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Annals and Magazine of Natural History: Series 8

Publication details, including instructions
for authors and subscription information:
<http://www.tandfonline.com/loi/tnah14>

XVIII.—Notes from the Gatty Marine Laboratory, St. Andrews.—No. XXXIX

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Published online: 11 Sep 2009.

To cite this article: Prof. M'Intosh M.D. LL.D. F.R.S. (1916) XVIII.—Notes from the Gatty Marine Laboratory, St. Andrews.—No. XXXIX, *Annals and Magazine of Natural History: Series 8*, 18:104, 161-199, DOI: [10.1080/00222931608693835](https://doi.org/10.1080/00222931608693835)

To link to this article: <http://dx.doi.org/10.1080/00222931608693835>

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THE ANNALS

AND

MAGAZINE OF NATURAL HISTORY.

[EIGHTH SERIES.]

No. 104. AUGUST 1916.

XVIII.—*Notes from the Gatty Marine Laboratory, St. Andrews.*—No. XXXIX. By Prof. M'INTOSH, M.D., LL.D., F.R.S., &c.

[Plate VII.]

1. On the Coloration of *Cæsicirrus neglectus*, Arwidsson.
2. On *Cirratulus (bioculatus) incertus*, M'L.
3. On the British Serpulidæ, with a Note of those procured in the 'Porcupine' Expeditions and those obtained by Canon Norman in Norwegian Waters.
4. On a *Placostegus* from the 'Porcupine' Expedition of 1870.

1. *On the Coloration of Cæsicirrus neglectus, Arwidsson.*

ALL that is known of the coloration of this by no means uncommon species is the remark by Cunningham and Ramage*, in their "Polychæt Fauna of the Firth of Forth," that in their "*Axiothea catenata* the colour is pinkish, pale towards the anterior end, with broad bands surrounding the body at intervals." The region whence these authors drew their supplies has since altered its character, probably from pollution, so that a careful search was unsuccessful. It lives gregariously in tubes of sand-particles sunk in the sand. In the Welsh examples† the anterior end of the annelid is somewhat pale, though the median vessel causes a streak along the dorsum, the blood

* Trans. Roy. Soc. Edinb. vol. xxxiii. pp. 679 &c. (1888).

† I am indebted to Mr. Arnold Watson for the living examples which he sent from Wales.

at the same time tinting the cephalic plate. In front of the third bristle-tuft the anterior region has a smooth and glistening cuticular coat, which is iridescent; and at the segment-junction in front of the tuft (third) a faint reddish belt, apparently from a blood-vessel, occurs. The next segment-junction has a belt of red on each side of it, apparently of reddish pigment, the specks of which pass a short way on the following segment (fifth bristled), which has its bristle-tuft about the middle. Then there is a slight constriction of the body-wall—at which a broad red belt occurs, a bristle-tuft (sixth) being placed just in front of another red belt which passes all round the body. The next bristle-tuft (seventh) is in front of a furrow marking another segment, the anterior third of which has the broadest band of red yet met with in front. This is followed by a pale region ending at the next bristle-tuft (eighth), and concluding the specially differentiated region anteriorly, the seventh to eighth tufts being separated by a long interval. The next segment and half of the following are coloured except at the margins by a longitudinal belt of red, apparently along the intestine, probably from an intestinal sinus, and thereafter the reddish hue is due to the longitudinal and circular vessels, especially those of the gut, the tip of the tail and its cirri being pale. In these examples the majority of the short anal cirri had processes at the tip, as Arwidsson shows in his figure*, and describes as “short, fringe-like lobes,”—some being only bifid, others trifid or quadrifid, whilst each of the processes in a bifid form may have two or more minor papillæ at the tip. Occasionally the cirrus ends in a bluntly conical apex, with a minute papilla at each side near the apex. The gut itself is yellowish or pale orange. The proboscis, which is constantly protruded by the animal when removed from its tube, shows a tinge of red from a blood-vessel along the middle in extrusion, and its distal region appears to be smooth.

2. *On Cirratulus (bioculatus) incertus, M'I.*

In the ‘Monograph of the British Marine Annelids’ † ambiguity was caused by the use of the specific name *bioculatus* for a Cirratulid dredged in the Zetlandic seas by Dr. Gwyn Jeffreys, the name *bioculatus* having been applied by Keferstein ‡ to another Cirratulid differing

* Proc. Roy. Irish Acad. vol. xxix. no. 6, p. 219.

† Vol. iii. pt. i., text, p. 253.

‡ Zeitschr. f. wiss. Zool. Bd. xii. p. 121, Taf. x. figs. 23-27.

from this in several particulars. The species is small, and it is unknown whether it is a young or an adult form, only a single example having been obtained, and it measures about five-eighths of an inch in spirit, its diameter being about 1 mm. The general aspect is indicated in the sketch (Pl. VII.), though the eyes have now disappeared. The segments are about fifty-five in number. The head shows less of a basal constriction than usual in examples of *Cirratulus cirratus* of the same size. The cirri from the fourth segment are of great length, probably reaching in life beyond the tip of the tail. The latter has a similar termination to that of *C. cirratus*, the ventral papilla being the more prominent. The caudal region thus diverges from Keferstein's *C. bioculatus*, which possesses two well-marked caudal cirri.

The dorsal capillary bristles in front are of considerable length, and shorter forms are continued behind these. Thus at the tenth foot the long slender tuft of finely-tapered capillary bristles with a slight curvature at the tip* occupies the dorsal division, whilst the ventral series consist of bristles having short cylindrical shafts, which expand into knifeblade-like tips finely tapered at the extremity, five being fully developed. About the twentieth foot the dorsal bristles are shorter but retain the same character, and by-and-by hooks appear in this division. In the ventral division they are at first accompanied by a bristle—indeed, occasionally a bristle is found in the dorsal division with the hooks† posteriorly. The hooks thus correspond with those of *Cirratulus*, and differ from Keferstein's species or any allied form with the bifid hooks‡.

I am indebted to Mr. Southern, who has specially worked at the Cirratulids, for drawing my attention to the ambiguity of the title in the Monograph. It had escaped observation. A reference to the figure of the hook in the Monograph will show that it cannot be confounded with Keferstein's species.

