sci. Nat. Zool. XVII. 1894, p. 292.

Plymouth. Large specimens from the shore at Rum Bay and Jennycliff Bay in crevices of shale. Occurs also attached to rocks below the Laboratory, at Wembury Bay and other rocky shores. Not uncommon in holes in limestone from Plymouth Breakwater.

Torquay. On the sides of a cave at Petit Tor (*Elwes*, Journ. M.B.A., vol. 9, 1910, p. 65).

Potamilla Torelli Malmgren: *de St. Joseph*, Ann. Sci. Nat. Zool. XVII. 1894, p. 296.

Plymouth. Common in dredgings from Millbay Channel, Asia Shoal and Yealm River.

In the former list *Potamilla incerta* Langerhans, found in dredgings from the Yealm River, was recorded. Fauvel considers this form to be a young stage of *P. Torelli*.

Torquay. Common in small rock pools in the limestone rocks between Oddicombe and Babbacombe beaches (*Elwes*, Journ. M.B.A., vol. 9, 1910, p. 65).

Bispira volutacornis (Montagu): *de St. Joseph*, Ann. Sci. Nat. Zool. XVII. 1894, p. 286.

Plymouth. In cracks between rocks at extreme low-tide mark on Reny Rocks and in Jennycliff Bay.

Myxicola infundibulum (Renier): *de St. Joseph*, Ann. Sci. Nat. Zool. V. 1898, p. 433.

Plymouth. Found occasionally on the shore. North side of Drake's Island (R.A.T.); Barn Pool (E.J.A.); Ram's Cliff Point (S.P.).

Salcombe. Very frequent on all parts of the Salstone and on the *Zostera* flat immediately to the south of Pilworthy Point. Occasional specimens in the lower parts of Salcombe Harbour (Journ. M.B.A., vol. 6, 1900, p. 199).

Myxicola (Leptochone) æsthetica Claparède: Annél. Chétop. Naples, Supplément, 1870, p. 150.

Plymouth. Common in dredgings from Millbay Channel and

Asia Shoal. Occasional specimens in dredgings from all parts of the Sound. From the shore at Rum Bay in crevices of shale.

AMPHIGLENA MEDITERRANEA Leydig: *de St. Joseph*, Ann. Sci. Nat. Zool. XVII. 1894, p. 307.

PLYMOUTH. Amongst Laminaria roots from the rocks below the Laboratory. In crevices of shale at Wembury Bay.

TORQUAY. From roots of Laminaria and pieces of limestone rock (*Elwes*, Journ. M.B.A., vol. 9, 1910, p. 65).

JASMENEIRA ELEGANS de St. Joseph: Ann. Sci. Nat. Zool. XVII. 1894, p. 316.

PLYMOUTH. Amongst dredgings from Duke Rock and Asia Shoal.

TORQUAY. From roots of Laminaria and pieces of limestone rock (*Elwes*, Journ. M.B.A., vol. 9, 1910, p. 65).

FABRICIA SABELLA Ehrenberg: *de St. Joseph*, Ann. Sci. Nat. Zool. XVII. 1894, p. 319.

PLYMOUTH. Very abundant amongst mud scraped from piles at Millbay Dock.

Breeding. February.

TORQUAY. Very common in little pools in the rocks at Babbacombe (*Elwes*, Journ. M.B.A., vol. 9, 1910, p. 65).

ORIA ARMANDI Claparède: *de St. Joseph*, Ann. Sci. Nat. Zool. XVII. 1894, p. 321.

PLYMOUTH. Amongst Ascidians from the piles at Millbay Dock.

TORQUAY. One specimen from Babbacombe rock pools (*Elwes*, Journ. M.B.A., vol. 9, 1910 p. 65).

HAPLOBRANCHUS ÆSTUARIUS Bourne: Quart. Journ. Micr. Sci. XXIII. 1883, p. 169.

PLYMOUTH. In tide pools not far from the mouth of the Yealm (*Buchanan*, Rep. Brit. Assoc. 1892, p. 359).

SERPULIDÆ.

SERPULA VERMICULARIS Linnæus: *de St. Joseph*, Ann. Sci. Nat. Zool. XVII. 1894, p. 328.

PLYMOUTH. Occasional specimens in the Sound. In small numbers from Mewstone Grounds, Looe-Eddystone, Rame-Eddystone and Eddystone Grounds.

