A Complete List of the Opisthobranchiate Mollusca found at Plymouth;

WITH FURTHER OBSERVATIONS ON THEIR MORPHOLOGY, COLOURS, AND NATURAL HISTORY.

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With Plates XXVII and XXVIII.

THIS paper is intended to furnish a complete list of all the species of Opisthobranchiate Mollusca found up to this time by the Marine Biological Association at Plymouth, together with various notes upon their morphology and natural history. The Nudibranchiate section of the group has, however, already formed the subject of a preceding report published in this Journal,[1] so that species which have not since been taken are recorded here by their names only, a fuller account of them being given in the previous report. All the species there recorded are distinguished in this paper by asterisks (*) affixed to their names. I have had the advantage of several works upon the classification of the group which have recently appeared, notably Carus's excellent Prodromus Faunæ Mediterraneæ, vol. ii, part 1, 1889; Bergh's *Die cladohepatischen Nudibranchien* (Zoolog. Jahrbüch., v, 1890; for a copy of this admirable work I am indebted to the author); and Norman's *Revision of British Mollusca* (Ann. Mag. Nat. Hist., VI, vol. vi, No. 31, 1890, pp. 60—91). I must also mention Vayssière's *Recherches Zoologiques sur les Mollusques Opistobranches du Golfe de Marseille—I. Tectibranches* (Ann. Mus. Hist. Nat. Marseille, Zool., II, 1885, Mém. No. 3) as having been of great service; and I regret that up to the time of going to press the second part of M. Vayssière's work has not arrived at the Laboratory, and I have been unable to refer to it.

Since my Report on the Nudibranchiata was in type last year Prof. Herdman[2] has published several papers upon the value of

[1] Garstang, *Report on Nudibranchiate Mollusca of Plymouth Sound*, Journ. Mar. Biol. Assoc., N. S., vol. i, No. 2, 1889, pp. 173—198.

[2] Herdman, *On the Structure and Function of the Dorsal Papillæ in Nudibranchiata*,

colour in this group of animals, extending the observations of Giard upon protective colouration, and supporting Wallace's view that the colours of Æolids are generally "warning colours as a sign of inedibility." In conjunction with Mr. Clubb[1] he has also published an account of a number of experiments designed for the verification of these views. Having been myself occupied from time to time in similar experiments, a few of the decisive results were communicated to Mr. Poulton, who has inserted them in his recent work on The Colours of Animals (Int. Sci. Series, London, 1890, pp. 199, 200). I hope soon to give an account of the results of other experiments.

In this paper I have taken the opportunity of correcting some mistakes of classification and nomenclature which had not been avoided in my report on the Nudibranchiata.

It is a pleasant task to express my sincere thanks to those who have generously helped me in the investigations here described, and particularly with regard to *Aplysia*. I am especially indebted to Dr. Norman and to Mr. A. R. Hunt.

OPISTHOBRANCHIATA.

Sub-order 1.—TECTIBRANCHIATA

(= OPISTHOBRANCHIA PALLIATA, Lankester).

A. *CEPHALASPIDEA.*

Family—SCAPHANDRIDÆ.

1. SCAPHANDER, *Montfort.*

1. SCAPHANDER LIGNARIUS, *Linnæus.*

This species is frequently obtained by trawlers on the Eddystone trawling-grounds; it does not live in the Sound, but has been taken off Penlee Point.

Family—BULLIDÆ.

2. HAMINEA, *Leach.*

2. HAMINEA HYDATIS, *Linnæus.*

Several large specimens were dredged in the estuary of the river

Rep. Brit. Assoc., 1889, Section D; and Quart. Journ. Micr. Sci., xxxi. Prof. Herdman kindly sent me copies of these papers, which, though containing views similar to some expressed in my previous Report, were written for the most part before its publication.

[1] Herdman and Clubb, *Third Report on Nudibranchiata of L.M.B.C. District*, Trans. Liverpool Biol. Soc., iv, 1890, pp. 150—163; and Nature, June 26th, 1890, pp. 201—203.

Yealm in August of this year, and were brought back alive to the Laboratory. About twelve more specimens were obtained there on another occasion in September. Empty shells may often be found on the shores of the Yealm; probably, therefore, the species frequents this estuary.

Clark states, in his History of the British Marine Testaceous Mollusca, 1855, "Twenty years ago I observed hundreds of these creatures swimming [by means of their pedal flaps] and creeping on the fine mud in the lakes of the Mount Pleasant Warren, near Exmouth; they, however, suddenly disappeared from the locality, and not one has been seen for many years."

Cocks, in 1849, recorded the species as common in Falmouth Harbour.

Family—PHILINIDÆ.

3. PHILINE, *Ascanius.*

3. PHILINE APERTA, *Linnæus.*

This species is common on sandy bottoms, in Cawsand Bay and especially in Whitsand Bay. The animal is said to be able to swim, but I have not myself seen it progress in this way.

4. PHILINE PUNCTATA, *Clark.*

I have only seen one specimen of this small species, found among some *Bowerbankia* dredged in the Sound. Clark recorded it as inhabiting the littoral zone at Exmouth along with *P. catena*, which was "rare amongst algæ in the sheltered pools." Cocks found it among shell sand at Falmouth, rare.

B. *ANASPIDEA.*

Family—APLYSIIDÆ.

4. APLYSIA, *Linnæus.*

5. APLYSIA PUNCTATA, *Cuvier.*

APLYSIA PUNCTATA,	*Cuvier.*	Blochmann, Mittheil. Zool. Stat. Neapel, v, 1884, pp. 28—49.
—	— *Cuvier.*	Vayssière, Ann. Mus. Hist. Nat. Marseille, 1885, Mém. No. 3, pp. 68—71.
—	— *Cuvier.*	Gwyn Jeffreys, British Conchology, v.

APLYSIA HYBRIDA, *Sowerby*. Forbes and Hanley, British Mollusca, iii, pp. 554—556.
— DEPILANS, *Pennant*. Clark, Brit. Mar. Test. Moll., pp. 271, 272.
? — — *Linnæus*. Blochmann, l. c., pp. 32, 33.
? — — *Linnæus*. Vayssière, l. c., pp. 65—68.

The specimens of *Aplysia* in our collection have been taken as follows:

I. North of the great Breakwater, November, 1886: two young ones, in trawl.
II. Mouth of the river Yealm, July 18th, 1887: six, large and small, in dredge.
III. North of the Shagstone, February 2nd, 1888: one dredged.
IV. Mouth of the Yealm, October 20th, 1888: many little ones, dredged or trawled.
V. North of Batten Breakwater, November 12th, 1888: nine or ten, all young, in trawl.
VI. Estuary of the Yealm, opposite coastguard station, May 25th, 1889: a dozen very large specimens.
VII. Mouth of the Yealm, September 20th, 1889: one small specimen, of pure brown colour with white spots.
VIII. Cawsand Bay, October 3rd, 1889: one, much smaller in size, about $\frac{3}{4}$ inch long, bright rose-red in colour, with white spots.
IX. Duke Rock, May 8th, 1890: one considerably larger specimen, of a bright pinkish-red colour, dredged with a quantity of *Delesseria sanguinea*, of exactly the same colour.
X. Middle of Sound, August 14th, 1890: one very small specimen, $\frac{3}{16}$ inch in length, found by Mr. Tate on a stone brought up in the trawl. In this beautiful little individual the shell was still uncovered, being without any reflexed fold of the mantle. The colour of the animal was almost the amethyst-purple of Alder and Hancock's figure of *Æolis Landsburgii*, but deeper and redder.

In addition to these a few other small or moderate-sized specimens (1—2 inches) have been taken, but have not been recorded. In the summer of last year several such individuals were generally brought up on weeds at each haul of the trawl along the inside (north) of the great Breakwater.

All our specimens belong to the second of the two subdivisions of the genus *Aplysia* defined by Blochmann (l. c., p. 29). The pleuropodia[1] ("epipodia," "parapodia," *Schwimmlappen*) are fused

[1] See under *Oscanius membranaceus*, infra, p. 419.

posteriorly from their origin on the foot to the level of the exit of the pallial (anal) siphon. The edge of the mantle-folds, reflexed over the shell and fused, bounds a circular aperture conducting to the shell, but is never raised up into a tubular prominence. The opaline gland behind the genital aperture is not lobulate (grape-shaped) with a single pore, but consists of a number of large unicellular bottle-shaped glands opening separately to the exterior. Anteriorly, however, as Vayssière has observed in *A. punctata* (l. c., p. 54), these elongate gland-cells are bunched together, and in my specimens have a single excretory pore which it is quite easy to discover.

Colour.—The colour of our smallest specimens has always been of a more or less bright and deep rose-red, generally if not always sprinkled with opaque white spots. At this stage our *Aplysiæ* correspond with Rathke's "species" *rosea* and Thompson's *nexa*. Our largest specimen measures (preserved in alcohol and consequently much contracted) 3 inches in length, $1\frac{5}{8}$ inches in height, and $1\frac{1}{4}$ inches in breadth. Its shell is figured of the natural size on Pl. XXVIII, fig. 9; the structure of the central teeth of its radula is shown in fig. 7. When alive this individual probably measured rather more than 6 inches in length in a state of complete extension. The colour of this specimen and of the other large ones dredged in May last year was olive-green,[1] of various shades and intensities. An individual which was living in the tank in the Laboratory for some time in the autumn of last year, and measured about 4 inches in length during extension, was of a pure brown colour; while the specimen dredged on the 8th of May this year was kept alive for some time, and being of a bright pink-red colour at the time of capture had changed in a month's time (June 6th) to a brownish red, and by the 23rd of June to a deep red-brown. Its colour when captured was just that of the alga *Delesseria sanguinea*; on the 6th of June it was exactly that of *Iridæa edulis*. Thus this species changes its colour with growth from a violet, purplish, or rose-red colour, through brownish red and brown to olive-brown or olive-green. There is considerable variation, as is well known, but these are, I believe, the chief changes which occur. Vayssière attributes the different colours of specimens of *A. punctata* at Marseilles to the nature of the bottoms upon which they are found (l. c., p. 69), but I may remark that the living *Aplysia* whose colour-changes I observed was kept under the same conditions for the two months during which it was under observation.

[1] In recording a specimen found on the shore at St. Andrews, Prof. McIntosh remarks, "No spots or other markings were present on the dull olive hue of the body" (Mar. Inv. and Fish, St. Andrews, p. 84).

Markings.—The markings of our specimens I have studied only in the preserved condition. In some of the smaller specimens no markings at all are to be observed, but as others preserved in the same way show very conspicuous markings it is probable that conclusions drawn from these preserved specimens are valid. The largest of the small specimens in which markings are absent, measures $1\frac{3}{4}$ inches long in a fair state of extension. Where present, the marking of the integument is always due to small grey dots, either pale or dark, slightly elongate in form, which may be grouped in various ways. They may be evenly dispersed over the whole of the integument, forming no rings and leaving no clear spaces, or, though arranged in the same way, may be distributed over only a limited portion of the integument, viz. on the back of the head and on the upper portion of the sides of the body. It is, indeed, generally the case that, as Brock has described for *A. punctata* (Blochmann, l. c., p. 34), the marking does not extend to the foot and inner side of the pleuropodia, but is limited to the upper surface of the body. The most usual type of marking, however, consists in the dots being so distributed (either over the whole surface of the integument or over the upper portion only) as to leave round or elliptical clear spaces from which all markings are absent. The spaces may be either definitely bounded by a close series of dots or not very definitely bounded; there is every gradation between these two conditions. The former of these conditions is represented in Mrs. Gray's Figures of Molluscous Animals, vol. ii, pls. cxxxviii, cxxxix, and cxlii, both for *A. depilans* and *A. punctata;* the latter condition is shown on pl. cxlii* for *A. depilans*. The dots in most specimens show a great tendency to be arranged in a certain order, either in straight or curved lines, or in the form of hexagonal, circular, elliptical, or irregular markings, enclosing clear spaces of small diameter. But there is every gradation between these small dot-bounded spaces and the large ones mentioned above. In a number, though not the majority, of individuals, the dots enclosing these small circular spaces may be so continuous as to produce very definite ring-like spots. These are chiefly to be found on the head and neck, and more rarely on the sides of the body. In our largest specimens the marking consists largely of a reticulum formed by lines of pigment-dots running in all directions, crossing one another and anastomosing, here and there leaving large or small clear unpigmented spaces, with indefinitely bounded edges.

So far as the marking is concerned, therefore, some of our smaller specimens have the positive characters of *A. punctata* as described by Blochmann and Vayssière; but many of the smaller ones, as well as all the largest ones, could equally well be placed—so far as the

marking is concerned—in the species *A. depilans* (= *fasciata*) of their descriptions.

Radula.—In 1875, 1877, and again in 1878, Mr. A. R. Hunt,[1] of Torquay, obtained a number of *Aplysiæ* in Torbay of various sizes, some of which were of the ordinary English type, the species *punctata* of Blochmann and Vayssière, the largest of these having a radula with fifteen completely formed lateral teeth on each side in a single transverse row, while others were of very much larger size, and are referable to the species *depilans* of the same naturalists, the smallest having, according to Mr. Hunt, twenty-six completely formed lateral teeth on each side of the median row. Mr. Hunt, however, by examining a series of radulæ of different sizes found that the number of lateral teeth as well as the number of transverse rows was dependent upon the age (size) of the individual, and arrived at the conclusion that probably his large specimens were not specifically distinct from the smaller ones, but were simply unusually large individuals of the common English species, *A. punctata*, Cuvier.

I owe to Mr. M. F. Woodward, of South Kensington, my acquaintance with Mr. Hunt's papers, which were published in a journal not generally known to zoologists, and had escaped my notice. Mr. Woodward had intended to re-investigate the matter himself, but upon finding that I was engaged in an examination of the Plymouth *Aplysiæ* very courteously referred me to Mr. Hunt's papers, and, as I am pleased to acknowledge, helped me in various other ways.

As to growth of the radula in either *Aplysia depilans* or *punctata*, the comparatively recent papers of Blochmann and Vayssière render little assistance. Blochmann figures the radula and teeth of a single average-sized specimen of each "species," and gives their respective formulæ; while Vayssière remarks upon the variability in the dental formulæ of *A. punctata*, and describes the structure of the teeth of an average specimen, but for *A. depilans* gives a similar description, and regrets having obtained no young individuals (l. c., pp. 67, 61). From Blochmann's account, again, I cannot gather that he has examined young specimens of this latter species, for he gives the size of the animal as from 10 to 20 cm., and only mentions "quite young individuals" as being *possible* exceptions to the general rule as to the markings of the species (l. c., p. 32).

Is there a possibility that the young *Aplysia depilans* is no other than *Aplysia punctata?*

On Pl. XXVIII the structure of the central tooth and of three

[1] Hunt, *On some Large Aplysiæ taken in Torbay in* 1875, Trans. Devonshire Assoc., vol. ix, 1877, pp. 400—403; *On the Growth of Aplysiæ in Torbay*, Trans. Devonshire Assoc., x, 1878, pp. 611—617.

adjacent lateral teeth of a median transverse row is represented for five Plymouth *Aplysiæ* of different sizes. Fig. 3 represents these teeth in a very small specimen, whose radula measures 1·05 mm. in length by 0·6 mm. in breadth, and consists of twenty transverse rows, its formula[1] being (8·1·8) × 20. The central tooth consists of a broad but short basilar portion, deeply excavated behind, and a transverse projecting ridge, arising from the basilar portion in its anterior half, directed posteriorly, and made up of five well-developed cusps, of which the median is the largest and has five serrations on each side, while the internal and external lateral cusps are smooth, the external cusp being smallest. The posterior excavation of the basilar portion of the tooth will be referred to as the "posterior bay;" a similar but smaller excavation in front will be called the "anterior bay." The structure of the tooth in a very young specimen being understood, the modifications entailed by further growth can be most accurately shown by a series of measurements, although the striking nature of the changes is more graphically shown on Pl. XXVIII.

Mr. Hunt has very kindly lent me a number of the preparations made by him in 1877 and 1878, so that I have been able to incorporate the results of a re-examination of them with those obtained from Plymouth specimens. These results are contained in the accompanying tables. For the "species" *A. punctata* (Nos. 1—10) the measurements and observations show—

(1) That the radula may attain a size of 8·8 mm. in length by 5·4 mm. in breadth, considerably larger than that figured by Blochmann (6 × 4), and may consist of forty-four transverse rows of teeth, the lateral teeth numbering (according to age) from eight to nineteen. Blochmann gives twenty rows and thirteen lateral teeth for this species at Naples, while Vayssière has observed from thirty-five to thirty-six rows and sixteen lateral teeth at Marseilles.