3. On the British Serpulidæ.

The earlier investigators of the Serpulids gave a large share of their attention to the calcareous tubes, founding species on the nature of the coils and their texture, or, it may be, on the structure of the opercula and branchiæ.

* 'Monograph,' pl. ciii. fig. 16.

† *Id.* pl. cv. fig. 19.

‡ *Id.* pl. cv. fig. 18.

CIRRATULUS INCERTUS.

No modern investigator, however, would feel safe in relying on these distinctions without also subjecting the bristles, hooks, body-wall, and life-history to careful examination. In order to indicate the proportional abundance of the Serpulids in British waters, notes of a few of the collections made by exploring ships and by zoologists at various limited localities are added, as well as extracts from one or two memoirs devoted to the group.

Philippi * (1844) furnished a description of the Mediterranean Serpulids, entering no less than twenty-six, though Grube in the same region had only twelve. Philippi relied much on the structure of the opercula and, in the case of *Portula*, on the spiral arrangement of the branchiæ, or the fan-like nature of the branchiæ in *Psygmodbranchus*. These data are insufficient, and consequently considerable confusion resulted. Thus, for instance, his genus *Vermilia* included six new species, and of the two new forms one was the common *Pomatoceros triqueter* and the other was probably synonymous with the ubiquitous *Serpula vermicularis*, entered, as also was the former, under another genus.

Mörch † (1861-63), in his "Revisio Critica Serpulidarum," has about 125 species of Serpulids under sixteen genera, *Spirorbis* having no less than twenty-seven, *Hydroides* seventeen, *Serpula* fourteen, *Vermilia* twelve, *Protula* and *Placostegus* each eleven, *Ditrypa* eight, and the others smaller numbers. This list could be considerably reduced almost under every genus.

Dr. Johnston ‡ (1865) gives ten in the body of the work, and in the Appendix Dr. Baird adds another and no less than seventeen species of *Spirorbis* from the literature of the subject; but in both cases the number of species needs substantial reduction, since some appear under two or three titles.

De Quatrefages § (1865) mentions about a hundred and nine species as occurring throughout the ocean; but it is evident that many are synonymous, and that the series could be much reduced.

Twenty species are recorded by Malmgren || from the extensive northern waters, ranging from Greenland to the North Sea; but some of these are evidently doubtful, such as the second species of *Filograna* and several species of

* Archiv f. Naturges. Bd. x. p. 186, Taf. vi. figs. A-T.

† Naturhist. Tids. Kjøbenhavn, Bd. i. p. 347.

‡ Cat. Worms Brit. Mus. pp. 264 & 346.

§ Annel. t. ii. pp. 484 &c.

|| Annul. Polych. (sep. copy), p. 119.

Spirorbis, and there is also doubt concerning *Vermilia* and the two species of *Ditrypa* and *Hydroides*.

Claparède* (1868) includes nine Serpulids in his Neapolitan Polychæts, and they are spread over nine genera, of which *Psygmodbranchus* alone has two species.

Grube† (1877) records only two species in the extensive collections of the German ship 'Gazelle,' viz. a *Serpula* and a *Pomatoceros*. In his Philippine Annelids seven Serpulids are entered, six falling under *Serpula* and one under *Ditrypa*.

Levensen‡ (1883) includes twenty species in his Northern Polychæts, nine being Spirorbids, the rest being distributed over nine genera, of which *Protula* and *Ditrypa* had each two.

In the great expedition of the 'Challenger' (1885) through the diverse waters of the world§, twenty-two Serpulids were encountered, the genera most in evidence being *Protula* (four), *Serpula* (five), and *Placostegus* (five), the three thus representing more than half the total number secured. It is interesting that not a single complete *Spirorbis*—only two or three fragments of tubes—was obtained. In all probability, the haunt of the majority of the Spirorbids is the littoral region both of foreign seas and our own.

The expedition of the U.S. Coast Survey Steamer 'Blake' || (1887) in the rich waters of the Gulf of Mexico and the Caribbean Sea produced under the able hands of Ehlers (1887) only eleven species, but spread over nine genera—*Spirobranchus* having three species, the rest but one representative.

Twenty-six species of *Spirorbis* are described by Caullery and Mesnil ¶ (1897) in their important memoir on the genus, and collected from various parts of the world.

Ehlers** (1901) has thirteen Serpulids in the collection of Polychæts from the Straits of Magellan and from Chili, of which eight are Spirorbids, the rest spread over four genera.

In the careful account of the Serpulids from the Pacific

* Annél. Chétop. Naples.

† Monat. Königl. Akad. Wiss. Berlin.

‡ Meddel. nat. Forh. Copenhagen, pp. 189 &c.

§ 'Challenger' Reports, vol. xii.

|| "Results of Dredging," &c., Mem. Museum Comp. Zool., Cambridge, U.S.A., vol. xxxi.

¶ Bull. Ac. France et Belgique, t. xxx. p. 185, pls. vii.-x.

** Polychæten Magell. u. Chilen. Strändes.

Coast of N. America by Mrs. Pixell-Goodrich* (1912) eighteen species are recorded, more than half of which are Spirorbids.

The same authoress (1913) describes six in her report on the Serpulids of the Scottish Antarctic Expedition, three being Spirorbids and three other genera having one each.

Mrs. Pixell-Goodrich (1913) enters no less than twenty-five species secured by Prof. Stanley Gardiner in the "Percy Sladen Expedition" to the prolific waters of the Indian Ocean. About half of these are under two genera, viz. *Hydroides* (five) and *Spirobranchus* (eight), two of the other genera having two species and *Spirorbis* three.

Twenty-nine species appear from the wide area included in the 'Campagnes Scientifiques' of the Prince of Monaco by the experienced hand of Prof. Fauvel † (1914). Seven of these are Spirorbids.