Obtained at a number of positions S.S.W. of the Eddystone in depths of 42 to 49 fms. (*Crawshay*, Journ. M.B.A., vol. 9, 1912, p. 346).

Large masses of this species were obtained by a diver somewhere in the Hamoaze and brought to the Laboratory.

Breeding. Specimens from Eddystone Grounds in August and September were ripe (C.S.).

TORQUAY. On shells thrown up on the shore at Tor Abbey Sands (*Elwes*, Journ. M.B.A., vol. 9, 1910, p. 66).

POMATOCEROS TRIQUETER (Linnæus): *de St. Joseph*, Ann. Sci. Nat. Zool. XVII. 1894, p. 353.

PLYMOUTH. Common, attached to shells and stones on all grounds from the shore to 30 fms.

Dredged by Crawshay at several positions S.S.W. of the Eddystone in depths of 42–51 fms. (Journ. M.B.A., vol. 9, 1912, p. 347).

SALCOMBE. Common in dredge material from Salcombe Harbour and the Kingsbridge Estuary (Journ. M.B.A., vol. 6, 1900, p. 199).

EXMOUTH. Found only at Orcombe Rocks, at the mouth of the estuary (Journ. M.B.A., vol. 6, 1902, p. 322).

TORQUAY. Extremely common on stones (*Elwes*, Journ. M.B.A., vol. 9, 1910, p. 66).

HYDROIDES NORVEGICA Gunnerus: *de St. Joseph*, Ann. Sci. Nat. Zool. V. 1898, p. 440.

PLYMOUTH. Common on stones and shells from the shore to 30 fms., increasing in abundance in the deeper water.

Dredged by Crawshay at a number of positions S.S.W. of the Eddystone in depths of 40–49 fms. (Journ. M.B.A., vol. 9, 1912, p. 347).

Breeding. August (C.S.).

TORQUAY. On a stone at Petit Tor Beach; numerous on buoys in Torquay Harbour (*Elwes*, Journ. M.B.A., vol. 9, 1910, p. 66).

FILOGRANA IMPLEXA (Berkeley): *de St. Joseph*, Ann. Sci. Nat. Zool. XVII. 1894, p. 335; ditto, p. 340 as *Salmacina Dysteri* Huxley.

PLYMOUTH. In quantity from Millbay Channel, from the piles of the Promenade Pier (E.J.A.); on piles at the entrance to Millbay Dock (R.A.T.); on the Breakwater (T.V.H.). Occasionally met with in all dredgings from the Sound and on the outer grounds to the Eddystone.

Recorded by Crawshay at three stations S.S.W. of the Eddystone in 42–43 fms. (Journ. M.B.A., vol. 9, 1912, p. 347).

The distinction given by de St. Joseph and others between Filograna and Salmacina is that the former has opercula, whilst the latter has not. McIntosh considers the two forms the same, a view which is accepted by Cunningham and Ramage (Trans. Roy. Soc. Edin. XXXIII. 1888, p. 673) and by Southern (Proceed. R. Irish Acad. XXXI. 47, 1914, p. 147). The Plymouth specimens, of which a considerable number have been specially examined, have been without opercula.

Breeding. July, August and September (C.S.).

SPIRORBIS BOREALIS Daudin: *de St. Joseph*, Ann. Sci. Nat. Zool. XVII. 1894, p. 345.

PLYMOUTH. Common on weeds, especially Fucus, and on stones on all shores.

SALCOMBE. Common in dredge material from Salcombe Harbour and the Kingsbridge Estuary (Journ. M.B.A., vol. 6, 1900, p. 199).

TORQUAY. Very common on Fucus (*Elwes*, Journ. M.B.A., vol. 9, 1910, p. 66).

SPIRORBIS SPIRILLUM Linnæus : *Caullery and Mesnil*, Bull. Sci. France et Belg. XXX. 1897, p. 198.

PLYMOUTH. Dredged by Crawshay at a number of positions S.S.W. of the Eddystone in 42–51 fms. It occurred commonly on Hydroids, especially on *Sertularia abietina* (Journ. M.B.A., vol. 9, 1912, p. 347).

TORQUAY. On *Sertularia abietina* thrown up on the shore (*Elwes*, Journ. M.B.A., vol. 9, 1910, p. 66).

PROTULA TUBULARIA (Montagu) : *de St. Joseph*, Ann. Sci. Nat. Zool. XVII. 1914, p. 362.