(2) That the basilar portion of the central teeth may increase in breadth (according to age) from 0·15 mm. to about 0·4 mm., when it begins to be reduced in width (Nos. 9 and 10), and that it increases in height regularly (with age) from 0·025 mm. to 0·15 and even 0·2. In several of the radulæ (Nos. 5, 6, 8, 9, and 10) this increase can be actually observed by comparing the heights of the central teeth in front and of those

[1] In my formulæ for the teeth of *Aplysia* the three, or sometimes four, rudimentary lateral teeth at the extremities of the transverse rows are always included. In comparing these formulæ with those given by Mr. Hunt it should be remembered that Mr. Hunt counts only the perfectly developed lateral teeth.

further behind. This increased height is due to additional chitin formation at the *posterior* margins of the teeth, and it thus comes about that the "posterior bay" may be entirely obliterated (Pl. XXVIII, fig. 7). This has not before been observed for *A. punctata*, and breaks down one of the previously maintained distinctions between the central teeth of *A. punctata* and *A. depilans*.

(3) That with age the central cusp of the central tooth becomes less prominent and much more obtuse (Nos. 7, 9, and 10); that the external lateral cusp becomes reduced in size, and may even disappear (Nos. 5, 9, and 10); and that the internal lateral cusp also becomes reduced in size, and, while quite smooth in young individuals, may become in older specimens irregularly serrated on its external edge (Nos. 6, 9, and 10).

Turning now to the results in the case of the few radulæ of *A. depilans* which I have been able to examine, it is seen that, as in *A. punctata*, the radula varies in size and number of rows very largely according to age. My smallest radula (No. 11) is a fragment only, and possesses thirty-one lateral teeth. It is obviously, however, an older specimen than my largest *punctata*, for it is 1·6 mm. wider, and probably possessed fifty rows of teeth originally. The central teeth differ remarkably from those of my largest *punctata* in being of much smaller size in every way.

The next (No. 12) is a little larger (0·5 mm. wider), and possesses fifty-six rows of teeth, while the number of lateral teeth increases remarkably in passing from the front to the back of the radula. There are thirty-two lateral teeth behind and twenty-three in front. This radula in this respect, therefore, approaches *A. punctata* very closely, for in No. 10 the lateral teeth were seventeen in front and twenty behind. As regards number of teeth, therefore, there is no ground for specifically separating these two forms. The width of the central teeth is still much smaller than in Nos. 9 and 10, but, as in them, the width shows a crescendo followed by a remarkable diminuendo in size, passing from the front to the back of the radula. It is impossible to avoid the inference that in the growth of this individual the width of the central tooth has never exceeded that which it attains at the climax of its crescendo (0·3 mm.), and therefore Nos. 9 and 10 (in which the tooth attains a width of 0·4 mm.) cannot easily be regarded as stages in its growth. This inference is also strengthened by the other measurements of the central teeth of the radula, and by comparison with Nos. 13 and 14, which exhibit an *increase* in the size of their teeth with age. This

increase indicates growth through stages possessing central teeth of smaller, not of larger, size.

At the same time I cannot place the same confidence in inferences drawn from measurements of the teeth in Nos. 12, 13, and 14, for these teeth are shrunken and distorted, owing to the method in which the radulæ were mounted. No. 8 was also mounted dry, and it may be noticed that the teeth in this specimen show a considerable reduction in width compared with Nos. 7 and 9. As it has been shown above that in many points of structure increased age brings about a closer and closer resemblance of the teeth of *A. punctata* to those of large examples of *A. depilans*, I am inclined to give more weight to this trustworthy evidence than to that afforded by the shrunken teeth of Nos. 12, 13, and 14; and in the absence of any definite statements upon the matter by Mediterranean zoologists I think considerable grounds are afforded by this examination of the teeth for regarding *A. depilans* as merely *A. punctata* modified by further growth. I trust that the subject may receive more conclusive treatment in the hands of a naturalist upon a coast where large *Aplysiæ* are more common than they are with us in England. It is especially needful that the young *A. depilans* should be identified and described.

While upon the subject of the teeth of *Aplysia* I may add that Dr. J. E. Gray, in his Guide to the Distribution of the Mollusca in the British Museum, 1857 (p. 200), gives a description of the teeth of *A. depilans* and *A. punctata* which is very difficult to understand. For *A. depilans* he describes a radula having a formula 12·1·12, of which the central tooth is "distinct and truncated, *triangular, dilated beneath*,[1] with an arched front edge; apex truncated, reflexed; reflexed part subcordate, dark, with three large toothlets in front." Is this a true *depilans* at an early stage? For *A. punctata* he says, "Central tooth with the base on each side expanded; apex recurved, *with one sharp point lobed on both sides;* lateral teeth about thir een."

Curiously enough, this latter description is very applicable to the figure given by Mr. Jabez Hogg[2] of the central tooth of an *A. hybrida* from Torbay, which numbered "seventy-two rows of divergent teeth," but possessed "numerous laterals." Certainly I have seen no *A. punctata* having this number of rows of teeth or this structure, although Mr. Hogg's figure closely corresponds with that given by Vayssière for *A. punctata*. I wish to thank Mr. Hogg for his kindness in lending me a copy of his original paper at a time when it was impossible to obtain one from the libraries. Fig.

[1] The italics are mine.

[2] *The Lingual Membrane of Mollusca*, Trans. Micr. Soc., xvi, N. S., pl. x, fig. 42.

41 of his paper represents the teeth of an *Aplysia* taken in Vigo Bay, having "forty rows of divergent teeth; the median broad, produced at the base, reflexed, *tricuspid; centre cusp prolonged and serrated.*" This *Aplysia* received no specific name in print, but Mr. Hogg has added in his own copy the word *punctata*, an identification which there is every reason to believe to be correct, although the shape of the posterior margin of the basilar portion of the tooth is unusual. Mr. Gwyn Jeffreys, however, confused matters by taking this radula for that of an *A. depilans*, and that of Mr. Hogg's *A. hybrida* (Fig. 42) as the normal one of *A. punctata*. Mr. Hunt follows Gwyn Jeffreys' identification, but suggests that "70" is an accidental misprint (l. c., 1877, p. 401), or that the numbers 40 and 70 should be transposed. The latter of these suggestions is impossible, because the central tooth of the radula of an *Aplysia depilans* numbering seventy rows is not so distinctly tricuspid, nor is the centre cusp prolonged and serrated. It is best, I think, to leave this confusion unsolved, and to hope that the radulæ of *Aplysia*, as well as the other structures, may be investigated and described again for the different species *at different stages of growth.*

Shell.—The shell of our Plymouth *Aplysia punctata* is figured on Pl. XXVIII (figs. 8 and 9) for two individuals of different ages, the larger shell (represented of the natural size) being taken from the individual numbered "10" in the table of measurements. This shell is considerably larger than that figured by Vayssière for *A. punctata*, and is intermediate in character between that shell and the shell of *A. depilans*, just as Vayssière's shell is intermediate in character between those shown in my figs. 8 and 9. Canon Norman has kindly forwarded to me a shell of *A. depilans* from Palermo, which I have represented by fig. 10. It is much broader than that of the same species figured by Vayssière, and its left edge is much more curved, the margin of the anal excavation also sloping continuously forwards (in the natural position), and not forming a true "bay" like that of Vayssière's. As Dr. Norman has stated (Rev. Brit. Moll., l. c., p. 69), Mr. Hunt's large shells closely correspond with those of Mediterranean *A. depilans*. I have been favoured with three of the shells of the Torbay *A. depilans*, and the two largest agree in character with the shell sent me by Dr. Norman, the curvature of the left side being a little less convex; but the smallest of the three, measuring 1½ inches long by 1 inch wide, has its anal margin sloping away much more and is less flattened than the larger ones. It approaches the shell of *A. punctata* in this respect. Indeed, when the shell of the young *A. depilans* is described I doubt if it will be distinguishable from that of *A. punctata*, even if it is not the same.

Gill.—The gill of our specimens corresponds with Blochmann's figure of the gill of *A. punctata*, except that it is larger in our larger individuals. It is divided, of course, into a series of lamellæ, but it shows even in our largest specimens no trace of the bilobed appearance figured by Blochmann for *A. depilans*.

Mantle.—I have cut sections of the mantle of four specimens, large and small, but cannot confirm Blochmann's statements as to the presence of cilia over the upper surface.

Breeding Habits.—I have only one fact to adduce under this head as regards Plymouth specimens. An individual of a brown colour, measuring nearly 4 inches when extended, was living in the Laboratory for some time in the autumn of last year, and several times deposited eggs in the form of slender gelatinous strings of a brown-pink colour.

Lo Bianco[1] states that *A. depilans* spawns at Naples from March to August, and *A. punctata* from April to August. *A. limacina*, on the other hand, spawns all the year round, although especially in the summer.

Dr. Norman has observed *Aplysia punctata* spawning at Connemara, and some of the shells of these individuals, according to Mr. Hunt,[2] measure only $\frac{5}{8}$ inch in length.

Mr. Hunt has also called my attention to a statement by Gwyn Jeffreys, which is in itself a strong argument for the unity of the two species *punctata* and *depilans*. In a *Report on Dredging among the Channel Islands*,[3] prepared for the British Association, Mr. Jeffreys states, "It was also noteworthy that *Aplysia depilans* and *punctata* (usually considered distinct species) copulated when a pair was placed in a vessel of sea water."

Attitude.—I have often observed small *Aplysiæ* of about an inch in length, when kept in a dish or aquarium, attach themselves firmly by the posterior portion of the foot to the sides of the dish, extend their bodies out at full length, and remain in this condition motionless for hours together. As these small *Aplysiæ* have just the colour of many red seaweeds among which they are generally dredged, I am inclined to compare this habit with that of *Geometer* larvæ, which extend themselves also in a similar way, and are coloured like the twigs upon which they are attached. These little *Aplysiæ* have a very inanimate appearance in this condition, their tentacles and pleuropodia being rendered prominent (the latter being generally compressed or rolled together), and simulating the stunted branches of many

[1] *Notizie Biolog. rig. spec. il Periodo di maturità, ecc.*, Mitt. Zool. Stat. Neap., viii, 1888, pp. 415, 416.

[2] Loc. cit., 1878, p. 615.

[3] Rep. Brit. Assoc., vol. xxxv, Birmingham, 1865.

weeds. It is often extremely difficult to distinguish a small *Aplysia* when among red weeds. The colour of large *Aplysiæ* is generally that of the littoral *Fuci*, and of somewhat smaller specimens that of *Laminaria*. It is perhaps significant that an *Aplysia* migrating with growth from deep water to the shore would pass through algæ coloured first red, then brown, and finally olive-green. These are the stages of its own colour-changes.

MEASUREMENTS OF TEETH OF

ANIMAL (inches).		RADULA (millimetres).	
No.	Length × breadth × height.	Length × breadth.	Formula.
1	L. $\frac{3}{16}$ × B. $\frac{3}{32}$	1·05 × 0·60	(8·1·8) × 20. Three lateral teeth on each side rudimentary
2	$\frac{7}{16} \times \frac{3}{16} \times \frac{5}{16}$ (contracted)	2·0 × 1·5	(12·1·12) × 23. Four laterals rudimentary
3	$\frac{13}{16} \times \frac{3}{8} \times \frac{3}{8}$ (extended)	3·0 × 2·5	(12·1·12) × 25. Three laterals rudimentary
4	Mr. Hunt's No. 11, loc. cit., 1877, p. 402. Shell (wet) $\frac{3}{8}$ inch long	4·30 × 2·75	($\frac{13}{14}$·1·$\frac{13}{14}$) × 31. One lateral tooth more behind than in front. Three rudimentary laterals
5	$2 \times \frac{7}{8} \times 1\frac{3}{16}$ (contracted)	5·4 × 3·2 (the breadth ought to be a little more, owing to a crease in the mounted radula)	(16·1·16) × 33. Four lateral teeth rudimentary
6	$2\frac{5}{8} \times 1\frac{1}{8} \times \frac{3}{4}$ (extended)	5·3 × 3·4. This radula is of about same breadth behind as No. 5, but is narrower anteriorly	(15·1·15) × 35. Four laterals rudimentary
7	$1\frac{1}{4} \times \frac{1}{2} \times \frac{7}{8}$ (much contracted). From Yealm, 18th July, 1887	4·5 × 3·6. More short and broad than usual	(16·1·16) × 30
8	Mr. Hunt's No. 12, loc. cit., 1877, p. 402. Shell (wet) $\frac{7}{8}$ inch × $\frac{3}{4}$ inch	6·6 × 4·4 (mounted dry and somewhat shrunk)	13·1·13 (front). 15·1·15 (middle). 17·1·17 (behind). Three rudimentary laterals, 44 rows

Aplysia punctata AND *depilans*.

	Central teeth (millimetres).				
	Basilar portion.		Cusped ridge.		Notes.
	Breadth.	Height.	Breadth.	Height.	
	0·15	0·025	0·085	0·06	Central cusp with 5 serrations on each side. External lateral cusps well developed. Posterior bay large. (Pl. XXVIII, fig. 3.)
	0·25	0·05	0·11	0·08	Serrations as in No. 1. External lateral cusps reduced, in several teeth almost indistinguishable, being fused with the inner laterals. Posterior bay reduced. (Pl. XXVIII, fig. 4.)
	0·28	0·095	0·12	0·11	Serrations 5 or 6. External lateral cusps still more reduced. Posterior bay much filled up. (Pl. XXVIII, fig. 5.)
	0·30	0·12	0·125	0·09. Thus the median cusp does not project into the posterior bay	Serrations more variable in number than in above, from 3 to 7, but usually 4. External lateral cusps very rudimentary. Inner lateral cusps reduced and obtuse. Posterior bay nearly filled up; almost the condition of fig. 7.
	0·33	0·09 anteriorly to 0·12 or 0·13 in the middle and posteriorly	0·13 to 0·14	0·1 to 0·11	Serrations reduced in size, and only 3 or 4 distinct in most teeth. External lateral cusp lost in many teeth, very rudimentary in the others. As the numbers show, the median cusp projects into the posterior bay anteriorly, but does not reach it posteriorly. No irregular serrations on the lateral cusps.
	0·35	0·1 anteriorly to 0·2 and 0·4 in the middle of the radula and posteriorly	0·13 anteriorly to 0·15 posteriorly	0·13. Projects into the bay in front, not so behind; just as in No. 5	Serrations 3—5. Inner lateral cusps fairly well developed; occasionally bifid, or sometimes notched with small irregular serrations. External lateral cusps not so rudimentary as in No. 5. (Pl. XXVIII, fig. 6.)
	0·36	0·11 (throughout)	0·17	0·15 in front, reducing through 0·13 to 0·12, and even 0·11 behind	Central teeth closely resemble in general form those of No. 6 (Pl. XXVIII, fig. 6). Median cusp prolonged and acute in front of the radula; broader and shorter behind. Serrations well developed, usually 6. Inner lateral cusp well developed. External lateral cusp rudimentary, but distinct, and of same size as the most anterior serration of the median cusp.
	0 31	0·12 in front to 0·13 and 0·14 behind	0·13	0·11	Cusps normal, the central being a little obtuse, and having 5 or 6 serrations on each side. Posterior bay almost completely filled up; shape of basilar portion resembling that of Vayssière's fig. 58 (*A. depilans*).