In Canon Norman's Norwegian dredgings three species were obtained, viz. *Hydroides norvegica*, *Serpula vermicularis*, and *Ditrypa arietina*. The same forms, with the addition of *Placostegus tridentatus* at 305 fathoms, were procured by the 'Knight Errant.' In the 'Porcupine' Expedition of 1869 *Protula protensa*, *Filograna implexa*, *Hydroides norvegica*, and *Ditrypa arietina* were dredged. The list was slightly extended in the 'Porcupine' Expedition of 1870; for, in addition to *Filograna implexa*, *Hydroides norvegica*, *Serpula vermicularis*, *Placostegus tridentatus*, and *Ditrypa arietina*, a variety of *Placostegus* ‡, if not a new species, was obtained off Cape de Gatte in 45 fathoms, and *Pomatoceros triqueter* from Ras el Amush. The great numbers of *Ditrypa* from Bono Bay, and their comparatively small size, were noteworthy.

The paucity of Serpulids in local faunas is noteworthy. Thus, in the 'Catalogue of the Marine Invertebrates and Fishes of St. Andrews' (1875) seven occur, two being Spirorbids, the others distributed over various genera. The same number is given by Marion and Bobretzky § (1875) at Marseilles, two belonging to the genus *Apomatus*, the others singly to different genera. Leslie and Herdman || (1881), in their "Invertebrate Fauna of the Firth of Forth," enumerate three Serpulids, two of which are Spirorbids.

* Proc. Zool. Soc. 1912, p. 784.

† Fascicule xlv.

‡ Vide p. 15.

§ Ann. Sc. Nat. 6^e sér. t. iii. p. 94.

|| Proc. Roy. Phys. Soc. Edinb. vol. vi. p. 67.

Langerhans * (1880) enters eleven from Madeira, three of which are Spirorbids. Some of the entries are doubtful. Harvey Gibson † (1886) mentions seven in his "Catalogue of the Vermes of the Liverpool District"; but one of the two Spirorbids is uncertain. Nineteen species are entered by Lo Bianco ‡ (1893) in his "Tubicolous Annelids of Naples," and several of these are synonymous. As a result of many years of patient labour at Dinard, France, De St. Joseph met with nine species, all under diverse genera. A single species of *Spirorbis* is entered.

Mr. Southern § (1914) enters eight species in the "Survey of Clare Island," three of which are Spirorbids.

Six occur in Allen's || (1915) "Catalogue of the Polychæta of Plymouth and South Devon," three of which are Spirorbids.

The first form is *Protula tubularia*, Montagu, which especially abounds in British waters, both in the south and in the north. When the branchiæ are removed, the anterior aspect of the *cephalic plate* presents in the middle the two somewhat triangular scars for the bases of the branchiæ, each surrounded by a rim, whilst between and beneath them is the central mass connected with the mouth. Dorsally, a fillet trends upward on each side to join the prominent, curved, and acutely-pointed dorsal folds of the collar, which forms a continuous frill on the lateral and ventral edges. The branchiæ are barred with pink and green (*Montagu*), those, however, from Plymouth being tinted only with red.

Whilst a certain agreement exists between the cephalic region of *Protula* and the Sabellidæ, the tenacity with which the branchiæ cling to the basal tissue is characteristic of the Serpulids. In *Protula* the branchiæ form two comparatively short forms, the filaments in each of which range from thirty to sixty. They do not, as a rule, present a spiral arrangement in the preparations, though the tips are often coiled in various ways. Each filament springs from a basal web, which is elongated dorso-ventrally to accommodate the large series of these organs, and distally ends in a free subulate process, considerably longer, for instance, than in *P. intestinum*, in which the short tip

* Zeitschr. f. w. Zool. Bd. xxxiv. p. 118.

† Proc. Lit. Phil. Soc. Liverpool, vol. xl. p. 159.

‡ Atti Acad. Fische Mat. Napoli, vol. v. no. 11, pp. 81-93.

§ Proc. R. Irish Acad. vol. xxxi. no. 47, p. 146.

|| Jour. M. B. A. n. s., vol. x. p. 643.

has a slight web on the inner side. The pinnæ are of moderate length and closely arranged in a double row along the inner border, the basal region of each being wider; thereafter it tapers to the blunt tip. None of the camerated chordoid tissue so characteristic of the Sabellid branchiæ is present either in filament or pinna, though it is clear that cellular supporting tissue must be in both. The filaments are best developed toward the dorsal edge of the fans.

Toward the tip of the filament the pinnæ diminish in length, and end in short papillæ at the base of the free distal processes, into which, so far as can be observed, only a blood-vessel enters. When thrown off, the vitality of the branchiæ is considerable.

A bilobed fillet lies between the bases of the branchiæ dorsally, and at its ventral edge is a triangular process. Ventrally is a wide gap leading to the mouth, which has a short fissure in the lower lip.

In the small variety from Herm the subulate process at the tip of the branchial filament and the pinnæ are proportionally shorter, but the structure is the same.

The dorsal lip, ciliated and often bordered with brown, is placed between the first two dorsal branchiæ, and carries two palpi. This is separated from the mouth by the ventral lip, which is colourless.

The *body* in the free example is somewhat broad anteriorly, and tapers from the middle gradually to the tail, which has a terminal anus. It is somewhat flattened both dorsally and ventrally, a median groove occurring dorsally in the anterior region and ventrally in the posterior region. The anterior region, moreover, has the broad membranous web, continuous anteriorly with the dorsal fold of the collar, and which passes laterally above the bristle-tufts, ending ventrally by joining that of the opposite side behind the last bristle-tuft of the region. This membrane is supported by a greatly developed alar or dorsal process of the foot, which tapers distally, and is freely mobile, so that when the annelid withdraws itself into the tube this membrane and the bristles are closely applied to the dorsum. No spine supports the alar process, so that the muscles of the bristles suffice for all its movements, which would appear to be partly respiratory, since its blood-vessels are finely reticulated.

The pore for the thoracic organ is placed on the second setigerous segment in the mid-dorsal line (*De St. Joseph*). The "thorax" is greenish, the alar membrane veined with green, and each segment is distinguished by a band of red.

The first segment has two touches of orange or red (without crystalline elements), whilst the abdomen is reddish or orange.