PLYMOUTH. Found on Mewstone Grounds, Rame-Eddystone Grounds and Eddystone Grounds (R.A.T., E.J.A.).

Dredged by Crawshay at four positions S.S.W. of the Eddystone in depths of 42–49 fms. (Journ. M.B.A., vol. 9, 1912, p. 347).

Breeding. Females with ripe eggs from Eddystone Grounds in June (A.J.S.)., August and September (C.S.).

HERMELLIDÆ.

SABELLARIA ALVEOLATA (Linnæus) : *de St. Joseph*, Ann. Sci. Nat. Zool. XVII. 1894, p. 160.

PLYMOUTH. Common attached to rocks on sandy shores at Whitsand Bay.

EXMOUTH. Very common at Orcombe Rocks at the mouth of the estuary, forming the usual reef-like masses (Journ. M.B.A., vol. 6, 1902, p. 322).

TORQUAY. Very common on all the Torquay coast (*Elwes*, Journ. M.B.A., vol. 9, 1910, p. 66).

SABELLARIA SPINULOSA Leuckart : *de St. Joseph*, Ann. Sci. Nat. Zool. XVII. 1894, p. 154.

PLYMOUTH. Occasional specimens attached to shells, etc., from all dredging grounds in the Sound, and from outside dredging and trawling grounds to the Eddystone.

Found in small numbers at many positions S.S.W. of the Eddystone by Crawshay (Journ. M.B.A., vol. 9, 1912, p. 348).

Breeding. May (W.G.) ; September (E.J.A.).

PALLASIA MURATA Allen : Journ. Mar. Biol. Assocn. vol. 7, 1904, p. 299.

PLYMOUTH. Two or three specimens have been obtained from

gravel off Stoke Point and from shell gravel near the Mewstone. Empty tubes are frequently found on the latter ground.

Crawshay obtained tubes or portions of tubes at a large number of positions S.S.W. of the Eddystone in depths of 40 to 50 fms. Living specimens were obtained at three positions, the largest number being at Position 17, situated 23·3 miles S. 28° W. of the Eddystone, at a depth of 45 fms., where portions of six worms were taken (Journ. M.B.A., vol. 9, 1912, p. 348).

Marine Biological Association of the United Kingdom.

Report of the Council, 1914.

The Council and Officers.

Four ordinary meetings of the Council were held during the year, at which the average attendance was ten. A committee of the Council visited and inspected the Plymouth Laboratory.

The Council has to record with regret the death of the Rt. Hon. Joseph Chamberlain, M.P., a Vice-President of the Association and one of its earliest supporters.

The meetings of Council have been held in the rooms of the Royal Society at Burlington House, and the thanks of the Association are tendered to the Royal Society for the use of these rooms.

The Plymouth Laboratory.

The buildings, fittings and machinery at Plymouth have been maintained in a state of good repair, without any exceptional expenditure being incurred during the year. It will soon be necessary to provide more accommodation for the Library, as the present room contains as many books as can be stored there with safety.

The Boats.

The *Oithona* was in commission during the first eight months of the year and is in good condition. She was laid up at the end of August. The new sailing boat, built last year, has continued to give satisfaction, being a powerful sea boat for her size and easily handled. The small motor-boat remains in our possession, but has not been much used during the year.

The Staff.

The members of the permanent staff are as follows: Director, Dr. E. J. Allen; Hydrographer, Mr. D. J. Matthews; Naturalists, Messrs. L. R. Crawshay and E. W. Nelson, Dr. J. H. Orton and Mr. R. S. Clark; Assistant Naturalist, Mr. E. Ford.

At the beginning of August Mr. R. S. Clark volunteered, at short notice, to join Sir Ernest Shackleton's Antarctic Expedition, to take the place of the marine biologist to the expedition who had been called up for military service. Subsequently Mr. Nelson and Mr. Ford both joined His Majesty's Forces for the period of the war, so that during the later months of the year the staff was considerably reduced in strength. Dr. Orton has taken charge of the fishery work during Mr. Clark's absence.

Occupation of Tables.