Animal (inches).		Radula (millimetres).		
No.	Length × breadth × height.	Length × breadth.	Formula.	
9	$3 \times 1\frac{1}{4} \times 1\frac{5}{8}$ (contracted)	7·5 × 4·9	$(\frac{13}{16} \cdot 1 \cdot \frac{13}{16}) \times 42$	
10	$3 \times 1\frac{1}{4} \times 1\frac{5}{8}$ (much contracted, and altogether a considerably larger individual than No. 9). Shell (wet) $1\frac{1}{4}$ inches long. (Pl. XXVIII, fig. 9)	8·8 × 5·4	$(\frac{17}{16} \cdot 1 \cdot \frac{17}{16}) \times 44$	
11	Size ? Oxford specimen	Length ?, breadth 7·0	(31·1·31) × ? A fragment only. The 30 posterior rows are partially preserved, but only 20 have central teeth	
12	Mr. Hunt's No. 1 or 2, loc. cit., p. 402. Shell (wet) $1\frac{3}{4}$ inches long	9·5 (in median line) × 7·5. Short and broad. Teeth a little distorted, having been mounted dry originally	23·1·23 in front, increasing posteriorly to 32·1·32. 56 rows	

	Central teeth (millimetres).				
	Basilar portion.		Cusped ridge.		Notes.
	Breadth.	Height.	Breadth.	Height.	
	0·38 in front, increasing regularly to 0·4, then reducing regularly to 0·37	0·12 in front, increasing to 0·15 behind	0·15 or 0·16	0·14 in front, decreasing gradually to 0·12, and even 0·115 behind	As in No. 7, the median cusp is prolonged and relatively acute in front, becoming more obtuse and shorter behind. Posteriorly it becomes remarkably broad and short, the angle made by its two sides being no longer acute, but almost or quite 90°. Serrations 3, 4, or 5. They form now a continuous series with the lateral cusps, being in the same straight line. External lateral cusp extremely reduced, indistinguishable in many of the teeth. Inner lateral cusp frequently showing irregular serrations.
	0 40 in front, 0·42 in middle, 0·37 behind	0·16 in front, increasing through ·17 to 0·19 behind; a few teeth even measure 0·20	0·15, increasing posteriorly to 0·18	0·16, decreasing not quite regularly through 0·15 to 0·14 behind	The median cusp does not project into the posterior bay in any tooth, although it touches the edge anteriorly. Hardly a trace of the external lateral cusps. Serrations of median cusp fairly strong. The external edge of inner lateral cusps generally shows irregular serrations as in Nos. 6 and 9. The cusped ridge arises, as in all the above radulæ, in the anterior half of the tooth. (Pl. XXVIII, fig. 7.)
	0·28, decreasing regularly to 0·26 behind	0·15, constant	0·10	0·15 in front, decreasing to 0·14 behind	This is the first indubitable *depilans*. The radula is imperfect, but by comparing with No. 12 it probably possessed 50 rows originally. Central cusp broad, short, and blunt, trilobed, without serrations. Inner lateral cusps broad, short, with small irregular serrations as in Nos. 9 and 10. External lateral cusps entirely absent. Posterior bay quite filled up; shape very much as in the posterior teeth of Nos. 9 and 10. Anterior bay is partially obliterated, owing to additional deposit of chitin in front. Cusped ridge posterior in position.
	0·26, increasing to 0·30, then decreasing a little irregularly through 0·26 to 0·22 behind	0·12 in front, rising to 0·14 and 0·15, with variations probably due to distortion	0·11, constant	0·10 in front, rising to 0·12 and 0·13, then decreasing to 0·11 and 0·10 (the cusps are completely worn down in front; allowing for this, there is probably a decrease in height from the very front of the radula)	Posterior margin of basilar portion convex (as in Blochmann's figure of *A. limacina*) or arcuate, much as in my fig. 7. The cusped ridge arises in the posterior half of the tooth, owing largely to the additional chitin deposited anteriorly. Central cusp very rudimentary, as also the inner lateral. No trace of external lateral. Serrations, where present, in form of a variable number of small projections on each side of the median cusp, and on the diminished representative of the inner lateral (cf. Nos. 9 and 10). Anteriorly, and in the middle of the radula, the cusps form a broadly V-shaped serrated ridge; posteriorly they are merely serrations on a nearly straight line, as in Vayssière's figure of *A. depilans*.

Animal (inches).		Radula (millimetres).		
No.	Length × breadth × height.	Length × breadth.	Formula.	
13	Mr. Hunt's No. 4, loc. cit., p. 402. Shell (wet) 2¼ inches long	12·7 × 10·0	30·1·30 in middle, 34·1·34 behind. 70 rows	
14	Mr. Hunt's No. 5, loc. cit., 1878, p. 613	14·7 × 12·3	33 lateral teeth in front, increasing to 37 behind. 80 rows	

Postscript.—The word "height" in reference to the central teeth is used in these Tables to denote what is in reality their "length." The "height" of the basilar portion is its antero-posterior dimension in the middle line, *i.e.* the length of the line joining the median points of the anterior and posterior bays. The "height" of the cusped ridge is the length of the same line terminating posteriorly at the apex of the central cusp. The breadth of the basilar portion is its maximum breadth posteriorly.

Such a formula as $\frac{13}{16}\cdot1\cdot\frac{13}{16}$ was suggested to me by Mr. Weldon, to indicate the number of lateral teeth in an anterior and posterior row of the radula at the same time. This formula denotes an

	Central teeth (millimetres).				
	Basilar portion.		Cusped ridge.		Notes.
	Breadth.	Height.	Breadth.	Height.	
	0·23, increasing, with variations due to distortion, to 0·38 behind	—	0·14 to 0·15	0·09 to 0·10	It is impossible to give accurate measurements for comparison with the preceding results, owing to the radulæ having been mounted dry, and the teeth being distorted. Posterior margin occasionally convex as in No. 12 (probably due to distortion), generally arcuate. The shape of the teeth closely corresponds with Vayssière's figure of *A. depilans*. The cusped ridge consists of a median unserrated projection, short and thick, and lateral wings bearing numerous minute irregular serrations. No trace of true lateral cusps.
	0·38, fairly constant	0·12 to 0·14	0·16	0·08, varying slightly; never more than 0·10	The teeth are very low and broad; the posterior margin is generally arcuate. The most posterior teeth are very small and degenerate. In all the teeth the cusped ridge is prolonged into a line curved posteriorly on each side, which meets the posterior margin of the tooth, as shown in Blochmann's figure of *A. depilans*. The ridge is very simple, as in No. 13. No such definite cusps are to be found as are figured by Blochmann, whose specimen was probably much younger.

increase in the number of lateral teeth from 13 to 16 on each side, passing from the front to the back of the radula.

I have seen, through the kindness of Mr. H. M. Gwatkin, the radula of a Guernsey *Aplysia* 9·5 mm. long by 6 mm. broad, distinctly intermediate in its characters between Nos. 9 and 10 on the one hand, and Nos. 11 and 12 on the other. Formula (21·1·21) × 53. Teeth resemble those of 9 and 10, but the breadth decreases from 0·37 mm. in front to 0·34 behind, without the anterior crescendo. This points also towards the unity of the two "species."

C. *NOTASPIDEA.*

Family—PLEUROBRANCHIDÆ.

5. Oscanius, *Leach.*

6. Oscanius membranaceus, *Montagu.*

Examples of this species have been occasionally brought to us by fishermen from the refuse of the beam trawl, but have been obtained very rarely in the Sound. A very large specimen was caught in a drift-net in 5 or 6 fathoms water off Jennycliff on January 24th this year, and another large one was trawled in the Sound exactly a month later. A few others had been taken in previous years.

The habits of congregation and migration of this species, as of other Opisthobranchs, are worthy of notice, and I add here therefore some observations made by other naturalists on the Devon and Cornish coasts.

Clark states,[1] "These animals are frequently met with in the coralline zone in summer, and in the winter are often washed ashore on the Warren sands at Exmouth in considerable numbers."

At Falmouth, thirty years ago, Cocks[2] found the species rare at Gwyllyn Vase under stones, and not uncommon in the Helford River.

At Torbay, according to Mr. A. R. Hunt,[3] "in December, 1873, and January, 1874, *Pleurobranchus* (*Oscanius*) *membranaceus* was very abundant in the bay." On February 7th Mr. Hunt took a large specimen with a landing-net "at the back of the new pier, floating about four feet below the surface." Immediately afterwards rough weather came on, and for more than four years Mr. Hunt saw only one specimen in Torbay. "The species was swept out of the bay, and probably driven on shore."

The broad foot ("pedal disc") of this species serves for swimming as well as for creeping. When swimming freely the animal is generally upon its back, but sometimes turns over either partially or completely. It moves slowly forwards in this way, alternately flapping, with wave-like contractions from before backwards, the two halves of its broad foot. The mantle-flaps assist also in the action. This power of swimming explains the capture of one of our specimens in a drift-net, as it does also of one of Mr. Hunt's with an ordinary landing-net.

[1] Clark, loc. cit., p. 269.

[2] Cocks, *Contributions to the Fauna of Falmouth*, Trans. Cornwall Polytech. Soc., 1849.

[3] Hunt, *Notes on Torbay*, Trans. Devon. Assoc., vol. x, 1878, pp. 189, 190.

The structure of the foot of *Oscanius* and its habits of locomotion are of interest as indicating the way in which the lateral folds of the foot (epipodia) of *Aplysia*, *Lobiger*, and other Opisthobranchs have probably arisen. As Cuvier originally pointed out, these lateral folds in reality correspond to the lateral portions of the undifferentiated foot of such forms as *Scaphander*, *Oscanius*, and *Haminea*. In *Oscanius* the sides of the foot are frequently folded over the body of the animal when at rest, and this habit is still more marked in *Haminea*. Now the animals are found to live on muddy bottoms, and a broad flexible expanse of foot is obviously advantageous for gliding over such surfaces (cf. *Alderia modesta*, which also creeps upon mud). But the habits of *Aplysia* are different. *Aplysia* lives upon algæ, and for creeping over the narrow stems and fronds of seaweeds a wide plantar surface would be not only unnecessary but disadvantageous; so we find that the median portion of the originally broad foot has become specialised for creeping purposes, while the lateral portions no longer form part of the plantar surface, but arise from the vertical sides of the median portion, and retain only their power of flapping for the purpose of natation. The series of forms illustrating the evolution of the lateral folds of *Aplysia* is so complete as to leave no doubt about the truth of this view; but at the same time it becomes almost impossible[1] to regard the epipodia of Opisthobranchs and those of *Haliotis* and the lower Prosobranchs as strictly homologous. On this account Von Jhering has proposed for the folds of *Aplysia* the term "parapodia," which has been adopted by Pelseneer, and in part by Vayssière. Professor Herdman[2] still regards the homology as possible, and therefore retains the name "epipodia" for the lateral folds of Opisthobranchs; but he justly objects to the term "parapodia," as being "already appropriated by a totally different structure in another group of animals." Perhaps the term "pleuropodia" would at the same time be free from this objection, and also prevent confusion with the epipodia of the *Rhipidoglossa*.

This species is well known to secrete from its general body-surface a fluid containing sulphuric acid, which reddens blue litmus strongly. As Bateson[3] has shown that food otherwise palatable is refused by fishes generally when it "has been soaked for a few minutes in dilute acids," there can be no doubt that this secretion is a great means of protection to the species from the attacks of fishes. I have tasted this fluid, and it is strongly acid; but I have

[1] See Pelseneer, *Sur l'Epipodium des Mollusques*, Bull. Sci. Fr. Belg., 1888, p. 192, &c.

[2] Herdman and Clubb, *Third Report on the Nudibranchiata*, Trans. Liverpool Biol. Soc., iv, p. 147.

[3] Bateson, *The Sense Organs and Perceptions of Fishes*, this Journal, N. S., vol. i, p. 247.

found no trace of it in either *Scaphander, Haminea,* or *Philine aperta.* Now the two latter forms, at any rate, are largely eaten by fishes,[1] and are inconspicuously coloured; while *Oscanius membranaceus* is not eaten by fishes, and is handsomely coloured with red-brown and yellowish markings. I am not sufficiently acquainted with this animal to be able to assert anything with regard to the degree of conspicuousness of these markings amid natural surroundings; but they would appear to be conspicuous, and to assist fishes in the recognition of a distasteful animal.

6. PLEUROBRANCHUS, *Cuvier.*

7. PLEUROBRANCHUS PLUMULA, *Montagu.*

A specimen of this species was dredged in the autumn of last year, south of the Mewstone, adhering to the under side of one of the valves of a dead *Pecten.* Mr. Bourne found another specimen on the shore at Wembury Bay early in May this year, and Dr. Fowler brought back another from the same shore in September.

At Falmouth, Cocks used to find it "not uncommon" under stones at Gwyllyn Vase, Swanpool, &c.

Family—RUNCINIDÆ.

7. RUNCINA, *Forbes,* 1853

(= *Pelta,* Quatrefages, 1844; not Beck, 1838).

8. RUNCINA CORONATA, *Quatrefages.*

RUNCINA HANCOCKI, *Forbes.* In Forbes and Hanley, Brit. Moll., iii, p. 612, pl. ccc, fig. 2.

This species was first obtained at Plymouth by Mr. Heape, who secured a single specimen. It was very abundant in the middle of April this year in tide-pools below the bathing pond, not far below high-water mark. The animals were to be seen creeping over brown muddy areas and weeds, but did not frequent the green weeds. The brown colour of the molluscs, although somewhat deeper than that of the surfaces upon which they were crawling, rendered them difficult to detect for some little time, but when once detected it was easy to find many more. When fully extended large specimens measured nearly $\frac{3}{8}$ of an inch in length.

These pools contained, besides *Runcina,* large numbers of *Lima-*

[1] Verrill, *Rep. Invert. Anim. Vineyard Sound,* U.S. Fish. Rep., 1873, pp. 371, 372.

pontia crawling over the tufts of *Cladophora*. Curiously enough, when the largest pool was examined again in the following August not a specimen of *Limapontia* or *Runcina* was to be found, while I obtained several specimens of *Actæonia corrugata*.

On a subsequent visit (September 26th) I found half a dozen small ones, measuring from $\frac{1}{16}$ to $\frac{1}{8}$ of an inch in length, in this large pool and in another. Plainly the large specimens of April were congregating for spawning purposes, and afterwards probably died. In August the young *Runcinas* were too small to notice easily, while by the end of September they had grown to the size recorded. On this latter visit I found no *Limapontia* and no *Actæonia*.

Mr. Cocks records this species as not uncommon at Gwyllyn Vase, Falmouth, on algæ in pools, half-tide and low-water mark, May, 1852.

Sub-order 2.—NUDIBRANCHIATA

(=OPISTHOBRANCHIA NON-PALLIATA, Lankester).

Section A.—ASCOGLOSSA, Bergh.

Family—ELYSIIDÆ.

8. ELYSIA, *Risso.*

9. *ELYSIA VIRIDIS, *Montagu.*

The bright green variety of this species occurs in the estuary of the Yealm and Wembury Bay.

Inside the Sound several specimens have been taken of the variety named *olivacea* by Gwyn Jeffreys. On August 14th Mr. Tate discovered one of these upon a stone dredged near the Duke Rock, and Prof. Johnson brought me one found by him among some algæ trawled on the same day in the middle of the Sound. A week later I found two more crawling over *Cladophoræ* in a large tide-pool near high-water mark below the bathing pond. In this pool they were highly inconspicuous among the tufts of algæ. Other specimens were found in this and neighbouring pools during the same month. The colour of these littoral forms was always dull, either dark olive-green or brownish ; in one specimen the colour was reddish brown.

M. Giard[1] has found in the spring of the year little *Elysiæ* hardly more than a centimetre in length, of a vivid red colour with blackish

[1] Giard, Bull. Sci. France et Belg., 1888, p. 502.

markings, the foot being of a clear yellowish red. This variety he terms *aurantiaca*.

Family—LIMAPONTIIDÆ.

9. LIMAPONTIA, *Johnston*.

10. *LIMAPONTIA CAPITATA, *Müller*.

LIMAPONTIA NIGRA, *Johnston*. See Norman, loc. cit., p 91.

Large numbers of this species were found creeping over the tufts of *Cladophoræ* in tide-pools on the north-west side of Cawsand Bay, March 26th, 1890, and on the same green weeds in pools near high-water mark south of the bathing pond in the middle of April. In these latter pools I could not discover a single individual during August and September, although I visited them on several occasions.

Early in August a number of specimens were found creeping upon *Bryopsis plumosa* at low water, south-east of Drake's Island.

It cannot be stated of this species that it is inconspicuous when creeping over the green weeds which it usually frequents ; its black colour renders it at once noticeable.

Mr. Thomas Scott[1] has recorded this species from "pools among the stones left dry at low water a little east of Newhaven Pier, August, 1887," and observes that it is not easily perceived except when crawling. I have myself found it at Lytham, on the Lancashire coast, in shallow muddy pools which receive fresh sea-water only at spring tides and are dried up during neap tides. The specimens were either creeping over the mud or over small green *Confervæ*. They were buried in the mud during the dry seasons, and appeared to survive them.

10. ACTÆONIA, *Quatrefages*.

11. ACTÆONIA CORRUGATA, *Ald. and Hanc.*

Six specimens were found creeping over *Cladophoræ* in a tide-pool south of the bathing pond on August 19th, 1890. None were to be found a month later. This species is one of Mr. Cocks's discoveries at Falmouth.

[1] *Some Additions to the Fauna of the Firth of Forth, with Notes of some Rare East Coast Forms*, Seventh Ann. Rep. Fish. Board for Scotland, 1889, pt. 3, pp. 324, 325.

Family—PHYLLOBRANCHIDÆ.

11. HERMÆA, *Lovén.*

12. HERMÆA BIFIDA, *Montagu.*

A single specimen of this very interesting species was discovered by Prof. Johnson creeping over a frond of *Delesseria hypoglossum* obtained at St. Peter's Point below St. German's River, on September 26th, 1889. In length it was $\frac{3}{16}$ inch. The head, tentacles, and body were of a pale, delicate, transparent green colour; the lateral hepatic canals and their branches to the pleuropodial cerata were of a pink colour, exactly resembling that of the alga upon which the animal was feeding. The right hepatic canal extended almost to the posterior end of the body, the left ceased more anteriorly. The cerata (homologous in a general sense with the pleuropodial folds of *Elysia*, the lateral fins of *Lobiger* and *Aplysia*, and the dorso-lateral processes of *Lomanotus* and *Tritonia*) consisted of five large ones on each side alternating with one or sometimes two small ones. I cannot speak with any emphasis, having examined only this one specimen, but if this alternating disposition of the large and small cerata exists regularly in young individuals (cf. *Hermæa cruciata*, Agassiz[1]), a comparison can be made between the pleuropodia of this genus and the pleuropodial folds of *Tritonia*, which are also arranged in a waved line down each side of the back with alternately larger and smaller processes. The cerata were coloured like the hepatic canals, but differed in being transparent.