The first region of the body consists of eight segments as a rule, viz., the peristomial and seven bristled segments. Moreover, as De St. Joseph pointed out, the first and the last have glandular scutes on the ventral surface, the first, in a line with the first bristle-tufts, being especially large. The first setigerous process and its bristles are usually directed differently from those which follow, viz., obliquely upward, forward, and outward, the rest being in repose placed obliquely upward and backward. The bristles are somewhat shorter than those which follow, and present more distinct, though very translucent and narrow wings. The typical anterior bristles are pale golden and highly iridescent long slender bristles with straight shafts and but slight curvature of the finely tapered tips, the wings being so narrow as to be almost indistinguishable, only a linear streak indicating their presence on careful inspection. Such, therefore, differs from the condition in *P. tubularia*, where De St. Joseph describes and figures the wings as not only distinct, but striated. The wings are also more distinct in *P. intestinum* from the Mediterranean. It is possible that friction modifies the wings in this region, and hence the more evident nature of those on the first bristle-bundles, which are less exposed.

The posterior region differs from that in *Protula intestinum*, for instance, since it presents no evident bristles to the naked eye or under a lens, for they are usually so closely adpressed as to escape notice, whereas in *P. intestinum* the posterior region has on each side a palisade of long glistening bristles. Such, however, is apparently due to friction, since in those best preserved similar though smaller bristles occur in this species.

Other tufts show only short shafts dilating gradually toward the distal end, which is curved, flattened, and translucent, the slender tips of which occasionally project beyond the surface.

The small variety dredged off St. Peter Port, and found between tide-marks at Herm, has somewhat better-developed wings to its bristles, and the tips of the posterior bristles are more clearly scimitar-shaped, being curved backward like Symes's knife. In others, the straight tips ended in sharp points, but whether such was due to injury or malformation is not at present clear.

The rows of hooks occur on the ventral side and behind

the bases of the bristle-bundles in the anterior region, and consist of minute, thin, translucent organs, which have a long anterior face ending inferiorly in a slightly curved spine corresponding to the main fang in other forms. The edge appears to be minutely serrated. The outline below the main fang forms a narrow gulf, and then trends to the thin basal plate. The posterior outline dips inward so as to make a prominent and bluntly conical crown, and then joins the basal plate. The great number, transparency, and delicate nature of these hooks are characteristic features. If Wollebæk's figure* of the hook of *Protula arctica*, Hansen, is correct, it differs from the foregoing in general shape, shortness of the main fang, large size, and small number of teeth above it—indeed, there are five times the number in the British form.

The posterior hooks are smaller, but do not structurally differ from the anterior. They are situated on prominent lamellæ along the sides of the body, and toward the tail these are very closely arranged. The very minute serrations on the anterior face of these hooks is in contrast with the condition in *Protula intestinum*, and even with De St. Joseph's figure of *P. tubularia*.

No form in the whole range of the Polychæts is of greater interest than the second species, viz., *Filograna implexa*, Berkeley, the life-history and reproduction of which, its plastic and protean character, as well as the concrete calcareous masses, often of considerable size, formed by its thread-like tubes, combine to surround it with a halo of interest, were it only for the study of variability in a single type. In this form the cephalic region presents a smooth gap between the rounded ends of the lamella forming a border to the anterior division of the body. A little below the edge of the lamella on each side is a flattened process of the collar which expands considerably distally so as to form a conspicuous structure. Ventrally the collar in the preparations folds backward as a broad lamella, split distally into two lobes, which in all probability are directed forward when in the tube. Two eyes occur in the dorsum of the peristomial segment. Each consists of pigmented spherules ("crystallins," *De St. Joseph*), numbering in the one seven and in the other eye ten.

The branchiæ are eight in number, four on each side, and in the spirit-preparations are about half the length of the

* Skrift. svensk. Krist. 2 Bd. no. 18, p. 120, pl. xlviii. figs. 6a & 6b.

body. Each consists of a tapered filament with a somewhat camerated axis, giving a transversely barred aspect due to what De St. Joseph calls mucous cells, which have not the differentiation of the Sabellid axis, and become indistinct in mounted preparations. The long diameter of these cells is about 2500th of an inch, less in their short diameter. A double row of proportionally thick pinnæ is attached to the inner edge, each pinna having a central axis of similar structure to that of the filament, and the tip is bluntly rounded and often curved. The distal pinnæ diminish in length, the last being a mere papilla, and the filament ends in a short smooth process, often slightly clavate in spirit and more opaque than the rest. Moreover, the dorsal filament on each side ends in a thin, flattened, and somewhat ovoid plate, the pair performing the function of an operculum. In fresh examples the pinnæ present a double row of rough granular cells (mucous cells, *De St. Joseph*) set in a hyaline matrix, and in some views these have a spiral arrangement.

In an example a pair of elongated glandular sacs (nephridia?) occurred in front of the sixth bristle-tuft of the anterior region in the cœlom, the tips crossing each other. In structure they were granular. The intestinal canal is dilated behind the anterior region (seventh bristle-tuft), and runs as a straight tube from end to end. No diatoms or radiolarians were found in it, only brownish granules and sand-particles. The colour is translucent orange with the intestine dusky brown. It tints the tube, so that it has a faint reddish hue when the animal is within. The branchiæ are pale.

The first region of the body has seven or eight pairs of bristle-tufts, which, with the peristomial segment, makes a total of eight, the second region has from thirty-five to forty segments. The body is somewhat flattened both dorsally and ventrally, with a median groove in the posterior region on both surfaces, and terminates posteriorly in an anus with a prominent papilla at each side, which, according to De St. Joseph, may assist in the formation of the tube. The anterior region has the alar membrane, which stretches from the collar along each side to the posterior edge of the last segment of the anterior region, where it bends ventrally and joins that of the opposite side, as in *Protula*, leaving a free flap posteriorly. It forms a more uniform margin than in *Protula*, and is, in the preparations, generally directed obliquely upward, the bristle-tufts being

beneath and so closely applied as to appear to be oblique rays supporting it.

The first bristle-tuft is directed outward and forward, and the bristles have translucent straight shafts and a knife-shaped tapered tip. Two or three, again, have broader curved tips with a differentiation or "bite" at the basal edge of the blade, but the serrations on this were not visible under the power used.