The following Naturalists have occupied tables at the Plymouth Laboratory during the year :—

Miss Bartholomew, Oxford (Parasitic Triclad on Lobster).
Prof. G. C. Bourne, f.r.s., Oxford (Corals).
E. T. Browne, b.a., Berkhamsted (Hydrozoa).
J. T. Cunningham, m.a., London (Polychæta).
W. De Morgan, Plymouth (Protozoa).
A. N. Drury, b.a., Cambridge (Physiology of Fishes).
J. S. Dunkerly, b.sc., Glasgow (Myxosporidia).
H. M. Fuchs, b.a., London (Echinoderm Hybrids).
Dr. E. S. Goodrich, f.r.s., Oxford (Parasitic Protozoa).
Mrs. Goodrich, Oxford (Parasitic Protozoa).
F. M. Gossen, Plymouth (Fishes).
J. Gray, b.a., Cambridge (Electrical Conductivity of Echinus Eggs).
Dr. S. Hatta, Japan (Embryology).
Dr. Herbert Henry, Sheffield (Blood Parasites of Fishes).
A. G. Huntsman, Toronto (Tunicata).
Miss M. Irwin, b.a., Cambridge (Embryology).
W. O. R. King, m.a., Ray Lankester Investigator (Echinoderms).
Mrs. W. O. R. King, Leeds (Echinoderms).
Dr. P. L. Kramp, Copenhagen (Hydrozoa).
Mrs. D. J. Matthews, m.sc., Plymouth (Development of Alcyonium).
J. T. Saunders, m.a., Cambridge (Alkalinity of Sea-water).
Dr. H. D. Senior, New York (Elasmobranchs).
Mrs. E. W. Sexton, Plymouth (Amphipoda and Polychæta).
Dr. C. Shearer, m.a., Cambridge (Echinus).
Miss A. W. Thomson, Oxford (Nicothoe).
Dr. J. Stuart Thomson, Manchester (Brain of Selachians).
H. G. Thornton, b.a., Oxford (Protozoa).
Dr. Otto Warburg, Berlin (Echinus).
R. W. Watkins, New York (Elasmobranchs).
P. Worthington, Oxford (Parasitic Triclad on Lobster).

In addition to the above, the usual Easter Vacation Course in Marine Biology was conducted by Dr. J. H. Orton, and was attended by sixteen students. Mr. J. T. Cunningham, m.a., brought a class of six students from the South-Western Polytechnic, Chelsea, at Whitsuntide.

General Work at the Plymouth Laboratory.

The two numbers of the Journal issued during the year (Vol. x., Nos. 2 and 3) contain several important reports upon investigations carried out in the Laboratory. Mr. R. S. Clark's report on the Larval and Post-Larval Teleosteans in Plymouth waters records the results of work which has been in progress for some years, and Mr. Clark has been able to describe from the material collected by the Association many interesting stages in the life-histories of fishes belonging to a number of different families. Some of these stages are illustrated for the first time by careful drawings, which were made by the Assistant Naturalist, Mr. E. Ford. Incidentally the records of occurrence of the larval fishes give useful indications as to the time and duration of the spawning season of many different species of fishes in the western part of the English Channel.

A paper by the Director on the culture of the plankton diatom *Thalassiosira gravida* in artificial sea-water gives an account of a series of experiments made with a view to studying the exact conditions most favourable to the growth of such organisms, which, as is well known, form one of the fundamental sources of the food-supply of the sea, the first step of the food-chain leading from inorganic substances, through the invertebrate animals of the plankton and the bottom fauna to the fishes. Dr. Allen has been able to show that good cultures cannot be obtained in a purely artificial medium made by dissolving pure chemicals in doubly distilled water in the proportions in which the salts occur in sea-water with the addition of nitrates, phosphates and iron. If, however, a small percentage of natural sea-water, even as little as 1 per cent, be added and the solution sterilized, excellent cultures result after inoculation with the diatom. The result appears to be due to some specific substance present in minute quantity in the natural sea-water which acts as a growth stimulant. The actual nature of this substance has, however, not yet been determined. Provided the small quantity of natural sea-water be present in the culture medium the other constituents can be varied within wide limits and the salinity of the medium can also be considerably altered without damaging the growth.

The Council particularly desires to draw the attention of the members of the Association to the high scientific value and general interest of this paper. Dr. Allen's results are somewhat analogous to discoveries made in the department of human physiology, which suggest that it is necessary to the life of the higher animals that there should be present in their food small quantities of obscure chemical substances which have been given the name of vitamines.