As Mr. Poulton has already stated in his recent work, The Colours of Animals (pp. 70, 200), I found that when a shadow was caused to pass over this active little Nudibranch it at once contracted itself, drawing in its head and erecting briskly its cerata. The reaction to shadows is correlated with the unusually large eyes of this species, and is paralleled by a similar reaction, as I shall show below, in a true Æolid, *Coryphella gracilis*.

The pink colour of the hepatic canals and their intra-ceratal branches disappeared in my specimen entirely after twelve days' captivity, apparently owing to its refusing to feed any longer upon the *Delesseria* which was placed in the same dish of sea water with it. On September 29th the colour was paler than at first, and a number of opaque white spots (mucous glands?) became conspicuous upon the rhinophores. Next day the colour of the hepatic branches was very much paler, hardly noticeable, but the faint rosy colour of the larger cerata and the greenish colour of the rhinophores were still persistent. The opaque white spots had attained a great development upon the rhinophores, head, and cerata. On October 8th

[1] See Verrill, *Rep. Invert. Vineyard Sound*, 1873, pl. xxv, fig. 175.

the animal was perfectly colourless and quite transparent except for numbers of opaque white spots on the rhinophores and cerata.

13. HERMÆA DENDRITICA, *Ald. and Hanc.*

We owe again our only examples of this species to Prof. Johnson, who, while examining some *Bryopsis plumosa* from a tide-pool from the south-east side of Drake's Island, discovered two individuals creeping on the weed, August 5th, 1890.

They applied themselves usually to the stem of the weed, and crawled about actively among the tufts and branches, being excellently concealed from observation by their form and the green colour of their hepatic canals. The mucus of the foot is very adhesive, and this enables the animals to cling tightly to the weed ; it is indeed a most difficult thing to remove one forcibly from it. I repeatedly tried the experiment of passing a shadow over them, both when in the weed and when creeping openly on the bottom of a capsule, but never obtained the reaction of the cerata described above in *H. bifida*. The eyes, though conspicuous for a Nudibranch, were not so large, if I remember rightly, as in the latter species. The erection of the cerata may, however, be produced by touching the head with a blunt needle.

I tried also the experiment of adding a number of differently coloured algæ to the dish of sea water in which the *Hermææ* were living. On the first night the green weeds supplied were *Enteromorpha*, *Ulva*, and *Bryopsis*, and representing the red weeds was a tuft of *Antithamnion plumula*. Next day the *Hermææ* were on the *Enteromorpha* and *Ulva*, not on the *Antithamnion*. Some additional red weeds, *Rhodymenia laciniata* and *Spondylothamnion multifida*,[1] were then put in to afford more chance of the *Hermææ* meeting the red weeds in their peregrinations. In spite of this, on the next day, August 8th, one was crawling on the sides of the dish, the other was on the *Bryopsis*. Next day one was again on the *Bryopsis*, the other was swimming inverted at the surface of the water. Indeed, within the fortnight during which they were kept alive, they were frequently observed upon the green weeds, especially the *Bryopsis*, never on the red ones. This indicates with much probability that the green species of *Hermæa* avoids the red weeds upon which it would be conspicuous, and does not avoid the green weeds upon which it is concealed from observation.

As with *H. bifida*, the distinctive colour of these specimens faded entirely after a certain time of captivity. By August 13th the green

[1] I need hardly say that I owe the identification of many of these algæ to my friend Prof. Johnson, who has rendered me much help in this way during his visits to Plymouth.

colour had all disappeared, and the hepatic cæca were pure brown in one individual, yellowish brown in the other. This loss of the green colour was probably due to the creatures eating no more of the green weeds, for several days previously the *Bryopsis* had turned brown and died, and the *Hermæas* were not seen upon the *Enteromorpha* after August 7th.

Section B.—CLADOHEPATICA, Bergh.

Sub-section—CERATONOTA, *Lankester.*

Family—TRITONIIDÆ.

12. TRITONIA, *Cuvier.*

14. *TRITONIA HOMBERGII, *Cuvier.*

This species is common on the trawling-grounds. Early in August I found half a dozen young specimens in various stages of growth feeding upon a large colony of *Alcyonium digitatum* brought in from the fishing-grounds.

I kept these young individuals (one inch and under) for several weeks in a dish containing algæ only—no *Alcyonium*—to see the effect of starvation upon their colour. They gradually lost almost all their characteristic flesh-colour, and became very transparent.

13. CANDIELLA, *Gray.*

15. *CANDIELLA (TRITONIA) PLEBEIA, *Johnston.*

This species has not occurred so frequently this year.

Family—DENDRONOTIDÆ.

14. DENDRONOTUS, *Alder and Hancock.*

16. *DENDRONOTUS ARBORESCENS, *Müller.*

This species has not again been taken.

Family—LOMANOTIDÆ.

15. LOMANOTUS, *Verany.*

17. *LOMANOTUS GENEI, *Verany.*

LOMANOTUS GENEI, *Verany.* Cat. Anim. Invert. Mar. Golf. di Genova e Nizza, Genova, 1846.

— MARMORATUS, *A. and H.* Monograph.

— FLAVIDUS, *A. and H.* Monograph.

LOMANOTUS PORTLANDICUS, *Thompson*. Ann. Mag. Nat. Hist., 3rd ser., v, 1860, pp. 48—51.
— HANCOCKI, *Norman*. Ann. Mag. Nat. Hist., 4th ser., xx, 1877, p. 518; 6th ser., 1890, pp. 80, 81.
— GENEI, *Ver*. Bergh, Verh. Zool.-Bot. Ges. Wien, xxxii, 1882, pp. 66, 67.
— VARIANS, *Garstang*. Journ. Mar. Biol. Assoc., New Ser., I, ii, 1889, pp. 185—189.
— EISIGII, *Trinchese*. J. V. Carus, Prodr. Faun. Mediterr., II, i, 1889, p. 207.

In my previous Report three specimens of *Lomanotus* dredged in June last year were externally described, and the inference was drawn that the specimens previously obtained on the English coasts (although originally described as possessing specific differences from one another), together with our three specimens, really were members of one and the same species; and I proposed to give this species a new name, *L. varians*, though in this proposal, as Dr. Norman points out in his recent Revision, and as others have mentioned to me, I was breaking a recognised "law of nomenclature." Dr. Norman, however, admits the probability of my conclusions except as regards *L. Hancocki*, which he holds to be distinct. Bergh,[1] on the other hand, brackets together *L. flavidus*, *Portlandicus*, *Hancocki*, and *varians*, leaving *L. genei* and *marmoratus* distinct, by which, however, he may have wished to indicate rather his views upon the degree of affinity between the "species" than his agreement upon the question of their unity.

What seemed to myself to be a remarkable thing on the supposition of there being but one English species was the fact recorded in my original account (l. c., p. 187) of two individuals, whose length did not exceed half an inch, bearing "pieces of spawn." The form of the spawn was certainly unusual, but as nothing was known about the spawning of *Lomanotus* there was no valid *a priori* objection to the view that this spawn was deposited by themselves. I was unwilling at the time to dissect the specimens or otherwise alter their appearance, but I have since found that the egg-strings belonged not to the *Lomanotus*, but to a remarkable parasitic Copepod, probably a species of *Splanchnotrophus*, which was buried in the viscera of the molluscs, its egg-sacs only being protruded.

Thus the possible physiological objection to the unity of the British species, viz. that two specimens had been stated to deposit eggs at an unusually early age—when only one fifth of the extreme size—cannot be now urged; and the question remains to be settled upon morphological grounds only.

On August 21st of this year I had the good fortune to meet with

[1] Bergh, *Die cladohepatischen Nudibranchien*, Zool. Jahrbüch., Abth. f. Systematik, Bd. v, 1890, p. 50.

eight additional specimens of *Lomanotus*. They were all small in size; the majority were $\frac{3}{16}$ inch long, while the smallest was only $\frac{1}{8}$ inch and the largest was $\frac{1}{4}$ inch—just the size of Alder and Hancock's *Lomanotus flavidus*. They were fixed on the stem and branches of a colony of *Antennularia antennina* dredged in seven fathoms water between the Breakwater lighthouse and the Queen's Grounds buoy: their elongate and low form and pale orange colouration—exactly that of the Hydroid—rendered them so inconspicuous that similar specimens have probably been more than once passed over.[1]

Bergh,[2] in his recent revision of the *Cladohepatica*, remarks upon the absence of any knowledge of the bionomics of this genus; but it should be noticed that the occurrence of so many as eight young individuals upon a single hydroid colony points very strongly towards the conclusion that *Lomanotus* attaches its spawn upon or very near to the stems of zoophytes, and that the veliger-stage in the development is passed through in the egg, or that the free-swimming stage is of very short duration, for otherwise the larvæ would be dispersed over a wide area, and the chances would be greatly against the congregation of the young metamorphosed individuals upon a single hydroid stock. I have already shown that *Lomanotus* possesses a power of rapid motion through the water (l. c., p. 189), so that even if a free-swimming larval stage is absent in this genus the dispersal of the species can be readily effected by the movements of the adult.

The structure of these young specimens is shown very fairly by figs. 1 and 2 of Pl. XXVIII, representing two different individuals of the same size ($\frac{3}{16}$ inch long), one seen from the side, the other from above. The *form* in a healthy and active individual is elongate and slender, being broadest just behind the rhinophores, and tapering gradually to the posterior extremity. Fig. 2 was drawn from a very active specimen, while alive, and shows the characteristic shape. *Colour*, a pale transparent orange, exactly that of the majority of healthy colonies of *Antennularia*. In some of the specimens the colour was enriched by red-brown spots on the tubercles of the rhinophoral sheaths and on the papillæ of the lateral (pleuropodial) folds. This red-brown pigmentation was quite absent in the smallest individual ($\frac{1}{8}$ inch), but in the two largest was considerably developed, and gave the animal a more conspicuous appearance (not on the Hydroid, however, for the small oval sporosacs situated all down the stem have also a deeper colouration than the stem itself, and the

[1] I have indeed since found two other specimens in the preserved collection of *Antennularia ramosa*.

[2] Loc. cit., p. 50: "Die Lomanoten scheinen ziemlich träge Thiere zu sein, über deren biologische Verhältnisse nichts bekannt ist."

development of the pigment patches on the papillæ of the larger *Lomanoti* really served to render them inconspicuous). *Veil* absent in the smaller specimens, very small in the largest, but bearing two short tentacular processes on each side; these processes of the head appear before the veil itself, and existed in all except the smallest specimen, where the corresponding region was almost perfectly semicircular in outline, and in the specimen next it in size, in which the future oral tentacles were, however, indicated by short and broadly rounded prominences. In one individual, however, there appeared to be only a single velar process on each side, corresponding in position to the inner of the two normally present. *Rhinophores* clavate, laminated; the laminæ six to ten in number, not so closely set as in Alder and Hancock's *marmoratus*, and ceasing a little below the tip of the tentacle, which is smooth, conical, and not so sharply truncate as in the latter "species." Rhinophores in the larger specimens retractile within calyx-like sheaths, whose edges were produced into four, five, or six somewhat irregular processes, of either simple, papilla-like, digitate, or compressed triangular form; of these the postero-external papilla was in all cases the largest (see Pl. XXVIII, figs. 1 and 2, and cf. the descriptions of *L. flavidus* and *Portlandicus*). During life the rhinophores were constantly being retracted and protruded from the calyx-like sheaths, but some individuals kept their rhinophores retracted for hours at a time, while others were never seen to protrude them at all. In these latter cases the only part of the rhinophore visible was the smooth conical apex.

On account of the similarity in appearance between this condition of the rhinophores and that which Dr. Norman described as being the most striking feature of his *L. Hancocki* (l. c., 1877, p. 518; 1890, p. 81), I wrote to him to ask if the rhinophores of his specimen had been actually dissected out. With his usual courtesy he has informed me that he did not extract the rhinophores for examination, so that I cannot but be convinced that the appearance which these structures presented in his specimen of *Lomanotus* was due not in reality to the absence of laminæ upon them, but to a temporary state of retraction within the sheaths.

Pleuropodium (= "pallial margin," "branchial curtain," "*margo dorsalis*," "*membrana papilligera*," "epipodial ridge") on each side in the form of an undulating ridge extending from the sheath of the rhinophore (at the part produced into the large postero-external rhinophoral papilla) very nearly to the posterior termination of the foot, where it approaches the corresponding structure of the other side. The ridge is produced into irregular, flat, triangular papillæ, of which four are larger than the rest, and mark the centres of the inward undulations. The ridge in reality consists, as was pointed

out in my former paper, of a series of four arcuate lobes having their concavities external (cf. *Hancockia*), and this statement is borne out by the development. In the smallest specimen ($\frac{1}{8}$ inch long) the pleuropodium is represented only by a series of three small, broadly triangular processes on each side, the smallest posterior, recalling the condition of this fold in *Scyllæa*, *Glaucus*, and *Lobiger*;[1] the connecting ridge appears later, as in the case of the veil. In slightly larger individuals ($\frac{3}{16}$ inch) an additional smaller process has appeared on each side of the first three (see Pl. XXVIII, fig. 1), and another triangular papilla has arisen posteriorly. The posterior papillæ are more separated, since the continuous ridge is formed first in front. The papillæ of the pleuropodia and rhinophoral sheaths of the two largest specimens were pigmented exactly as in Alder and Hancock's *L. flavidus*; and on account of their flexibility and contractility there is not in my own mind the least doubt as to the specific identity of these specimens and the so-called "*flavidus*," which was also obtained upon *Antennularia*. *Foot* normal in the larger specimens, although the transverse groove was not observed; in the two smallest individuals the anterior angles of the foot were not produced into recurved processes, but simply rounded.

It remains to add that the *eye-spot* is round and black, and situated under the transparent integument beneath the large postero-lateral tubercle of the rhinophoral sheath on the outside (Pl. XXVIII, fig. 1); and that in the smallest individual the *sheath of the rhinophore* consisted merely of a thickening of the skin around its base, whose only tubercle was this postero-lateral one. This tubercle was in direct continuity with the primary papillæ of the pleuropodial series—another detail in the resemblance of the young *Lomanotus* to *Scyllæa*.[2] This continuity persists throughout life, and can be seen in fig. 1 of my plate (cf. also Bergh, l. c. supra, 1882, p. 67).

Alder and Hancock's otherwise beautiful figures of *L. marmoratus* are seriously wrong in representing a continuity between the pleuropodium and the oral veil. There is a figure of a preserved *L. genei* in Mrs. Gray's Figures of Molluscous Animals, 1874 (*Gastropoda*, pl. ccxxi, fig. 2), which, though not so artistic, is much more correct in this respect. The continuity between the rhinophoral sheath and pleuropodium exists also in *Tritonia* and *Dendronotus*;[3] it is

[1] The pleuropodial fins of *Lobiger* are, according to M. Vayssière, folded over the back of the animal when at rest, as in *Aplysia*, *Haminea*, &c. It is of interest to notice that this habit is still persistent in *Lomanotus* (see Thompson, l. c., p. 50; and previous Report, l. c., p. 187).

[2] Cf. Alder and Hancock on *Scyllæa* (Monograph): "The orifice [of the rhinophoral sheath] inclines forwards, and there is a thin, arched, crest-like appendage behind it."

[3] Cf. Bergh (l. c., p. 5), *Bei den Dendronotiden, Bornelliden, und Scyllæiden verschmelzen die vordersten Papillen mit dem Stiele der Rhinophorien.*

especially well seen in *Candiella plebeia;* while in the Holohepatica a series of forms (*Idalia Leachii, I. elegans,* and *I. aspersa*) illustrates conclusively the transformation of the anterior portion of the pleuropodium on the one hand into rhinophoral filaments (*Ancula cristata*), and on the other into an almost complete rhinophoral sheath (*Thecacera pennigera*). A survey of the group, indeed, leads to the generalisation that wherever the pleuropodia extend into the head region, their anterior extensions either unite in front of the rhinophores (*Idalia, Triopa, Ægirus, Polycera, Goniodoris, Archidoris, Proctonotidæ,* &c.), or enter into special relations with them (*Ancula, Thecacera, Scyllæa, Lomanotus, Dendronotus,* &c.) ; and since rhinophoral sheaths do not occur in the forms with a closed pleuropodium (except in cases like *Lamellidoris sparsa* and *Ægirus punctilucens,* where the tuberculate character of the whole body surface is also shown in the raised margins of the rhinophoral fossæ), it appears probable that rhinophoral sheaths in all cases contain a pleuropodial element.