The six pairs of bristles which follow slope upward and backward, have similar translucent straight shafts, but the tapered tips are more slender, and about two in each tuft have the curved tips with the differentiation of the base seen in the first bristle-tuft. The indistinctness of the serrations is in bold contrast with the condition of such species as *Salmacina œdificatrix*, of Naples, yet the difference is only one of degree.

The second region of the body seems to be devoid of bristles for a short distance, whilst the posterior part has them in pairs, the tips being long and finely tapered, with distinct wings at the base. De St. Joseph mentions one or two geniculate bristles in the ventral division.

The minute, translucent, anterior hooks have a nearly straight anterior edge, serrated throughout and ending below in a main fang, the outline being continued with a curve below the hook and ending at the basal edge. The crown is minute, and the posterior outline slopes to the base, which appears to have a straight edge. The rounded projection below the main fang, shown by De St. Joseph in *Filograna implexa*, differs from that of the present examples. These hooks are situated slightly behind and to the ventral side of the bristles, and form considerable rows. The posterior hooks are smaller, but agree in structure with the anterior. They are placed on the dorsal side of the bristle-tufts, and are few in number in each row.

The eggs are red and the embryos resemble those of *Salmacina dysteri*.

Early trochophores of a deep red colour occurred in the vessels on the 9th June, the prototroch being visible on each side. They simply rotate or swim in small circles, but the larvæ with commencing segmentation of the body dart through the water with great vigour, and often in a straight line; whilst others made larger circles near the bottom. One of the latter showed three segments behind the head, and in all the two eyes were distinct.

The sperms seem to develop a little later than the ova, none, indeed, appearing in the bud, but by-and-by they fill

the non-bristled region in front of the ovigerous segments and bulge laterally, the region being thus characterised by its pallor.

The masses of tubes formed by this species are often of large size, showing that by rapid budding it can hold its own in the struggle for existence, probably quite as effectively as in the case of those with large ova—these being few. The notion that the character of the tubes as to closeness and divarication may indicate specific distinction is uncertain. Much will depend on freedom from injury in the living or dead condition and the site inhabited.

Not all the examples from St. Andrews have opercula. Some have none, the tips of all the branchiæ (eight) showing only a process enlarged at the tip, the granular cells being arranged in a somewhat regular manner and often hexagonal in outline.

The prominent dorsal edges of the collar of the next species, *Hydroides norvegica*, Gunner, are supported by the first bristle-bundles, a considerable gap, however, occurring in the mid-dorsal line. It then passes ventrally to expand into a large thin lamella sloping on each side to a median notch, so as to be more or less bilobed, and is either reflected backward or stretched forward on the base of the branchiæ.

The branchiæ form two well-marked fans on each side of fifteen to eighteen filaments, the dorsal filament in addition on each side being modified either into a complete or a rudimentary operculum, and it seems to be immaterial which side develops the complete organ, since it is sometimes the one and sometimes the other. The branchial filaments are of moderate length, and taper distally to end in a short subulate process, often concealed when coiled. No special chordoid or other axial structure is present, but the cuticle is very thick. The pinnae are rather short, devoid of a special stiffening apparatus, and extend to the tip, partially overlapping the terminal process. They taper a little from base to apex.

In life the branchiæ are spotted with crimson, and have a pinkish hue from the colour of the pinnae.

The pedicle of the operculum has a transparent but tough investment of a cellular membrane (mainly hexagonal). Internally is a yellowish fibro-granular apparently muscular cylinder in the preparations. The distal funnel or disc of the operculum is brownish and horny, and when viewed from above has somewhat the aspect of a Chinese umbrella with

a fissured and spinous rim of sixteen to twenty or more processes. Moreover, the upper surface of the disc is armed with spikes, which form a series of rings round the central area. In lateral view it is vase-shaped, with a graceful inclination outward and upward from the narrow stem. Each of the rays forms a stout tapering process, terminated by a thin flexible tip, each side being armed with three or four stiffer and shorter spines, a double contour being visible for fully the basal half. The longest lateral spines are, as a rule, the distal pair, since they have a wider area to guard. This elegant horny apparatus takes the place of the calcareous operculum of other forms, and the flexible tips of the rays apparently yield to a certain extent in withdrawal into the tube, thus causing the spines to approach each other more closely, and efficiently protecting the aperture. In some large examples the dorsal and lateral spikes are bifid, various smaller spikes occur in the intervals, and an imperfect ray is intercalated between two of the others.

The second tier of the operculum forms a graceful fluted cup with about twenty-seven crenations, each separated from its neighbour by an involution of the tough integument enclosing hypodermic cells and granules. The muscular fibres in the centre of the stem expand as they approach the lower operculum, the centre of which they pull on, and so fix the elastic crenate margin on the sides of the tube. The protection of the aperture is thus doubly secure, for the distal spiny shield closes over the crenate cup and exposes only the tough spiny rays to an aggressor. It requires great force to detach this cup from the opercular stalk, apparently from the toughness of the cuticle. The rudimentary organ of the other dorsal edge is often minute, resembling a *Loxosoma*, and springs from the fan near the base of the first filament of the side.

The dorsal edge of the collar, which is supported by the first bristle-bundles, forms the commencement of the alar membrane, which passes backward over the anterior bristles to their termination, beyond which its thin edge projects ventrally as a flap of a bluntly conical outline. In the preparations, as a rule, the anterior edges of the alar membrane approach each other, whilst the posterior margins, as they tend to the ventral surface, are wide apart. The bristle-tufts stand clear of the membrane on each side, and the free ventral flap is ample. The dorsal surface in this region is somewhat flattened, whilst the ventral is slightly convex and marked by a median groove. In the second

region the dorsum of the body is slightly convex throughout, and the ventral surface is but little flattened and marked by a median groove, which runs to the tapered tail with the bilobed anus at its extremity. There are about seventy segments in the posterior region.

The general colour of the body is reddish orange, the alar membrane anteriorly being paler. The lower tier of the operculum is pinkish in lateral view.