Dr. J. H. Orton gives an interesting account of the mechanism by means of which the Brachiopods and certain Polychæte worms produce the currents which supply these animals with food and with a supply of water for respiration. The arrangement of the cilia, to the action of which the currents are due, is carefully described, as is also the direction and use of the different currents themselves. It is shown that the ciliary mechanisms on the gills of many Gastropods, most Lamellibranchs, Amphioxus, Ascidians, Brachiopods and Cryptocephalous Polychætes are essentially similar in character.

In a second paper Dr. Orton gives an account of certain Holothurians, which are common at Plymouth, describing in some detail the characters by which they can be differentiated, and recording some observations on their habits. Other papers by the same author deal with the breeding habits of the sea-urchin, *Echinus miliaris*, the feeding habits of the limpet, *Patella vulgata*, and with certain features of the life-history of Amphioxus.

Dr. Orton also gives a preliminary account of his work on the rate of growth of invertebrates and the age at which they commence to breed for the first time. This investigation when completed promises to be of considerable importance from a practical as well as from a theoretical point of view.

The Council desire to congratulate Dr. Orton on attaining the degree of D.Sc. at the University of London, which was awarded upon the researches which he has carried out at the Plymouth Laboratory.

The Journal also contains three papers by Prof. E. L. Bouvier, of the Paris Natural History Museum, which are the outcome of the work he did at the Laboratory as first "Ray Lankester Investigator" during the summer of 1913. Prof. Bouvier's work on the life-history of the sea-crayfish (*Palinurus vulgaris*) was referred to in the Council's Report for last year, and need not therefore be further described. His other papers deal with observations on the Crustacean larva, *Trachelifer*, and on variation in *Pycnogonum littorale*.

During the first half of the present year Mr. Clark continued his investigations on the mackerel fishery off the Cornish coast. A considerable body of valuable information has been collected bearing on the migrations and feeding habits of this fish. The work upon larval and post-larval fishes was also continued.

Mr. D. J. Matthews has been studying the chemical composition of sea-water, devoting himself for the most part to the elaboration of a method for the accurate estimation of the nitrates.

Mr. L. R. Crawshay has been continuing with marked success experiments upon keeping alive and rearing in the Laboratory some of the more delicate plankton animals. This work is important as a general study, which should lead to a better understanding of the right conditions which should be adopted for the rearing of sea fishes, molluscs and crustaceans.

Mr. W. O. R. King, of the University of Leeds, was appointed Ray Lankester Investigator for 1914, and has been engaged in studies on the physiology of Echinoderm development. The two subjects to which he gave special attention were a determination of the temperature coefficient of development of Echinus and a study of the enzymes present in the gonads of the same animal. Mr. King was assisted on the chemical side of the investigations by Mrs. King.

Mrs. Matthews has completed the study of the development of *Alcyonium*, upon which she has been engaged for some time, and a paper on the subject will shortly be published.

Mr. E. T. Browne, who hired the steamer *Oithona* for some weeks last winter, and thus enabled us to keep the vessel in commission during the whole winter, spent some time at the Laboratory in connection with his work on hydroids and medusæ. Several interesting species were obtained, some of which had not been recorded previously from British waters.

Mrs. Sexton has given much assistance to the work which Dr. Allen is carrying out on the Plymouth Polychætes, by making a series of excellent coloured drawings of many of the rarer species. On her own account she has been carrying out experiments on Mendelian inheritance of eye colour in the Amphipod, *Gammarus chevreuxi*.

Mr. W. De Morgan is continuing to study the local Protozoa.

Published Memoirs.

The following papers, either wholly or in part the outcome of work done at the Laboratory, have been published elsewhere than in the Journal of the Association :—

CRAWSHAY, L. R. *Report on the Distribution of the Microplankton.* (Report on the work carried out by the s.s. *Scotia*, 1913, pp. 68–126, plates 23–35.) H.M. Stationery Office, London, 1914.

DENDY, A. *Observations on the Gametogenesis of Grantia compressa.* Quart. Journ. Micr. Sci., vol. 60, 1914, pp. 313–76.

LEIGH-SHARPE, W. H. *Calliobdella Lophii*, Parasitology, vol. 7, 1914, pp. 204–18.

LLOYD, D. JORDAN. *The Influence of Osmotic Pressure upon the Regeneration of Gunda ulvæ.* Proceed. Roy. Soc., vol. 88, 1914, pp. 1–20.