The *veil* of *Lomanotus* must not be confused with the apparently similar structure existing in (*e. g.*) *Polycera quadrilineata,* which is of pleuropodial nature. It is a true "oral veil," strictly homologous on the one hand with that of *Lamellidoris, Acanthodoris,* and *Ægirus,* with the paired "oral tentacles" of *Archidoris, Goniodoris, Triopa,* and *Ancula* (the rudiments of which also exist in *Polycera* and *Idalia*), and on the other hand with the oral veil of *Embletonia* and the paired "oral tentacles" of the *Proctonotidæ* and *Æolididæ.* It is of course homologous with the veil of *Tritonia, Dendronotus,* and *Doto;* but although the veil in these genera has not the form of the pair of elongate tentacles of the majority of Æolids, it is so plainly the same morphological structure that Bergh's[1] distinction between the two should not be too finely drawn, especially as his term "margo frontalis" (*Stirnrand*) could be applied with equal correctness to the pleuropodial veil of *Polycera,* with which the former structure has nothing to do. The same objection can be urged against the use of Fischer's[2] term "voile frontal."

The *anal papilla* is situated on the right side of the body, under the second primary pleuropodial papilla; it is not easily seen in the living animal, but is readily perceived in one which is well preserved as a slight projection.

The *heart* could be seen through the integument of these individuals as an oval structure situated at the level of the interspace between the first and second pleuropodial lobes; in one individual it was observed to beat sixty-five times in the minute.

[1] L. c., pp. 4, 49, &c.

[2] Manuel de Conchyliologie, pp. 526, 535, &c.

The largest individual was observed on one occasion, after irritation, to contract itself vigorously from side to side; but it did not actually progress in this way.

These new specimens of *Lomanotus* throw considerable light upon the question of the number of species. There can be no doubt that they are members, with *L. flavidus*, *L. Eisigii*, *L. Portlandicus*, and *L. Hancocki*, of one and the same species; and the largest of the three specimens described in the previous Report so plainly connects *L. Eisigii* with *L. marmoratus*, and this latter through our two other specimens is brought so near to *L. genei*, that I have very little hesitation in referring all the known forms to the species *L. genei* possessing the characters of the genus.

These specimens will form the material for some notes upon the anatomy of the genus at no distant date.

Family—DOTONIDÆ.

16. Doto, *Oken*.

18. *Doto fragilis, *Forbes*.

This species has been frequently taken as before.

19. Doto pinnatifida, *Montagu*.

I am glad to be able to add this rare species to the fauna. Two specimens, $\frac{3}{8}$ inch long, were dredged by Dr. Benham adhering to *Antennularia antennina* on the Queen's Grounds, opposite Picklecombe Fort, in August. One had eight, the other nine pairs of cerata. I carefully examined these specimens, and the colour and structure were in every respect as described by Alder and Hancock. On the stem of the Hydroid was some *Doto* spawn, no doubt deposited by one of these individuals. It was of a pale rose-pink colour, and arranged on the stem in a regularly zigzag line, as is often the case with the spawn of *D. coronata*.

20. *Doto coronata, *Gmelin*.

Prof. Herdman[1] finds this species at Hilbre Island "invariably creeping on the under surfaces of ledges and stones on which are large colonies of the zoophyte *Clava multicornis*;" and in these conditions the molluscs are efficiently concealed, on account of the re-

[1] Herdman, *On the Structure and Function of the Dorsal Papillæ in Nudibranchiata*, Report Brit. Assoc., 1889, Sect. D, and Quart. Journ. Micr. Sci., xxxi, p. 56.

semblance of their cerata in brightness and similarity of colour and external form to the upper ends of the zooids of *Clava*.

It is an interesting fact that at Plymouth this species has never been found upon gymnoblastic Hydroids, but always upon Calyptoblasts, chiefly *Plumularia*, *Antennularia*, and *Sertularia*[1] (especially *S. pumila*). *Clava cornuta* and *multicornis* are to be found covering the under sides of stones and the bottoms of certain rock-pools on the shore, but I have searched these colonies in vain for a single specimen. Correlated with this dissimilarity of habit, Plymouth specimens very rarely show much of the bright rose-colour generally found in the species elsewhere. One such individual, however, was found creeping over a brightly coloured scallop-shell (*Pecten maximus*) upon which colonies of *Halecium* were growing. The *Halecium* had large quantities of the spawn of *D. coronata* attached round the bases of its stems, some of which no doubt had been deposited by this individual. If so, the *Doto* either was wise in keeping near the brightly coloured shell to deposit its eggs, or had been creeping over the Hydroid, in spite of its conspicuous coloration, with impunity.

Family—ÆOLIDIDÆ.

Sub-family 1.—ÆOLIDINÆ (= ÆOLIDIADÆ PROPRIÆ, *Bergh*).

17. ÆOLIS, *Cuvier* (*sens. strict.*).

21. *ÆOLIS PAPILLOSA, *Linn.*

Three specimens only have been taken this year, under stones at low water; one in April at Drake's Island, another in May immediately below the Laboratory, and the third was found by Dr. Fowler on July 16th at the east end of Drake's Island. Mr. Vallentin found it abundant in the spring in Falmouth Harbour, on the under side of rocks at low water.

In my former Report[2] I had occasion to refer to the resemblance of this species in colour and form to the Actinian *Sagartia troglodytes*, noticed and recorded by M. Giard, who also observed that the two creatures were frequently to be found in the same situations. As this is one of the most important of the "tests of mimicry" given by Wallace, I was inclined to regard *Æolis papillosa* as an instance

[1] Cf. McIntosh, Mar. Inv. and Fishes, St. Andrews, 1875, p. 86. Mr. Vallentin finds the species common at Falmouth on *Obelia geniculata*. I have found it on this Hydroid occasionally at Plymouth.

[2] L. c., pp. 175, 191. *Sagartia parasitica* on the former page was obviously an error, and I take this opportunity of correcting it.

of a species of Æolid evolved by the selection of the most *troglodytes*-like individuals of each generation. Since, however, it is only at Wimereux that the relations noticed by Giard to exist between the two animals are known even to approach constancy, and as similarly coloured specimens occur abundantly elsewhere, this view can be entertained at present only doubtfully. But as local colour-varieties of this species are not rare, the question could be settled almost conclusively if naturalists on the different coasts would notice whether the local race has or has not the special relations of mimicry to some locally abundant Actinian upon which it feeds or near which it lives. The colours of the local races ought to vary with the colours of such locally abundant species of Actinian. It they should be found to do so, then a strong case for true mimicry could be made out; if not, then selection of the individuals most resembling the locally abundant Actinian cannot have taken place, and the species, like its varieties, must find its causal explanation elsewhere.

18. Æolidiella, *Bergh.*

22. Æolidiella Alderi, *Cocks.*

This rare species, discovered at Falmouth in 1848 by Mr. W. P. Cocks, and not recorded from any other part of the English coast (Mr. Cocks himself never saw it after 1849), was found in large numbers by Mr. Bourne and Dr. Fowler on the shores of the Yealm estuary between Fox Cove and Thorn Cove late in October, 1889, at low water; and has been taken on subsequent occasions, though in less abundance, from the same locality. The ground here is fairly firm, consisting chiefly of small stones with an admixture of coarse, slightly muddy sand, while old oyster-shells are scattered about, Most of the specimens have been found under these shells or under stones. A yellowish-white species of Actinian, *Sagartia* (sp. incert.). is very common here also, being found attached to the pebbles or even free, but generally in either case half buried in the sand, and shrinking into it at the slightest touch. It is very probable that this anemone constitutes a chief source of the Æolid's food. Curiously enough, the Æolid and the Actinian are very like each other in colour and form, and it was easy when collecting the former to mistake at times half-buried specimens of the *Sagartia* for the Nudibranch. This case may be, like that of *Æolis papillosa* and *Sagartia troglodytes*, one of true mimicry, and I am collecting facts bearing upon the matter.

Early in February this year, upon another visit to this locality, I could find only a few specimens of the Æolid, but whether the

reduction in numbers was due to migration into deeper water or to death (the weather just previously to my visit had been extremely cold) it was impossible to determine. One of the specimens secured on this occasion had probably been attacked a day or two previously by some fish, for its cerata were all extraordinarily small. They had plainly been knocked or bitten off,[1] and were in course of recrescence, for next day they were larger in size. These observations support the views proposed in my former Report (l. c., pp. 175 and 191) as to the significance of the structure, colouration, erectile power, and fragility of the dorsal cerata in Æolids. If the head of this species be touched with a blunt needle, it is at once withdrawn (almost telescoped into the body), and the cerata rise up from their recumbent position and become very prominent, like the quills of a porcupine. This reaction is instantaneous if the stimulus be strong enough.

The size of fifteen specimens taken on October 24th, 1889, varied from $\frac{1}{4}$ inch to a little over 1 inch in length, only two specimens being under $\frac{1}{2}$ inch. The smallest specimen, $\frac{1}{4}$ inch long, had seven or eight rows of papillæ, while the anterior angles of its foot were rounded, not produced into recurved processes. In a specimen $\frac{7}{8}$ inch long the number of rows of cerata was fifteen or sixteen. The white "ruff" round the neck, as Mr. Cocks stated, is a good and permanent specific character. It appears to be caused by the cerata of the first two rows having each a very short hepatic diverticulum, instead of one reaching to the tip of the papilla.

The colour of the dorsal papillæ varies from a pale greenish fawn-colour to a dark brown. The tips are yellowish, sometimes almost white. The basal portions of the cerata of the ruff are always coloured like those behind, the colour being in all cases due to the hepatic cæca.

23. Æolidiella glauca, *Ald. and Hanc.*

I found a single specimen of this species, nearly an inch in length, under a stone at low water on the shore beneath Lord Mount Edgcumbe's winter villa on October 11th, 1890. The animal was white in colour, the hepatic cæca being of a fawn-colour, deeper below than above. Much opaque white was scattered on the back of the head and body, on the oral tentacles, and on the cerata. The curious vermicular character of the cerata, the suddenly attenuated extremity of the broad foot, and other points, readily dis-

[1] The same was the case with a number of the posterior cerata in one of the individuals taken on October 24th.

tinguish this species from its allies. In general appearance this specimen much resembled an *Æ. Alderi*.

Sub-family 2.—CRATENINÆ.

19. CRATENA, *Bergh*.

24. CRATENA VIRIDIS, *Forbes*.

MONTAGUA VIRIDIS, *Forbes*. Ann. Nat. Hist., v, 1840, p. 106.
EOLIS VIRIDIS, *Forbes*. Alder and Hancock, Monograph, Fam. 3, pl. xxxii.
— GLOTTENSIS, *Alder and Hancock*. Monograph, Fam. 3, pl. xxix.
— ARENICOLA, *Forbes, MS.* Alder and Hancock, Monograph, Fam. 3, pl. xxxi.
— NORTHUMBRICA, *Alder and Hancock*. Monograph, Fam. 3, pl. xxxi.

Four individuals of this species have been taken. One small one was dredged on September 24th, 1889, in about ten fathoms water, a quarter of a mile south-south-east of the Mewstone, on weedless ground. It was found by Mr. Bourne creeping on a mass of *Lepralia foliacea*. It possessed nine transverse rows of cerata, the first half-row consisting of two very small cerata, the second half-row of three, the third and its successors of four, while the eighth and ninth half-rows consisted of three and of two cerata respectively. The four anterior rows were set closely to one another, and were separated by an interval from the posterior rows, which were placed behind each other at regular distances. The hepatic cæca were very dark green in colour, and all the tissues were permeated with a green tinge.

The second specimen, of the same size and colour, was dredged on similar weedless ground in October.

The third was considerably larger, and was found among Polyzoa and Hydroids by William Roach inside the Sound during the first week of November.

The fourth was a very young individual, dredged near the Duke Rock on a stone covered with *Eudendrium capillare*, February 18th, 1890. The colour—a greenish yellow—was confined to the hepatic cæca. The cerata were as contractile and muscular as the tentacles.

The three "species," *glottensis, arenicola*, and *northumbrica*, described in Alder and Hancock's Monograph, appear to be merely slight varieties or different stages of *Cratena viridis*. Only a single example of each type has been recorded. Our first specimen was undoubtedly of the same species as the type of *glottensis*, but differed from it in not having the tips of the cerata orange-coloured, nor were the rhinophores thickened at the tip. *Eolis arenicola* may be distinct, but Forbes's specimen was probably an exceptionally large

Cratena viridis. In contrasting *Eolis northumbrica* with *Eolis viridis,* Alder and Hancock entirely overlooked the fact that in Forbes's original specimen of the latter species the rhinophores were described as being "rugose, or wrinkled concentrically." It is a very common occurrence for an Æolid possessing "smooth" rhinophores to contract them so as to give them the appearance of being "ringed" or annulate in structure; and I cannot help regarding the appearance described in *Eolis northumbrica* as being probably a transient, and not a specific difference.

Cratena viridis has been found in greatest abundance at St. Andrews by Prof. McIntosh,[1] who notices how readily this species loses its characteristic coloration in captivity. I can confirm Prof. McIntosh's statement by my observations on our Plymouth specimens.

25. *Cratena olivacea, *A. and H.* (= *Cavolina olivacea* of 1st Rep., p. 183).

This species has not again been obtained.

Sub-family 3.—Tergipedinæ.

20. Tergipes, *Cuvier.*

26. *Tergipes despectus, *Johnston.*

This species has not been noticed since my former Report.

21. Galvina, *Ald. and Hanc.*

27. Galvina exigua, *A. and H.*

This species has been taken on two occasions. One specimen was found among *Halecium* and *Eudendrium* on stones dredged near the Duke Rock, March 27th, 1890. It possessed five rows of cerata, the first half-row consisting of three cerata, the middle half-rows of two, and the posterior of one. The dorsal tentacles were twice as long as the oral. The cerata and tentacles were banded transversely with belts of olive-green, and there were reticular patches of the same pigment upon the dorsal integument.

Another specimen, quite colourless, was taken on *Halecium* dredged near the same spot on April 9th. It was some time before this individual was noticed, owing to the perfect resemblance of its cerata in form and colour to the white elongate gonophores of the Hydroid.

[1] Loc. cit., p. 5.

28. *Galvina tricolor, *Forbes* (= *Cavolina Farrani* of 1st Rep., p. 193).

Eolis tricolor, *Forbes*. Ald. and Hanc., Monograph, Fam. 3, pl. xxxiv.
— Farrani, *Alder and Hancock*. Monograph, Fam. 3, pl. xxxv.
— Adelaidæ, *Thompson*. Ann. and Mag. Nat. Hist. (3), vol. v, 1860, p. 49.
— — *McIntosh*. Mar. Inv. and Fish, St. Andrews, p. 86, pl. ii, fig. 11.
— Andreapolis, *idem*. Proc. Roy. Soc. Edin., 1864–5.
— Robertianæ, *idem*. Do. do.
— Farrani, *idem*. The Marine Invertebrates and Fishes of St. Andrews, 1875, pl. ii, figs. 12, 13.
— tricolor, *Forbes*. Friele og Hansen. *Bidr. til Kundsk. om de Norske Nudibranchier*, Vidensk. Selsk. Forhandl., 1875.

I have followed Friele and Hansen in uniting *G. Farrani* with *G. tricolor*.

Three individuals were found feeding upon *Obelia geniculata*, growing on *Laminaria*, on September 30th, 1889, measuring from $\frac{3}{8}$ to $\frac{1}{2}$ inch in length. One was quite white in colour, except for a faint tinge of fawn-colour in the cerata (due to the hepatic cæca), another was entirely orange-coloured, and in the third specimen the body was white, with deep orange-yellow patches on the back and on the front and sides of the head; the larger cerata near the median line were orange-coloured with a few markings of purplish umber, and the rest were of a much paler yellowish colour. All the cerata had white tips, bounded below by a narrow purplish ring, merging below into a ring of orange.

On October 2nd two more specimens were obtained under similar conditions, one being $\frac{5}{16}$, the other $\frac{7}{16}$ inch long. The former was exactly like the first specimen here described, while the latter was white, with orange-tipped cerata and tentacles, the orange pigment being also traceable on the back as well as over the surface of the cerata.