The first setigerous process is separated by a considerable interval from the second, and is directed upward and forward. It has two kinds of pale golden bristles, viz., a series with stout, slightly curved shafts which gently dilate from the base upward to the shoulder, beneath which, in the larger, is a slight convexity posteriorly. The shaft is striated and has a central differentiation or axis which trends distally to the long tapering process with a finely serrated edge. Anteriorly, the shoulder abruptly ends in two short spurs with rounded tips. Three of these bristles toward the upper edge of the tuft are larger and longer than the others and probably have special functions. The second kind of bristle is a slender form with simple, tapering, minutely serrated tip often slightly curved, and they are distributed over the whole breadth of the fascicle, a few shorter forms being visible at the lower edge.

Six pairs of bristle-tufts follow, their direction being obliquely upward and backward. These are simple, rather strong, slightly curved, and tapering bristles with narrow serrated wings, and in ordinary specimens the tips seem to have suffered from friction.

The posterior region of the body has no bristles anteriorly, but toward the tail from nine to eleven pairs of long, slender, tapering, capillary bristles appear, decreasing in length from the first to the last. They are usually in pairs, and are nearly straight, only a trace of a curve being observable in their slender tips, which appear to be minutely serrated. Moreover, at the base of these are four or five brush-shaped forms with a cylindrical shaft and funnel-shaped tip with short spikes.

The anterior rows of hooks are long and pass ventrally from the bristle-bundles. Each hook is somewhat polygonal in outline, the anterior edge having six strong teeth (occasionally only five, in which case they are somewhat larger) above the main fang, whilst below it a narrow gulf and a prominent prow give a character to the hook. The posterior outline forms one of the oblique sides of the polygon, the inferior outline being nearly straight, and slight

striæ cross the body of the hook obliquely. The number of hooks in these long rows is great, and the pigment-line indicating them remains after removal of the cuticle and hooks.

The posterior hooks have the posterior outline considerably lengthened, so as to alter the character of the hook and give it a resemblance to that often seen in the Ampharetidæ and Terebellidæ. They have four teeth above the chief fang, which is proportionally larger than in front, and the basal outline is slightly convex. Oblique striæ are also present on the body of the hook. The ligament, as in the anterior hooks, is attached to the angle between the posterior outline and the base.

Dorsally the edge of the alar membrane in the fourth form, *Serpula vermicularis*, L., is continuous with the collar on each side—a considerable gap, however, intervening between the points of attachment. The collar then passes on each side as a deep frilled lamella to the mid-ventral line, where it is continuous with that of the opposite side. The mouth opens between the branchiæ nearer the ventral than the dorsal border; dorsally it has the ciliated upper lip, and ventrally the ciliated lower lip, whilst below the latter is a triangular area.

The branchiæ, which are from 30–32 on each side, form two fans of moderate length, and are tinted of a fine red hue near the tip. Each filament diminishes toward the extremity and ends in a long tapering process. The cuticle is thick, and the longitudinal and circular muscles well developed, but no chordoid skeleton is present. The pinnæ are of moderate length, the longest being about a third of the length from the tip, and they taper from base to apex, and likewise show no chordoid skeleton. Their colour is variable, reddish with white bars, entirely red or white, with darker zones; sometimes the base is red and the rest white. The pinnæ take their hue from the bars of colour of the region to which they are fixed. In very young examples the base is red, and the filaments greenish from the blood.

The opercula spring from the dorsal edge of the branchial fans, that on the one side being short and rudimentary, whilst that on the other forms a finely fluted vase supported on a stalk, which gradually expands as it passes upward to the fluted cup, which has from fifty to a hundred or more denticulations (a hundred and six, *De St. Joseph*). In many cases the functional operculum is on the left, in others on the right. The distal cup is hollowed

and comparatively thin, and the divisional striæ run to the centre, cutting off the hypodermic area. Moreover, though the surface of the cup appears smooth to the naked eye, it presents under the microscope numerous minute chitinous papillæ, and, if it has been injured, the cicatrix and various irregularities of the divisions are apparent. Occasionally abnormalities not due to injury are present.

The body is, in the preparations, broad in front and tapered gradually to the tail, which ends in the anus. It is flattened both dorsally and ventrally anteriorly, and, indeed, more or less so throughout, and marked ventrally by a median groove which commences behind a triangular area in front and extends to the posterior end of the body. The anterior region consists of seven bristled segments and the fused peristomial segment, and it is proportionally shorter than in *Hydroides*. The alar membrane is broad dorsally, the sides touching in front and separating posteriorly, whilst the ventral lamella is of moderate breadth. The first pair of pale golden bristles is even more widely separated than in *Hydroides*, forming prominent setigerous processes a little behind the anterior dorsal angle of the alar membrane and collar. The distance between these and the next tuft is nearly as large as between the second and seventh, and the direction is upward and forward. The bristles closely correspond in structure with those of *Hydroides norvegica* and their function is probably similar. Each tuft has a series of strong bristles with long, slightly curved shafts which expand a little anteriorly at the shoulder, though some also present a slight convexity posteriorly in the same region. On the anterior edge of the shoulder are two short conical spurs, whilst the posterior half is extended into a long, tapering, serrated process. As indicated by Fauvel, the region below these spurs is roughened by numerous spikes in young forms. They afterwards completely disappear. Interspersed with these are the long, simple, tapering, curved bristles with minutely serrated edges, as in *Hydroides*. The other bristles of the region spring from shorter setigerous processes, have nearly straight shafts and slightly curved tapering tips with narrow serrated rings.

Bristles are absent from a great part of the posterior region, again reappearing in groups toward the tail. They are very long, extremely slender bristles, tapering to a hair-like point which is finely serrated. They are longest at the commencement of the series and diminish posteriorly, and are accompanied by short brush-shaped forms, one outline

of the funnel-shaped tip being longer than the other. The posterior bristles have a peculiar fungoid growth which forms a blackish coating to the shaft or to the tip.

The anterior hooks are avicular with four teeth above the main fang, which has a well-marked gulf below and a prominent prow, which projects about as far as the point of the chief fang. The crown is comparatively narrow, and the posterior outline is slightly concave, whilst the inferior outline of the base is convex with a slight incurvation posteriorly. The body of the hook is striated.

The posterior hooks are smaller, and have, as a rule, five teeth above the main fang; the prow is less prominent, the inflection of the posterior outline is nearer the base, and the basal outline has a more distinct inflection posteriorly. Striæ likewise pass from the teeth down the body of the hook. The number of hooks in each row is large. Fauvel gives a total of six to eight teeth in the posterior hooks.