MATTHEWS, D. J. *Hydrographical Observations in the Labrador Current in* 1913. (Report on the work carried out by the s.s. *Scotia*, 1913.) H.M. Stationery Office, London, 1914.

SEXTON, E. W. *On a Collection of Gammarus from the Königsberg Museum.* Schriften Physik-oekonom. Gesellsch. Königsberg, vol. 54, 1913, pp. 90–4.

SVEDELIUS, N. *Über die Tetradenteilung in den vielkernigen Tetrasporangium-anlagen bei Nitophyllum punctatum.* Ber. Deut. Bot. Ges., Bd. xxxii., 1914, pp. 48–57.

SVEDELIUS, N. *Über sporen an Geschlechts-pflanzen von Nitophyllum punctatum.* Bericht. Deut. Bot. Ges., Bd. xxxii., 1914, pp. 106–16.

The Library.

The thanks of the Association are due to numerous Government Departments, Universities, and other institutions at home and abroad for copies of books and current numbers of periodicals presented to the Library during the year. The list is similar to that published in the Report of the Council for last year. A number of authors have also been good enough to send reprints of their papers for the Library, which is gradually building up a collection of great value of separate works dealing with marine subjects. As these are all catalogued separately in the Library they become readily available for use by workers in the Laboratory.

Donations and Receipts.

The receipts for the year include the grants from His Majesty's Treasury (£1000) and the Board of Agriculture and Fisheries, Development Fund (£500), Fishmongers' Company (£600), Special Donations (£5), Annual Subscriptions (£149), Rent of Tables in the Laboratory (£118), Sale of Specimens (£460), Admission to Tank Room (£119).

Vice-Presidents, Officers, and Council.

The following is the list of gentlemen proposed by the Council for election for the year 1915–16 :—

President.

Sir E. RAY LANKESTER, K.C.B., LL.D., F.R.S.

Vice-Presidents.

The Duke of BEDFORD, K.G.
The Earl of DUCIE, F.R.S.
The Earl of STRADBROKE, C.V.O., C.B.
Lord MONTAGU OF BEAULIEU.
Lord WALSINGHAM, F.R.S.
The Right Hon. A. J. BALFOUR, M.P., F.R.S.
The Right Hon. AUSTEN CHAMBERLAIN, M.P.
W. ASTOR, Esq., M.P.
G. A. BOULENGER, Esq., F.R.S.
A. R. STEEL-MAITLAND, Esq., M.P.
Rev. Canon NORMAN, D.C.L., F.R.S.
EDWIN WATERHOUSE, Esq.

Members of Council.

E. T. Browne, Esq.
L. W. Byrne, Esq.
Prof. H. J. Fleure, D.Sc.
Dr. E. S. Goodrich, F.R.S.
Sir Eustace Gurney.
Prof. J. P. Hill, D.Sc., F.R.S.
E. W. L. Holt, Esq.
Prof. E. W. MacBride, D.Sc., F.R.S.
H. G. Maurice, Esq.
Dr. P. Chalmers Mitchell, F.R.S.
C. C. Morley, Esq.
F. A. Potts, Esq.
Geoffrey W. Smith, Esq.
Prof. D'Arcy W. Thompson, C.B.

Chairman of Council.

A. E. Shipley, Esq., D.Sc., F.R.S.

Hon. Treasurer.

J. A. Travers, Esq., Tortington, Arundel.

Hon. Secretary.

E. J. Allen, Esq., D.Sc., F.R.S., The Laboratory, Citadel Hill, Plymouth.

The following Governors are also members of the Council:—

G. P. Bidder, Esq.
George Evans, Esq. (Prime Warden of the Fishmongers' Company).
The Earl of Portsmouth (Fishmongers' Company).
Sir Richard Martin, Bart. (Fishmongers' Company).
The Hon. Nathaniel Charles Rothschild (Fishmongers' Company).
Prof. G. C. Bourne, D.Sc., F.R.S. (Oxford University).
A. E. Shipley, Esq., D.Sc., F.R.S. (Cambridge University).
Prof. W. A. Herdman, D.Sc., F.R.S. (British Association).