Three days later four more individuals were found upon *Laminaria saccharina* dredged in the Cattewater, the weed having no *Obelia* growing upon it, but quantities of slender branching algæ and of a calcareous Polyzoan. They were from $\frac{5}{16}$ to $\frac{3}{8}$ inch long. In one individual the back was of a semi-transparent white, with patches of deep orange-red and a certain amount of reticulating purplish pigment. There was a broad patch of deep purple on the front of the head, while in front and at the sides of the rhinophores there were patches of deep orange-red. The oral tentacles and tip of the "tail" were orange-coloured. The cerata were of a violet colour, faint below, with conspicuous orange tips. Two other individuals were white with fawn-coloured cerata, spotted profusely with microscopic opaque white spots, and having white tips. One had

seven rows, the other eight, of cerata. In the latter specimen there was one reticulating violet spot on the anterior part of the back, and another more compact orange spot about the middle. The fourth individual was white, with orange-tipped cerata. The oral tentacles were entirely orange-coloured. The distal halves of the rhinophores were orange-coloured, the proximal white. The back showed a number of orange-coloured spots and faint traces of violet.

When an individual of this species is in motion the oral tentacles are kept in a nearly horizontal plane, constantly touching the surface upon which the animal is creeping; on the other hand, the rhinophores are kept erect, extending outwards and somewhat forwards, in this way testing obstacles in the water, which are out of the range of the oral tentacles. If the tentacles or dorsal integument be touched, the animal at once contracts and erects its cerata: this reaction cannot usually be produced by touching the cerata themselves, which possess little power of sensation. There is a slight break in the regular sequence of the rows of cerata after the fourth (or sometimes the third) row; here the heart may be seen beating.

The curious fact that all the specimens of this Æolid obtained by us in 1888 and 1889 were found during a limited period in late autumn, from the end of September to the commencement of November, coupled with the fact that the individuals taken at the beginning of this period were slightly smaller in size than those found in November, led me to make particular search for the species during the spring of this year. I examined repeatedly blades of *Laminaria* for this purpose, but found not a single specimen, but a bottom tow-net devised by Mr. Cunningham and worked in Cawsand Bay during May and June brought up, among the filamentous algæ so abundant there, a number of Æolids which I cannot but regard as the more advanced stages in the growth of this species. I was unable to devote much attention to them, but give here some notes drawn up after an examination of two individuals.

Rhinophores long; almost, if not quite, equalled in length by the oral tentacles. *Cerata* in about nine or more rows, four cerata in each lateral half of a transverse row, perhaps five in some, the external cerata being much smaller than the internal; inflated, semi-transparent, with tips orange-coloured in one specimen, whitish in the other. *Hepatic cæca* slender, sacculated, running up to the tips of the cerata; over the cerata a faint sage-green pigment spread. *Body* very slender when thoroughly entended, approaching $\frac{3}{4}$ inch in length. The back covered with large conspicuous orange-red or almost crimson spots, each spot surrounded by an area of sage-green pigment consisting of a mass of microscopic sage-green dots. These also give rise to the faint sage-green pigment of the cerata.

There were no orange spots on the cerata. The rhinophores had a band of reddish pigment in the same region as the band of brown in *G. picta*.

In motion the oral tentacles were kept horizontal upon the bottom, and were then generally flattened out at the tips (cf. McIntosh on *Eolis Andreapolis*, l. c.). When the light was suddenly cut off from these individuals the action was followed by a slight erection of the tentacles, and by short restless movements of the head and anterior cerata—the animals having previously been quite still. But the cerata were not erected by this stimulus, although they were by touching the head as above described. The eyes were distinct, but not unusually large.

These two individuals were taken on May 14th. Two days later they had laid two ribbon-like pieces of spawn, which were not attached to the sides of the dish, but floating on the surface of the water.

On June 25th a smaller individual was obtained from the same place, orange-coloured all over, but possessing patches of a deeper reddish-orange and brownish colour on the back. The tips of the cerata were also more intensely orange-coloured.

On October 16th two very small specimens (2 mm. long) were found among *Obelia* on *Laminaria* trawled at Batten.

29. *Galvina cingulata, *Ald. and Hanc.*

Another individual of this species was found on August 21st among *Cladophora* from either Drake's Island or below the bathing pond. It measured $\frac{5}{16}$ inch in length. The lateral lines of olive-brown between the cerata were well marked, as also the patch of the same pigment behind the rhinophores. The cerata were arranged abnormally. Usually the rows of cerata on one side of the body are in the same transverse lines as those of the other side; but in this individual only the first and second rows were so arranged; the five succeeding pairs of lateral rows were arranged alternately, not in the same transverse lines. The heart was situated in the centre of the second transverse row of cerata.

Sub-family 4.—Coryphellinæ.

22. Coryphella, *Gray.*

30. *Coryphella rufibranchialis, *Johnston.*

No additional examples of this species have been taken during the past year, unless further observations should confirm Trinchese's view that the two following "species" are merely varieties of *C. rufibranchialis*. Herdman[1] and Clubb, however, have had good

[1] *Third Report on Nudibranchiata*, l. c., pp. 140—143.

opportunities of investigating this question, and are convinced of the distinctness of the species *rufibranchialis* and *Landsburgii*.

31. Coryphella gracilis, *Ald. and Hanc.*

Two individuals, agreeing with Alder and Hancock's description of this species, have been taken this year. One small specimen was dredged on May 13th in the Sound between the Duke Rock and Jennycliff, and another individual was obtained with the bottom tow-net in Cawsand Bay, July 7th. This latter specimen was kept alive for several weeks, and some time after its capture it was noticed that the hepatic cæca were of a ginger-yellow colour, like the original example of Alder and Hancock. I believe, however, that the colour was more reddish at the time of capture, and that it faded under the conditions of its captivity.

I was very much surprised to find that this individual responded to shadows as stimuli for the erection of its cerata, unlike any other nematocyst-bearing Æolid with which I have experimented. The reaction was like that exhibited in *Hermæa bifida* (*supra*), although not quite so rapid and complete. The eyes are conspicuous in this species, and relatively larger than in other Æolids which do not respond to this stimulus.

The opaque white spots at the tips of the cerata were not very regularly distributed: they were mostly in the form of semicircular patches on their anterior faces, as in *Facelina coronata* and *Drummondii*.

32. *Coryphella Landsburgii, *Ald. and Hanc.*

Another individual of this species, half an inch in length and of an extremely slender and attenuated form, was trawled on the 25th September this year by Mr. Cunningham among Hydroids (*Obelia geniculata* on *Laminaria*, *Sertularella Gayi*, and a little *Antennularia*) near the Duke Rock. In colour and markings it was quite normal and very transparent.

Sub-family 5.—Favorininæ.

23. Favorinus, *Gray.*

33. Favorinus albus, *Ald. and Hanc.*

Two individuals were found together on the under surface of a large flat stone at the east end of Drake's Island, low water, spring tide, November 22nd, 1889. On the same stone was the spawn of some Nudibranch (probably *Polycera quadrilineata*), in five or six circular ribbon-like patches; upon this spawn in captivity the

Æolids fed (cf. Alder and Hancock, Monograph). One of the individuals, more closely examined, was found to be $\frac{3}{8}$ inch long, and was entirely of an opaque white colour except for the rhinophores, which were deeply pigmented brown over the lower two-thirds of their length. The distal portion was pointed at the tip, and opaque white in colour. The infra-apical bulb never assumed the form of the "button-like expansion" figured by Alder and Hancock; indeed, there was no trace of it at times. Just below the bulb, at the junction of the white and brown portions, the left rhinophore was curiously and abruptly bent forwards, and this condition was persistent. The rhinophores over their pigmented portion were finely perfoliate, the laminæ apparently resembling those of *Facelina punctata*.

The cerata react to stimuli upon the head, as in *Galvina tricolor*; there is no reaction upon touching the back or the cerata themselves, or to shadows.

Opaque white spots were distributed upon the back, as described in the Monograph; they existed also at the tips, and occasionally over the whole external integument of the cerata.

This individual spawned on a stone a week after its capture, the spawn being exactly as described by Alder and Hancock.

Another small specimen, $\frac{1}{4}$ inch in length, was taken with the bottom tow-net in Cawsand Bay on the 7th of July. The infra-apical bulb of the rhinophores was quite absent.

Sub-family 6.—Facelininæ.

24. Facelina, *Ald. and Hanc.*

34. *Facelina coronata, *Forbes.*

Two more specimens have been dredged near the Duke Rock; one on September 23rd, 1889, the other in July, 1890. Another fine specimen, $1\frac{1}{8}$ inches in length, was found among *Obelia geniculata* on *Laminaria* dredged near the end of Batten breakwater (west of the Cobbler Buoy) on October 2nd, 1889: on the same piece of weed were two *Galvina tricolor*. The hepatic cæca were fawn-coloured, red at their extremities. Down the front of each of the cerata was a streak of opalescent blue; this characteristic coloration also existing, though more faintly, on the head, oral tentacles, and in patches on the back of the body. There was a more or less regular semilunar patch of opaque white on the anterior face of each of the cerata near the tip, and this was generally continued as a streak of white down the anterior face for a short distance.

On October 8th, 1890, a small specimen, not quite $\frac{5}{16}$ inch in length, was found again among *Obelia* on *Laminaria* dredged in the Cattewater. The *foot* of this individual was broad and thin as in *F. Drummondii*,

not elongate and narrow as usually in *F. coronata;* its anterior angles were produced into long processes. The *oral tentacles* were very long and slender, rather over $\frac{1}{8}$ inch in length (cf. A. and H. on this character in young specimens of *F. Drummondii*). *Rhinophores* perfoliate, with numerous laminæ alternately larger and smaller, resembling those described and figured by Alder and Hancock for *F. Drummondii* much more than for *F. coronata* (where they are less numerous). When contracted the rhinophores appeared to be annulate, not perfoliate. *Cerata* very numerous, clustered, the first cluster being very large; very contractile and changeable in shape, capable of much elongation. *Colour* of body transparent white, with patches of opalescent blue spots on the head, back, along the oral tentacles, and on the anterior faces of a few of the larger cerata. *Hepatic cæca* granular, yellowish brown; no pink or red at all in this specimen. Crescentic patches of opaque white on the anterior faces of the tips of the cerata.

In all points of external form and in the colour of the hepatic cæca this specimen agrees much more with the descriptions of *F. Drummondii* than with those of *F. coronata,* but on account of its possessing the opalescent blue markings, characteristic of the latter species, and not known to occur in the former, I have referred it with some hesitation to the species *coronata.* The specimen described in my former Report under the provisional name of *Eolis Huxleyi* (l. c., pp. 194, 195) I am inclined now to regard as a young *Facelina coronata,* in which some of the cerata had been broken off anteriorly. In very many points it agrees perfectly with the young individual just described.

The long oral tentacles of *F. coronata* are naturally employed very differently from the short tentacles of *Galvina tricolor;* they are not kept motionless and flat in locomotion, but are swayed about, feeling the surface and the surrounding medium on all sides. It may be noticed in Æolids that the oral tentacles are as a rule particularly long where the dorsal tentacles are laminated or otherwise distinctively specialised for olfactory purposes. This increased development of the oral tentacles probably saves the rhinophores from many liabilities to danger. That this view of the correlation is not merely fanciful is borne out by the condition of the same parts in the *Holohepatica,* where the rhinophores are protected either by being retractile into sheaths (*Doridid*æ *cryptobranchiat*æ), provided with special tactile appendages (*Ancula cristata, Idalia*), correlated with special development for tactile purposes of the oral tentacles (*Goniodoris*) or anterior extensions of the pleuropodia (*Triopa claviger, Polycera*), or by having the laminated portion bent backwards (*Acanthodoris pilosa, Polycera*). When a *Facelina coronata* also is at rest

the rhinophores are frequently thrown back on the dorsum between the lateral halves of the first cluster of cerata.

35. *Facelina punctata, *Ald. and Hanc.* (= *Flabellina punctata*, 1st Rep., p. 192).

This species has not again been taken.

Sub-family 7.—Antiopinæ.

25. Antiopa, *Ald and Hanc.*, 1848 (=*Janus*, Verany, 1844 ; not Stephens, 1835).

36. *Antiopa cristata, *Della Chiaje.*

Two more specimens have been taken : one, an inch in length, was trawled in the Sound between the Mallard Buoy and the Merchants' Anchorage on July 26th by Prof. Johnson, who found it among red branching weeds and *Laminaria ;* the other, also a large specimen, was discovered by Mr. Minchin in a tide-pool near the bathing pond late in August. It was creeping near the surface of the water over the *Cladophoræ* and other weeds of the pool, the delicate blue tips of its cerata being very conspicuous.

It is said by M. Giard[1] to be, at Wimereux, like *Thecacera pennigera*, particularly an autumn species feeding upon *Bugula*. Curiously enough, my friend Mr. Vallentin dredged an individual of each of these species at the same haul in Falmouth Harbour in the spring of this year, along with numerous oyster-valves covered with *Bugula flabellata*.

Section C.—HOLOHEPATICA, Bergh.

Sub-section—Anthobranchiata,[2] *Goldfuss*, 1820 (= Pygobranchia, *Gray*, 1821).

Family—DORIDIDÆ.

Sub-family—Doridid æ cryptobranchiatæ, *Bergh.*[3]

26. Archidoris, *Bergh.*

37. *Archidoris tuberculata, *Cuvier.*

As the colours of this species have a general resemblance to those

[1] Giard, Bull. Sci. France et Belg., 1888, p. 502.

[2] For the classification of the *Anthobranchiata*, cf. Abraham, Proc. Zool. Soc., 1877, pp. 196—269, pls. xxvii—xxx.

[3] Bergh, *Gattungen nordischer Doriden*, Arch. f. Naturgesch., Jahrg. 45, Bd. i, pp. 340—369.

of the sponges upon which it usually feeds, and as these sponges are themselves very variable in colour, a number of differently coloured specimens of this Nudibranch were kept in one of the small tanks in the Laboratory, and fed under similar conditions upon the same pieces of *Halichondria*, which were obtained of as uniform a colour as possible. After several months no change was detected in the colouration of the Nudibranchs. The species cannot therefore be regarded as possessing the power of variable protective resemblance.[1]

My friend Mr. Rupert Vallentin has several times sent me large individuals of this species from Falmouth, which have been of a much paler colour than is usual at Plymouth, although such individuals occur.

With regard to the spawning period of this mollusc, I may add to my previous account that specimens which had been living in the aquarium for some time last winter were found to have deposited spawn early in January.

38. Archidoris flammea, *A. and H.*

Near the Duke Rock a sponge of *Desmacidon*-like appearance, with prominent oscula, but of a bright red colour, is very common; and while looking over a quantity of the sponge early in April last I found an individual of this species feeding upon it, in dimensions just under three quarters of an inch long and half an inch broad. The colour of the Nudibranch closely approached that of the sponge, but had a more orange tinge. There were a few scattered purplish spots in the middle of the back. The animal was very flattened in form and very changeable in shape. Rhinophoral fossæ very wide and capacious, and tuberculated at their edges. Rhinophores and branchiæ completely retractile. It was occasionally seen to float inverted at the surface of the water.

On a piece of the sponge preserved in alcohol for identification I subsequently found another, rather smaller specimen of the same species. It was in a conspicuous position on the sponge, and I must have overlooked it when alive owing to the similarity of its colour to that of the sponge.

If this species should be found to feed generally upon red sponges, the adaptation will be of considerable interest. Perhaps its rarity may be due, as in many other cases, to an insufficient knowledge of its peculiar habits. I am inclined to believe that the red Dorises

[1] Mr. Poulton (The Colours of Animals, 1890, p. 108) has mentioned the probable existence in this species of the power of adjustment of its colour to that of its surroundings. Prof. Stewart's specimens, however, were in all probability not *tuberculata*, but a distinct species.

which Prof. Stewart found upon *Hymeniacidon sanguineus* (cf. my previous Report, p. 177) were large specimens of this species.

Another specimen, half an inch long, was again dredged on the same ground early in June.

It is important to prevent any confusion between this species and *Doris* (*Rostanga*) *coccinea*, which is also red in colour. The best character by which to distinguish them at once is the structure of the anterior portion of the foot: in *flammea* this is entire, and separated from the rest of the foot by a transverse groove only; but in *coccinea* it is split into two lateral portions, as in *Doris* (*Jorunna*) *Johnstoni* and *Doris* (*Platydoris*) *planata*. Alder and Hancock's two specimens were dredged in shallow water, Rothesay Bay, adhering to *Pecten opercularis*. Prof. Ed. Forbes dredged it off the Isle of Man in 25 fathoms. Dr. Norman has also found the species at Cumbrae, and Mr. Cocks recorded it in 1849 as "very rare, on stones at extreme low-water mark, spring-tide," at Gwyllyn Vase, Falmouth.

27. Jorunna, *Bergh.*

39. *Jorunna Johnstoni, *A. and H.* (= *Archidoris Johnstoni*, 1st Rep., p. 177.)

Three more specimens of this species have been obtained. One, half an inch in length, was found under a stone in a pool at Rum Bay on March 7th, and was very sponge-like and inconspicuous. Mr. Bourne also found two specimens on the shore at Wembury Bay, one early in May, and the other a month later.

The dark spots on the back of this animal have been constantly present, but very variable in position; they have the effect of rendering the darkly coloured rhinophores less conspicuous.