Tube either fixed or free, of a rosy or greenish colour, and measuring 3 or 4 inches in length, with a smoothly rounded and dilated trumpet-like aperture, various lines of growth, and occasionally with a keel more or less rough. Anteriorly it is straight or with a wide curve, but posteriorly often coiled in a spiral manner. It is attached to shells, masses of *Cellepora*, to rocks, stones, or vases thrown into the sea, and is generally solitary, though masses of the tubes occasionally occur both in the north and west of Scotland. When on the inner surface of the lower (flat) valve of a large oyster, the tubes are nearly parallel. In some the prolongation of the tube takes place from the narrow (inner) edge of the trumpet, and thus four or five prominent rings may be formed anteriorly. Fauvel describes seven longitudinal ridges in the typical form of tube—of which the median dorsal is the most conspicuous.

The dorsal part of the collar in the next species, *Pomatocerus triqueter*, L., forms a great free lamella, which, probably by accident, is sometimes separated from the rest of the collar, and its edges are lacinated, though normally it seems to be smooth. The collar continues to the ventral surface as a broad membrane usually thrown into folds in the preparations. De St. Joseph considers the separate parts of the collar dorsally are normal.

The branchiæ are somewhat short, and as usual arranged in two lateral fans of thirteen or fourteen (twenty, *De St. Joseph*) filaments, each of which is tapered from base to apex, where

it is terminated by a subulate process of some length. The pinnæ are short, and slightly tapered from base to apex. A white band of great purity runs round the base of the branchiæ, bordered by a belt of red on each side. The filaments are barred alternately with white and red. Methylated spirit alters the red colour of the branchial plumes to a permanent blue. De St. Joseph found *Trichodina pediculus*, Ehr., on the branchiæ at Dinard.

The single operculum springs from the dorsal edge of the left fan by a somewhat rounded stem, enlarges and flattens out as it proceeds upward, and dilates at the summit into a large flat cushion for the support of the calcareous operculum, which is prettily marked with white—shield-fashion. Just before the last-mentioned dilatation it sends out a process on each side resembling an ear, and occasionally this auricular process is bifid or quadrid. The calcareous tip assumes various forms—viz., conical, tuberculated, saucer-shaped, bifid, or very often trifold. On removing the calcareous cap, a tough layer is left on the summit of the cushion with projections corresponding to the form of the cap. The cone is not regular, but has its steepest side placed dorsally. After the action of hydrochloric acid, a brownish scale of organic tissue with somewhat regular hexagonal reticulations is left. Internally the opercular pedicle has a strong elastic ligament from the summit to the base surrounded by muscular bundles, chiefly transverse. The thrusting out of the operculum (if such happens) is thus voluntary, the withdrawal and retention more or less involuntary.

The cuticle of the entire opercular apparatus is tough and glistening, faintly marked under the microscope with fine striæ. The colour of the operculum varies, most being pale, the stalk often presenting two specks of brown. Almost every example from Lochmaddy, North Uist, has an operculum with three prongs, the only exception being one here and there with only two prongs, but in all probability a third would by-and-by appear. A variety with a flat operculum from which the three spikes arose was also occasionally met with. The operculum is a favourite site for parasitic growths, such as the chambered Foraminifera, *Vorticella*, and zoophytes.

The body is widest anteriorly, where the alar membrane further increases the breadth, and tapers gradually to the tail, which ends in a somewhat broad tip with a papilla at each side. It is rounded dorsally, slightly flattened and

grooved ventrally. The anterior region consists of six bristled segments* and the fused peristomial segment, thus differing from *Serpula* and *Hydroides* in the absence of the conspicuous first pair of bristles on the dorsal edge of the fused collar and alar membrane. The alar membrane passes backward above the bristles, the sides separating as they go to fuse with each other as a broad thin flap on the ventral surface behind the anterior region. Anteriorly it and the collar are yellowish externally and bluish internally, and the bluish colour appears laterally and posteriorly. The posterior region has sixty to seventy segments. All the bristles are directed upward and backward as pale golden flattened tufts, and the structure is the same throughout this region. Each bristle has a translucent and nearly cylindrical shaft with a slight curvature toward the commencement of the tapering tip, which has two narrow wings so arranged that in certain views the space between them seems to be hollowed out. The dorsum anteriorly is pale brown or purplish brown, whilst the general colour posteriorly is dull yellow with pink lateral regions.

The posterior bristles have slender cylindrical shafts, which diminish and then dilate superiorly as they approach the broad shoulder, the spinous distal edge of which has a concavity trending on one side to a delicately tapered whip. This peculiar tip would seem to combine the functions of the long simple and the brush-shaped bristles of other forms. The anterior bristles have a proportionally short hold of the tissues, a feature of importance in connection with the habits of the annelid, and, whilst they point upward and backward, the posterior are directed transversely or ventrally and slightly forward. In each case the bristles are at the end of the rows of hooks—the anterior at the dorsal end, and the posterior at the ventral end.

The alimentary canal appears to be similar to that of *Sabella*, forming a moniliform duct, wide anteriorly and diminishing posteriorly. It is coated with nucleated cells externally.

The cœlomic corpuscles are large and round.

A yellowish coiled gland (nephridium?) occurs anteriorly, external to the gut and adhering to the body-wall. Its structure is granular.

De St. Joseph found Protozoa apparently referable to *Anoplophrya*, Stein, in the intestine.

* De St. Joseph states that there are seven, but six only occur in Britain.

The anterior hooks have the shape of a triangle, the posterior outline, which is slightly concave, gently curving to the crown and forming the base of the triangle, the sides of which are formed by the anterior outline with its eight teeth and the peculiarly modified main fang, which resembles a blunt probe-like process with a small incurvation beneath, the prow of the hook being minute and trending with a slight curve to the inferior outline, which is nearly straight, and the body of the hook is crossed by oblique striæ. The number of these hooks in each row is great, and in some they are indicated by a dark line with a dark speck at the ventral end.