THE MARINE BIOLOGICAL ASSOCIATION

Dr. *Statement of Receipts and Payments for*

	£	s.	d.	£	s.	d.
To Balance from Last Year :—						
Cash at Bankers	540	13	4			
Cash in hand	4	2	6	544	15	10.
,, Current Receipts :—						
H.M. Treasury for year ending 31st March, 1915 ...	1,000	0	0			
The Worshipful Company of Fishmongers	600	0	0			
Annual Subscriptions received	149	1	0			
Rent of Tables (including Ray Lankester Trustees, £20 ; University of Cambridge, £25 ; University of London, £25)	118	4	0			
Interest on Investments	15	8	9	1,882	13	9
,, Extraordinary Receipts :—						
Donations—						
Dr. E. Schuster	5	0	0			
G. H. Fox	0	10	6			
J. F. Croonan	0	5	0			
	5	15	6			
Board of Agriculture and Fisheries, Grant from Development Fund for year ending 31st March, 1915	500	0	0			
Grant for Herring Investigations	50	0	0	555	15	6

The Association's Bankers hold on its behalf £410 14s. 8d. New Zealand 4 % Stock, 1943–63.

£2,983 5 1

the Year ending 31*st December*, 1914. **Cr.**

	£	s.	d.	£	s.	d.
By Salaries and Wages—						
Director	300	0	0			
Hydrographer	120	16	8			
Senior Naturalist	220	16	8			
Second Naturalist	116	13	4			
Additional Naturalist	116	11	4			
Assistant Naturalist	142	11	7			
Salaries and Wages	754	14	1	1,772	3	8
,, Travelling Expenses				64	0	
,, Library	98	12	5			
Less Duplicates sold	17	0	8	81	11	9
,, Journal	116	9	3			
Less Sales	17	3	7	99	5	8
,, Buildings and Public Tank Room—						
Gas, Water, and Coal	104	11	5			
Stocking Tanks and Feeding	50	19	4			
Maintenance and Renewals	52	9	1			
Rent, Rates, Taxes, and Insurance	94	11	0			
	302	10	10			
Less Admission to Tank Room	119	10	9	183	0	1
,, Laboratory, Boats, and Sundry Expenses—						
Glass, Apparatus, and Chemicals	173	4	2			
Purchase of Specimens	61	7	7			
Maintenance and Renewal of Boats, Nets, etc.	234	17	1			
Insurance of s.y. *Oithona*, *less* rebate	9	14	0			
Coal and Water for Steamer	111	11	6			
Stationery, Office Expenses, Carriage, Printing, etc.	153	13	1			
	744	7	5			
Less Sales of Apparatus	77	2	8			
,, Specimens	460	10	6			
,, Nets, Gear	137	0	4			
Hire of Boat and Gear	50	13	0	19	0	11
,, Loss on failure of Naval Bank				29	17	3
, Balance :—						
Cash at Bankers	720	14	3			
Cash in hand	13	10	11	734	5	2
				£2,983	5	1

Examined and found correct,
21*st January*, 1915.

(Signed) N. E. Waterhouse.
J. O. Borley.
Edward T. Browne.
P. Chalmers Mitchell.

Marine Biological Association of the United Kingdom.

LIST

OF

Governors, Founders, and Members.

1st May, 1915.

* Member of Council. † Vice-President. ‡ President.

Ann. signifies that the Member is liable to an Annual Subscription of One Guinea.

C. signifies that he has paid a Composition Fee of Fifteen Guineas in lieu of Annual Subscription.

I.—Governors.

The British Association for the Advancement of Science, *Burlington House, W.* £500
The University of Oxford £500
The University of Cambridge £500
The Worshipful Company of Clothworkers, 41, *Mincing Lane, E.C.* £500
The Worshipful Company of Fishmongers, *London Bridge, E.C.* ... £11,305
Bayly, Robert (the late) £1000
Bayly, John (the late) £600
Thomasson, J. P. (the late) £970
G. P. Bidder, Esq., *Cavendish Corner, Cambridge* £1500

II.—Founders.