28. Platydoris, *Bergh.*

40. *Platydoris planata, *Alder and Hancock* (= *Archidoris planata*, 1st Rep., p. 178.)

Two additional specimens have been taken. One, found at Drake's Island, August 14th, 1889, measures (preserved in spirit) 1⅛ inches long by $\frac{9}{16}$ broad. The gill-plumes are six in number, the third on each side being deeply bifurcated. They were completely retractile, and when protruded appeared to be composed of two distinct lateral halves. The underside of the pleuropodium and the foot were orange-coloured; the pleuropodium in life was often upturned at the edge, showing its orange-coloured under-side. The radula of this specimen is very abnormal, there being three longitudinal series of great irregular teeth formed by the fusion of several of the slender normal ones. On one side two teeth in each row are thus

fused, being united by their bases and at their tips, leaving an enclosed space in the middle. The tips of these double teeth are broad, flat, and triangular. On the other side of the radula there is a row of double teeth resembling those just described, and also a row of large teeth formed in exactly the same way by the fusion of three of the ordinary slender hook-like teeth.

Another specimen was dredged near the Duke Rock on September 24th, 1890, measuring $1\frac{1}{8}$ inches long by $\frac{11}{16}$ broad when at rest, and $1\frac{1}{4}$ inches by $\frac{9}{16}$ inch when *en marche*. Colour precisely as in Alder and Hancock's figure. Gill-plumes, exactly as in the previous specimen, protruded from the wide fossa in two separate tufts, one on each side. Each of these lateral tufts was formed of three plumes, the third on each side being distinctly trifid and very broad, and all the plumes very pinnate in character. On several occasions I saw the tuft of one side retracted independently of the other, pointing to a power of independent contraction of the branchial retractors of each side. This division of the branchial plumes into two independently retractile halves is a very marked character, and has not, I believe, been recorded before.

This genus is distinguished from the *Aldisa*[1] of Bergh, among other characters, in having the anterior lip of the foot deeply split into two lateral halves. This species has comparatively long, slender, and pointed oral tentacles, and the teeth of its radula are not serrulate—characters which also distinguish it from species of *Aldisa*.

29. Rostanga, *Bergh*.

41. *Rostanga coccinea, *Forbes* (= *Archidoris coccinea*, 1st Rep., p. 178).

This species is taken so rarely that its habits remain still uncertain. Mr. Bourne found a fine specimen, $\frac{3}{4}$ inch long and $\frac{5}{16}$ inch broad, on the 1st of August at Drake's Island, low water. It was under a stone resting on black mud with weeds attached, along with *Nebalia Geoffroyi*. There was no sponge or other red substance near. Cocks, and Alder and Hancock found the species fairly common at Falmouth forty years ago.

Sub-family—Doridide phanerobranchiatæ, *Bergh*.

Goniodorinæ.

30. Acanthodoris, *Gray*.

42. *Acanthodoris pilosa, *Müll*.

In addition to the previously recorded specimens, one was taken

[1] Bergh, *Gattungen nord. Doriden*, Arch. f. Naturgesch., lv, p. 348.

on the shore at Wembury by Mr. Bourne on the 5th of May this year, and on the 16th August Dr. Fowler dredged one large specimen, 1½ inches long, of a dark steel-grey colour, and five small ones, ½ inch long, of which two were almost entirely white in colour, and the rest were dark steel-grey.

Mr. Vallentin finds this species abundant at Falmouth on the Helford mud-flats, where young specimens are to be taken from the under sides of *Fucus*. Friele and Hansen (l. c.) also notice this habit.

31. Lamellidoris, *Alder and Hancock.*

43. *Lamellidoris aspera, *A. and H.*

This species has not been obtained since the date of the previous Report. It was not found by Cocks at Falmouth, and seems to be essentially a northern species.

44. *Lamellidoris bilamellata, *Linnæus.*

This species is common at Plymouth, as on most rocky coasts of the North Atlantic; curiously enough, it is not recorded by Cocks from Falmouth.

45. *Lamellidoris sparsa, *A. and H.*

This species has not been taken during the past year.

32. Goniodoris, *Forbes.*

46. *G. nodosa, *Montagu.*

This beautiful little species is very abundant at Plymouth, and I have made use of it for the purpose of testing some of Alder and Hancock's statements about the habits of migration of Nudibranchs. In his account of the Nudibranchiate Mollusca of St. Andrews Prof. McIntosh wrote concerning this species, "There is little to be met with at St. Andrews in support of the statement of the able authors of the Monograph in regard to the disappearance of the adult animal and the growth of the young; for the varying sizes occur throughout the entire year, fine full-grown specimens (1¼ inches) being found in December as well as in March, April, and May."

In order to examine into this matter, therefore, I began in the early spring of last year (1889) to keep a record of all the specimens of this species observed or captured. During February, and especially during March, April, and May, large individuals (1 inch long) were extremely abundant on the rocks below the Laboratory and

under the Hoe whenever they were visited at low water. They were congregated generally in groups of five or six together, but not infrequently I found isolated couples. They were most plentiful on rocks covered with the red gregarious Tunicate, *Styela grossularia*, and on this and elsewhere their spawn was abundant. Small individuals (*i. e.* of ½ inch and under) were not found upon the rocks at all, nor were they to be obtained with the dredge in deeper water. Veligers, however, were regularly taken during the early spring months in the surface-net. During June the numbers of mature individuals found on the shore, and at the same time the quantity of spawn, became appreciably reduced, and July found them more or less rare. Very small specimens were noticed in the contents of the dredge in June, and were frequently taken during July and August. My observations were here interrupted for several weeks, but on October 8th a specimen rather over ½ inch in length was trawled in the Cattewater; next day one of the same size was dredged on *Zostera* in Cawsand Bay, and on the 10th I found one also under a stone at extreme low water (spring tide) in Rum Bay. The dredge continued to bring up specimens between ½ and ¾ inch long off the Duke Rock and elsewhere, but they were never in such numbers as were those of July. On November 22nd during a spring tide I found a large one on a stone at Drake's Island, and on the 25th in a small crevice of rock under West Hoe, rather high up between tide-marks, I found two large ones together. I could find none at this time under the bathing pond. I brought the two large ones to the Laboratory, and placed them in an aquarium; on the 6th of December one of them deposited some spawn, and another piece was laid three days later. On the 20th of February this year, full-sized mature specimens, in considerable numbers, were copulating and depositing eggs on the rocks below the Laboratory, below the bathing pond, and at Drake's Island. At Drake's Island one individual was under ⅔ inch in length.

It is obvious from these facts that at Plymouth the habits of the species and its rate of growth are very much as Alder and Hancock found to be the case on the coast of Northumberland; and this induces me to believe that at St. Andrews also more detailed observations would lead to a similar conviction.

The rate of growth of the species is to some extent indicated by the following measurements of the individuals dredged at Plymouth during the present year up to the end of August.

June 26th.—One specimen dredged off the Duke Rock, just over ⅛ inch in length, and having three branchial plumes only on each side.

June 27th.—One specimen $\frac{3}{16}$ inch long, taken among weeds with the bottom tow-net in Cawsand Bay.

July 7th.—Eight specimens taken in Cawsand Bay with the bottom tow-net, varying in size from $\frac{1}{8}$ inch to nearly $\frac{1}{4}$ inch when completely extended. The largest individuals had seven branchial plumes only, the largest being median and anterior.

July 11th.—One, $\frac{3}{16}$ inch long when not fully extended (probably $\frac{5}{16}$ inch when extended), dredged off the Duke Rock. I found it on a colony of the compound Ascidian *Fragarium elegans*, and it was apparently feeding upon it.

July 24th.—One, $\frac{3}{8}$ inch long, on a stone dredged off the Duke Rock.

August 6th.—Three, the largest just over $\frac{1}{4}$ inch long, dredged off the Duke Rock.

August 7th.—Two, just over $\frac{1}{4}$ inch in length, dredged off the Eddystone in 25—40 fathoms, one mile south of the Hand Deeps.

August 11th.—Eight specimens, from $\frac{3}{16}$ inch to just over $\frac{3}{8}$ inch long, on stones dredged off the Duke Rock.

August 13th.—Three specimens dredged two miles south of the Mewstone, one being $\frac{3}{16}$, one $\frac{3}{8}$, and one $\frac{7}{16}$ inch long. The first specimen possessed an unusually broad foot, which, when the animal was viewed from above, extended beyond the pleuropodial frill on each side. This specimen agrees, therefore, with Montagu's *Doris marginata*, and shows the probable correctness of his figure—contrary to the opinion which Alder and Hancock expressed in their Monograph.

August 18th.—One specimen, $\frac{3}{8}$ inch long, on a stone covered with encrusting polyzoa and algæ, extreme low water, spring tide, east end of Drake's Island.

August 24th.—Two specimens, each $\frac{7}{16}$ inch long and with eleven branchial plumes, found under a stone in Bovisand Bay at low water, neap tide, by Mr. M. F. Woodward.

August 25th.—One, $\frac{3}{8}$ in. long, dredged between Picklecombe Fort and the Breakwater.

These statistics, in conjunction with the facts concerning last year's specimens, show conclusively that the eggs laid in the early spring have passed through their metamorphoses, assumed the specific form, and attained an average size of $\frac{1}{8}$ inch towards the end of June. The young Nudibranchs grow in size, being $\frac{1}{4}$ inch in length by the middle of July and $\frac{3}{8}$ inch by the middle of August. In October the average size[1] is $\frac{2}{3}$ inch, and by the end of November the specimens most frequently found are nearly $\frac{3}{4}$ of an inch in length, while they may attain to maturity in December under exceptionally warm conditions.

[1] This average is probably a little too high for the individuals which are still some distance from the shore. On October 16th, of seven specimens dredged near the Duke Rock, one was $\frac{3}{16}$ inch, one $\frac{1}{4}$ inch, four $\frac{5}{16}$ inch, and one $\frac{3}{8}$ inch in length.

The same statistics show that the veligers are carried out to considerable distances from the shore and that after falling to the bottom and undergoing their metamorphoses they gradually make their way to the shore. This year I found the first individual which had so migrated on August 18th at Drake's Island; and a few days later, as we were doing some collecting on the shore at Bovisand, Mr. Woodward found two more. During July and August I could not find a single large or mature individual either on the shore or with the dredge; and this leads to the conclusion that the disappearance of the old individuals after the spawning has been accomplished is due, not to a re-migration into deeper water or to habits of concealment, but to death. *Goniodoris nodosa* is an annual, and dies when it has ceased to deposit its eggs in the spring and early summer (cf. Woodward, Manual of Mollusca, 4th ed., p. 12).

Young specimens differ from full-grown individuals in several points of structure as well as in size. The pleuropodial frill is relatively larger, and is generally freely scalloped at the edge. I have given a representation of the animal at this stage ($\frac{1}{4}$ inch in length) on Pl. XXVII (fig. 4). The points formed by the scalloping are to be compared homologically with the filaments of *Idalia* and allied forms: they generally contain special aggregations of opaque white gland-cells, comparable with those of the pleuropodial filaments of *Ancula*, *Triopa*, &c. (cf. Herdman and Clubb, 3rd Rep., pp. 136 and 184; Friele and Hansen on *G. Danielsseni*, l. c., p. 72).

The specimens of the so-called *Doris Barvicensis* of Johnston which were found by Allman among the roots of *Laminaria digitata* in Courtmasherry Harbour in August and September, 1838 (see Thompson, 'Ann. Nat. Hist.,' vol. v, p. 87), and the *Goniodoris emarginata* of Forbes dredged in twenty fathoms off the Isle of Man in October, 1839 ('Ann. Nat. Hist.,' vol. v, p. 105), were undoubtedly young specimens of *Goniodoris nodosa* migrating to the shore.

Another difference of considerable morphological importance between the young and adult *Goniodoris nodosa* is to be found in the condition of the posterior portion of the pleuropodial frill. In young specimens the lateral portions of this structure are invariably discontinuous posteriorly, as represented in my figure: this condition is persistent in *Goniodoris castanea* throughout life, as it is in the closely allied genus *Idalia*. But as the animal grows the basal portions of the posterior terminations of these folds become connected together, and give rise to a continuous circular fold like that of *Archidoris*, which differs from the latter, however, in being deeply notched or emarginate posteriorly. This has been hitherto regarded as the final character assumed by the fold in the species, and ex-

cellent figures of this condition are to be seen in Alder and Hancock's Monograph. I find, however, that in very large individuals continuous growth may entirely obliterate all trace of the fusion which has taken place, so that a continuous, even, and circular fold is formed around the back (*nothæum*) of the animal, exactly as in *Archidoris, Lamellidoris,* &c. Pl. XXVII, fig. 6, represents this condition in a preserved specimen measuring $\frac{13}{16}$ inch in length and $\frac{1}{2}$ inch in breadth.

The process of growth thus described as taking place in the individual *Goniodoris nodosa* throws considerable light upon the question of the origin of the circular fold of *Archidoris*. It is many years since Huxley[1] suggested its homology (in part) with the paired "epipodia" of *Aplysia;* but although the suggestion has met with approval[2] little direct evidence has been collected in support of the view. The ontogeny of *Goniodoris nodosa,* however, shows conclusively that the circular fold has been arrived at by a process of posterior fusion of a pair of lateral folds; for the anterior union is clearly also secondary: the primitively discontinuous condition is persistent in *Polycera lessonii.* Therefore the origin of the circular fold of *Archidoris* and its allies from primitively paired lateral folds can no longer be considered as doubtful; and the existence of transition forms like the *Lomanotidæ* and *Ascoglossa* renders the homology of these paired folds with the "epipodia" (or better, "pleuropodia") of *Aplysia* almost certain.

In some way, perhaps, related to the fusion of the pleuropodia posteriorly is a curious transparent spot shown in my figure of the young *Goniodoris nodosa,* situated between the anus and the terminations of the folds. This was mistaken by Johnston (Ann. Nat. Hist., vol. i, p. 55) for a pore, but there is no perforation. Alder and Hancock rightly corrected this mistake, but fell into error in adopting Allman's explanation of it. Allman informed Mr. Thompson (Ann. Nat. Hist., vol. v, p. 88) that the pore-like appearance was "merely formed by the partial apposition of the edges of a slit existing in the posterior margin of the mantle, and which approximation is dependent on the will of the animal;" and Alder and Hancock followed him in stating that the spot was merely "caused by a deep indenture of the cloak." This is not the case, for the spot in question is simply an oval area from which the minute

[1] Huxley, *Morphology of the Cephalous Mollusca,* Phil. Trans., 1852.

[2] Cf. Lankester, *Mollusca,* Encycl. Brit., 9th ed., vol. xvi; Fischer, Manuel de Conchyliologie, 1887, p. 518 (Fischer's view is that the nothæum of *Doris* represents at the same time both the "epipodial" lobes of *Elysia* or *Aplysia* fused in the median line and the cephalic disc of *Philine*); Herdman and Clubb, *Third Report on the Nudibranchiata,* l. c., p. 147; also my *Report on the Nudibranchiata,* l. c., p. 181.

33. Idaliella, *Bergh.*[1]

48. *Idaliella (Idalia) aspersa, *A. and H.*

Only the two specimens described in my previous Report have been obtained by us.

34. Ancula, *Lovén.*

49. *Ancula cristata, *Alder.*

Only four additional specimens have been obtained. Three were found on the north side of Drake's Island at low water, one about the middle of May and two on the 3rd of June. These individuals were mature, but a small one $\frac{5}{16}$ inch long was taken with the bottom tow-net in Cawsand Bay on the 7th July. It bore a specimen of the remarkable parasitic Copepod, *Splanchnotrophus*, whose egg-sacs protruded through the back of the animal just in front of the anus. Two days later the parasite with its long tentacle-like processes had crawled out of the *Ancula*, which was only half its original size, and was being steadily devoured.

Professor Herdman[2] has found this species in extraordinary profusion at Hilbre Island during the breeding season; on one reef of rocks "for yards it was impossible to walk without treading on them, and handfuls were readily collected by scraping the specimens together from the mud-covered rocks." He also finds that the animal loses much of its conspicuous yellow coloration with age, and records some interesting observations on its means of defence against waves and strong currents (cf. A. R. Hunt, Journ. Linn. Soc., xviii, p. 265).

Polycerinæ.

35. Thecacera, *Fleming.*

50. *Thecacera pennigera, *Montagu.*

We have not yet obtained another specimen of this species. Mr. Vallentin dredged a single specimen in Falmouth Harbour during the spring among oyster-valves covered with *Bugula flabellata.*

[1] Bergh, *Ueber die Gattung* Idalia, Arch für Naturgesch., xlvii, i, p. 7. See also Norman on the name *Idalia*, loc. cit., p. 74.

[2] Herdman and Clubb, Third Report, p. 134; cf. also the Second Report, p. 227, and First Report, 1886, p. 270, and Thompson, Ann. Mag. Nat. Hist., 1860, p. 51.