1884 The Corporation of the City of London £210
1884 The Worshipful Company of Mercers, *Mercers' Hall, Cheapside* .....£341 5*s.*
1884 The Worshipful Company of Goldsmiths, *Goldsmiths' Hall, E.C.*..... £100
1884 The Royal Microscopical Society, 20, *Hanover Square, W.*..... £100
1884 The Royal Society, *Burlington House, Piccadilly, W.* £350
1884 The Zoological Society, *Regent's Park, London, N.W.* £100
1884 Bulteel, Thos. (the late) £100
1884 Burdett-Coutts, W. L. A. Bartlett, 1, *Stratton Street, Piccadilly, W.*... £100
1884 Crisp, Sir Frank, Bart., Treas. Linn. Soc., 17, *Throgmorton Avenue, E.C.* £100
1884 Daubeny, Captain Giles A. £100
1884 Eddy, J. Ray, *The Grange, Carleton, Skipton* £100
1884 Gassiott, John P. (the late) £100
‡1884 Lankester, Sir E. Ray, K.C.B., F.R.S., 29, *Thurloe Place, South Kensington, S.W.* £100

1884 The Rt. Hon. Lord Masham (the late) £100
1884 Moseley, Prof. H. N., F.R.S. (the late) £100
1884 The Rt. Hon. Lord Avebury, F.R.S. (the late) £100
1884 Poulton, Prof. Edward B., M.A., F.R.S., *Wykeham House, Oxford* £100
1884 Romanes, G. J., LL.D., F.R.S. (the late) £100
1884 Worthington, James (the late) £100
1885 Derby, the late Earl of £100
1887 Weldon, Prof. W. F. R., F.R.S. (the late) £100
1888 Bury, Henry, M.A., *Mayfield House, Farnham, Surrey* £100
1888 The Worshipful Company of Drapers, *Drapers' Hall, E.C.* £315
1889 The Worshipful Company of Grocers, *Poultry, E.C.* £120
1889 Thompson, Sir Henry, Bart. (the late) £110
1889 Revelstoke, The late Lord £100
1890 Riches, T. H., B.A., *Kitwells, Shenley, Herts* £230
1902 Gurney, Robert, *Ingham Old Hall, Stalham, Norfolk* £105
1909 Harding, Colonel W., *The Hall, Madingley, Cambridge* £100
1910 Murray, Sir John, K.C.B., F.R.S. (the late) £100
1912 Swithinbank, H., F.R.S.E., F.R.G.S., *Denham Court, Denham, Bucks.* £100
1913 Shearer, Dr. Cresswell, 30, *Thompson's Lane, Cambridge* £100

III.—Members.

1913 Adams, Alfred, M.B., B.Ch., Oxon., *Looe, Cornwall* ..... Ann.
1897 Adams, W. R., 11, *Windsor Road, Denmark Hill, Camberwell, London, S.E.* ..... Ann.
1900 Aders, Dr. W. M., *Zanzibar, East Africa* ..... Ann.
*1895 Allen, E. J., D.Sc., F.R.S., *The Laboratory, Plymouth* ..... Ann.
1889 Alward, G. L., *Enfield Villa, Humberstone Avenue, Waltham, Grimsby* Ann.
1910 Ashworth, J. H., D.Sc., *The University, Edinburgh* ..... Ann.
1892 Assheton, R., M.A., F.R.S., *Riversdale, Grantchester, Cambridge* £20
†1911 Astor, W., M.P., 4, *St. James's Square, London, W.* ..... *C.*
1910 Atkinson, G. T., 43, *Parliament Street, London, S.W.* ..... Ann.

1902 Baker, R. J., 13, *Brandreth Road, Mannamead, Plymouth* ..... Ann.
1884 Balfour, Prof. Bayley, F.R.S., *Royal Botanic Gardens, Edinburgh* ..... *C.*
1884 Bayliss, Prof. W. Maddock, D.Sc., F.R.S., *St. Cuthberts, West Heath Road, Hampstead* ..... Ann.
1884 Bayly, Miss, *Seven Trees, Plymouth* £50
1884 Bayly, Miss Anna, *Seven Trees, Plymouth* £50
1885 Beck, Conrad, 68, *Cornhill, E.C.* ..... *C.*
1884 Beddington, Alfred H., 8, *Cornwall Terrace, Regent's Park, N.W.* ..... *C.*
†1907 Bedford, His Grace the Duke of, K.G., *Endsleigh, Tavistock*... *C.* & Ann. £10 10s.
1903 Bidder, Capt. H. F., *Ravensbury Manor, Mitcham* ..... Ann.
1910 Bidder, Mrs. M. G., *Cavendish Corner, Cambridge* ..... Ann.
1912 Bles, E. J., D.Sc., *Elterholm, Madingley Road, Cambridge* ..... Ann.
1910 Bloomer, H. H., 40, *Bennett's Hill, Birmingham* ..... Ann.
1910 Borley, J. O., M.A., 43, *Parliament Street, London, S.W.* ..... Ann.
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