36. Polycera, *Cuvier*.

51. *Polycera quadrilineata, *Müller*.

Mr. Cunningham's bottom tow-net, designed for catching young flat-fish, brought up several specimens when shot in Cawsand Bay on May 14th and June 25th. The bottom here is sandy, and *Zostera marina*, *Ceramium*, *Antithamnion*, and other weeds are abundant[1] over certain areas. The Nudibranchs were among these weeds when caught. One individual possessed six frontal filaments, and no tubercles at all. The yellow colour was confined to the frontal and "branchial" (pleuropodial) processes, the rhinophores, and tips of the branchiæ.

Three fine specimens were taken by Dr. Fowler on a piece of drift weed at low water, east end of Drake's Island, on July 16th; and three more were found upon *Fucus* and *Ulva* by Mr. De Hamel between tide-marks near the same spot on August 18th. There was much spawn near them at the time of capture, and they continued to deposit it for many days. In captivity, though healthy and with plenty of weeds, they were reduced in size by the end of the month.

This species, as Alder and Hancock inferred, is undoubtedly herbivorous in habit; one or two of the specimens mentioned in my former report were dredged in weedless ground, but all the others have come from localities where algæ are abundant.

52. *Polycera Lessonii, *D'Orb., var.* ocellata,[2] *A. and H.*

At extreme low water on the north side of Drake's Island, June 3rd, I found what was almost certainly another specimen of this variety under a small stone. Unfortunately it was lost, owing to the breakage of a collecting bottle, and was not very closely examined beforehand.

37. Triopa, *Johnston*.

53. *Triopa clavigera, *Müll.*

Another specimen was again dredged off the Mewstone, about two miles south, in the middle of April. The pigment spots on the

[1] See Prof. Johnson's paper on *The Flora of Plymouth Sound*, this Journal, New Series, I, iii, pp. 297, 298.

[2] I have followed Dr. Norman in placing *ocellata* as a variety of *Lessonii*. Herdman and Clubb (Second Report, 1889, p. 227) have noticed the intermediate variations, but it is interesting to note that the type and the variety seem to live, as a rule, under different conditions of depth and food (see Alder and Hancock, Monograph).

back, as in the former specimen, were confined to a median row, excepting two or three small spots to the side.

38. ÆGIRUS, *Lovén.*

54. *ÆGIRUS PUNCTILUCENS, *D'Orbigny.*

A single specimen of this Nudibranch was taken near the Duke Rock on September 26th of this year.

DESCRIPTION OF PLATES XXVII AND XXVIII,

Illustrating Mr. W. Garstang's "Complete List of the Opisthobranchiate Mollusca found at Plymouth, with further Observations on their Morphology, Colours, and Natural History."

PLATE XXVII.

FIG. 1.—*Goniodoris castanea*, A. and H. A young individual, enlarged, possessing oral tentacles of simple, semi-crescentic form.

FIG. 2.—*Goniodoris castanea*, A. and H. Head-region of a full-grown individual, enlarged, showing the double sinuous curve of the anterior edge of the oral tentacles. After Alder and Hancock.

FIG. 3.—*Goniodoris castanea*, A. and H. A coil of spawn of unusual form. Nat. size.

FIG. 4.—*Goniodoris nodosa*, Mont. A young individual, enlarged. The pleuropodial folds are freely scalloped, but, as in *G. castanea* (fig. 1), are discontinuous posteriorly. Between the anus and the posterior termination of these folds is an oval unpigmented spot, represented rather too conspicuously in the figure.

FIG. 5.—*Goniodoris nodosa*, Mont. *α*. Two transverse rows of the radula of a full-grown individual, magnified. Zeiss, obj. A, eye-piece No. 2, *cam. luc.* The denticulations of the inner side-plates ought to be about 24 in number. *β*. The external side-plates of a young individual, $\frac{7}{16}$ inch long, more highly magnified. Zeiss, obj. A, eye-piece No. 4, *cam. luc.* The denticulations of the inner side-plates were 17 in number. In reality, the dimensions of the external side-plates are only $\frac{2}{3}$ those of *α*.

FIG. 6.—*Goniodoris nodosa*, Mont. Posterior region of a large individual ($1\frac{3}{16}$ inch long × $\frac{1}{2}$ inch broad, preserved in spirits), enlarged, showing the complete continuity of the pleuropodia behind.

PLATE XXVIII.

FIG. 1.—*Lomanotus.* A young individual, $\frac{3}{16}$ inch long, somewhat contracted, seen from the right side, and enlarged. The figure shows the continuity between the pleuropodial ridge and the postero-lateral tubercle of the sheath of the rhinophore. In this region of the sheath a diverticulum of the liver is seen to exist, as well as in each of the triangular papillæ of the pleuropodium. The eye-spot lies under the sheath of the rhinophore; the anal papilla is not represented. The two short oral tentacles of the right side are shown, as well as the right anterior process of the foot. Drawn from life; the animal, however, was not very healthy.

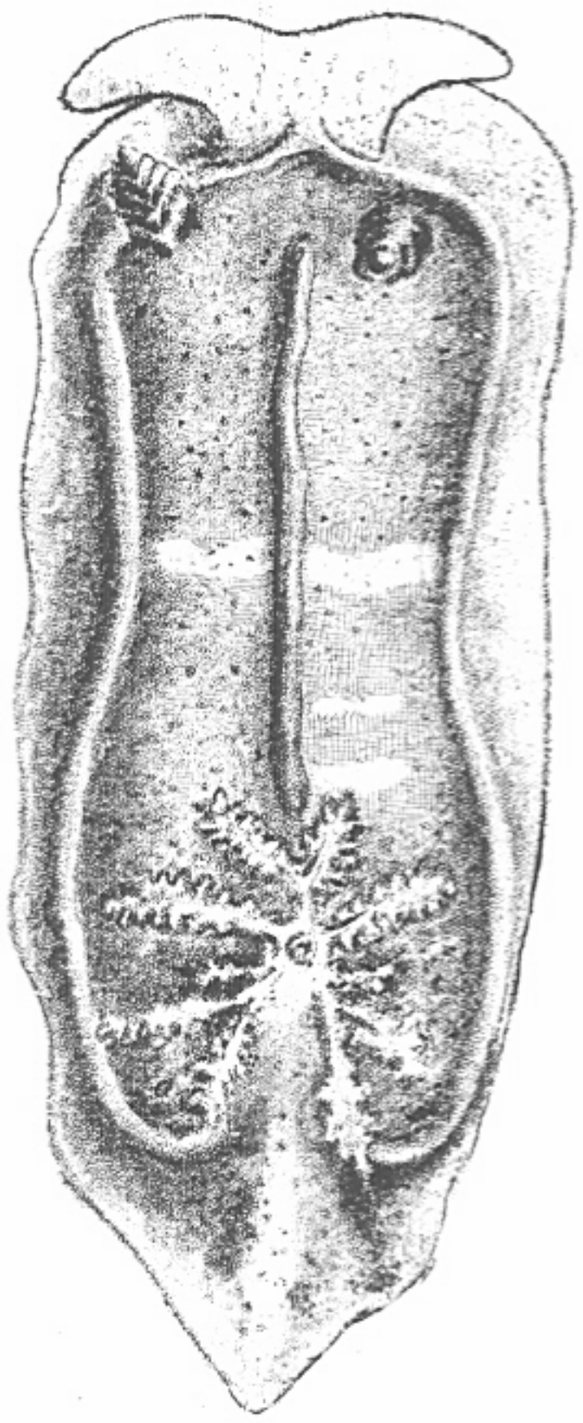

Fig. 1.

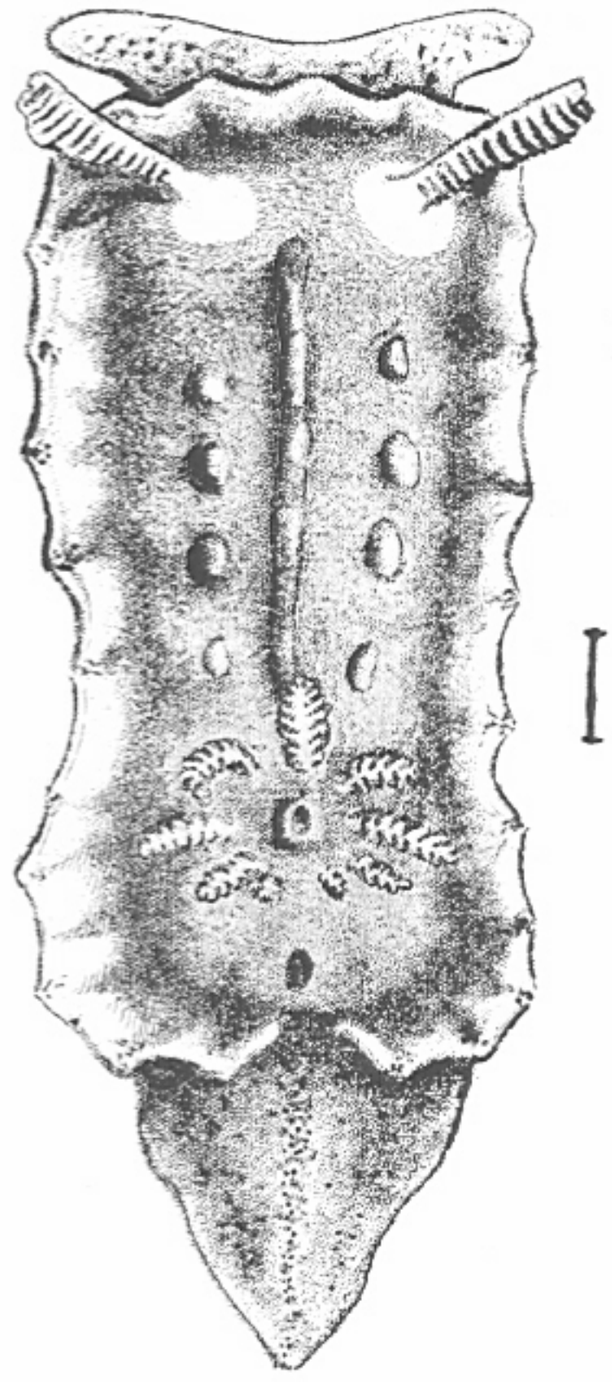

Fig. 4.

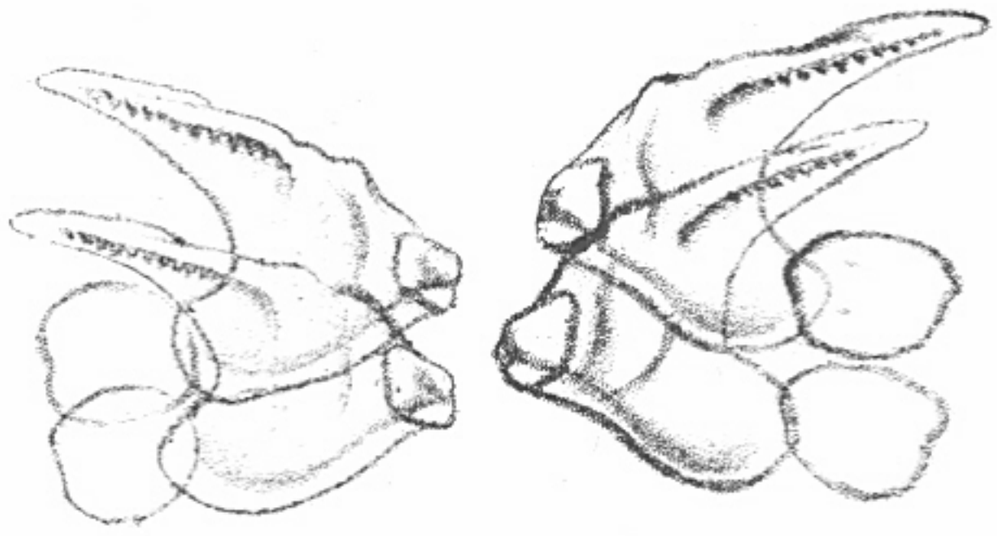

Fig. 5. α.

Fig. 5. β.

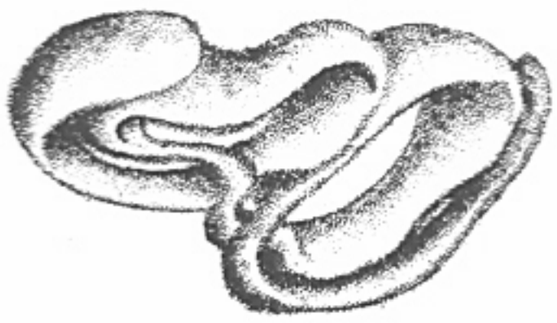

Fig. 3

Fig. 2.

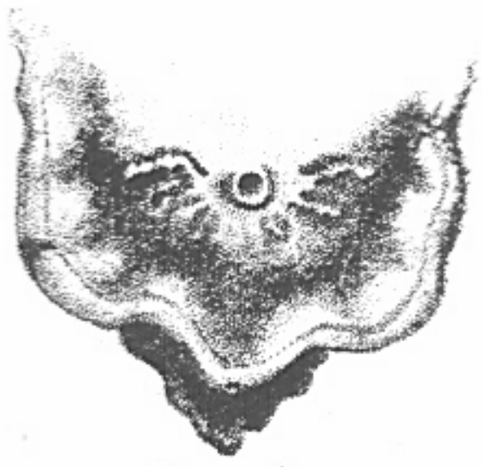

Fig. 6.

Goniodoris.

W.R. autogr.

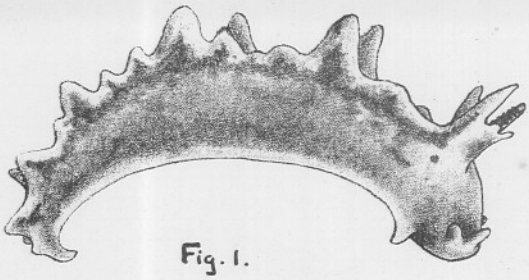

Fig. 1.

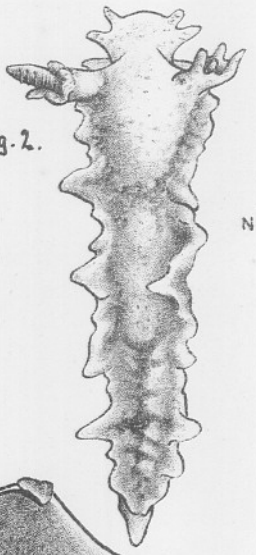

Fig. 2.

I
N. S.

Fig. 8.

Fig. 3.

Fig. 4.

Fig. 5.

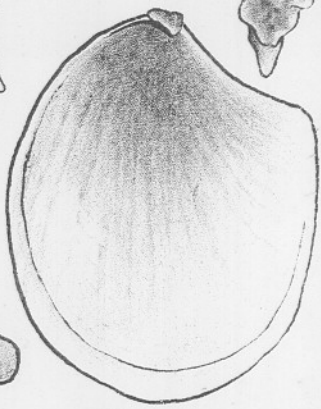

Fig. 10.

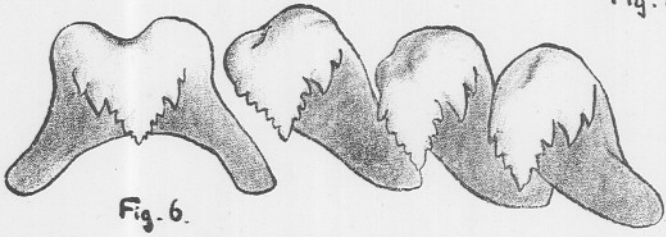

Fig. 6.

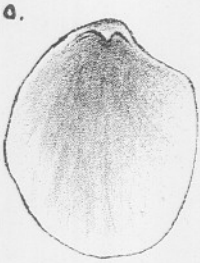

Fig. 9.

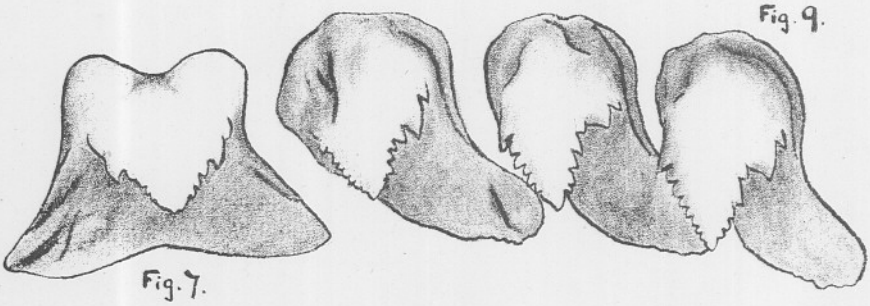

Fig. 7.

W. G. autogr.

Lomanotus & Aplysia.