The posterior hooks are smaller, and have only seven teeth above the modified main fang, but their shape agrees with those of the anterior hooks. Both these and the anterior hooks are situated near the edges of muscular lamellæ, a provision probably enabling them to fix on the walls of the tube with greater accuracy.

A variety which occurs abundantly at North Uist, and is characterised by the sharp spike over the aperture of the tube and almost invariably a three-pronged operculum, has hooks which deviate from those at St. Andrews, for they form a long triangle and have a larger number of teeth above the modified main fang, viz., eight in the anterior hooks and nine or ten in the posterior. A similar spike over the aperture is met with at St. Andrews.

Habits. The species has great vitality, surviving in impure water or living in a small quantity of unchanged sea-water for a week. One example from St. Andrews reached Perth on the 14th February, and lived till it was preserved on July 3rd in a jug of sea-water—meanwhile having made a considerable addition to its tube, the new portion being distinguished by its pure white colour. The rapid growth of the tube of the corresponding development of the annelid is sufficiently shown by the presence of well-developed examples on the carapace of the adult *Carcinus mænas*. Orton *, indeed (1914), found that it grew to nearly full size in four months, and at this age the ova yielded practically 100 per cent. of embryos on being artificially fertilized.

The collar in *Placostegus tridentatus*, J. C. Fabricius, the sixth form, is so thin as to be diaphanous, but it is deep, and it is joined by the alar membrane dorsally on each side of the hiatus, passing thereafter across the ventral surface to

* Journ. M. B. A. vol. x. p. 316.

the other side. It is usually thrown into various frills, but it presents no notch or break, though it is easily lacerated.

The branchiæ are about twenty-eight in each fan, of considerable length, the filaments little tapered, and ending in a short subulate process. The pinnae are comparatively short, but they pass to the base of the terminal process without apparent diminution, so that the effect is to widen the tip. No skeletogenous element appears in either filament or pinna, but the cuticle of the former is thick.

The operculum arises by a stout pedicle on the dorsal edge of the left fan, which is considerably thicker than a branchial filament. The pedicle is flattened inferiorly, gradually dilates in its upward course, and then enlarges into the clavate operculum, which is truncated and hollowed out, yellowish when seen laterally, somewhat olivaceous on its distal surface. In lateral view the ventral outline of the apparatus is the more convex, the dorsal being nearly straight.

The body is widest anteriorly, the alar membrane increasing its bulk in this region, then tapers a little to the tail with the anus at the tip posteriorly. It is rounded dorsally, slightly flattened ventrally, where a median groove runs throughout the posterior region.

Six pairs of bristle-bundles occur in the anterior region, as in *Pomatocerus*, and each has three fascicles. The pale golden bristles are a little narrowed at the insertion, have straight shafts, and slightly curved tapering tips, which end in translucent hair-points, and with very narrow wings. The posterior bristles are few in number, two or three, as a rule, being in each foot. The shaft is slender and nearly cylindrical, but is narrowed below the distal enlargement, which forms a flattened blade with an almost transversely spinous distal edge, one angle of which is produced into a short whip or pointed process. It is remarkable how closely such a bristle resembles the brush-shaped forms of the Eunicidæ and other groups.

The anterior hooks are in single rows, very numerous and fairly large, but it is difficult from their translucency to define their exact outline. The anterior edge is nearly straight and saw-like from minute denticulations, the last of which (probably corresponding to the main fang) projects outward and downward as a minute blunt process, the body of the hook forming a narrow, flattened, and transparent bar. The crown is small and rounded, and the whole body of the hook is easily curved under pressure.

The posterior hooks do not differ essentially in structure or arrangement, though they are smaller.

Reproduction.—An example procured off North Unst by Dr. Gwyn Jeffreys in July had a series of ova in a hollow on the ventral surface behind the anterior region.

The tube is of great density, slightly translucent or vitreous, and has anteriorly a sharp dorsal spike and two infero-lateral spikes. A serrated keel runs along the mid-dorsal line, and the tube is fixed to shells, stones, or other submarine bodies. The inner surface is smooth and vitreous, and the minute teeth along the anterior edge of the hook must be of great hardness. Whilst the initial coil is adherent the distal end stands up freely in many cases. When densely grouped on stones the tubes are less rough and the aperture is smoother, and as they are coiled and interwoven, with their ends often free, a considerable change takes place in the facies of the tube. It still retains its median ridge, but in a modified form. The whole aspect of the mass is in contrast with the ordinary conditions of the species. Yet here and there at the edges the usual aspect is observed. The examples indicated came from the deeper water off St. Andrew's Bay, attached to sandstone and accompanied by the tubes of *Sabellaria*.

In *Apomatus ampulliferus*, Phil., the seventh form, the collar is less developed than in *Placostegus*, but though narrower it is thicker and follows a similar arrangement, as starting from the dorsal edge of the fused collar and alar membrane it passes as a continuous fold across the ventral aspect to the opposite side. The truncated anterior end after removal of the branchiæ presents a somewhat rounded central elevation with a fossa between it and the collar.

The branchiæ are reddish in life and are seven in number on each side. They are of moderate length, somewhat soft and thick, and in the preparations are usually coiled and doubled. The broad filaments taper slightly toward the extremity, and end in a subulate process, the pinnæ extending almost as far, so closely do they approach the tip. The tissue of the filaments is lax, so that doubling readily occurs, and both they and the pinnæ have hypodermic glandular cells, the tissue of the ciliated pinnæ being especially soft, one moniliform blood-vessel being conspicuous. Instead of the firm hyaline cuticle of other

forms, this apparently has a very thin cuticle, the cells and granules of the hypoderm almost reaching the surface.

Marion and Bobretzky speak of a second operculum on another of the filaments. Their *Apomatus assimilis* differs in having "cystallins" on the branchial filaments, but perhaps this is only a variety of the above, which occasionally shows pigment-specks at the base of the branchiæ. A second small operculum is occasionally observed in those from the Channel Islands—arising, as in the case of the larger, from the tip of a branchial filament.

The operculum is a soft globular enlargement on the end of a branchial filament, of the ordinary character as regards general structure and the presence of pinnæ. It consists of a layer of cuticle with a granular coat internally, and, moreover, the globe contains several branching filaments, resembling modified distal processes, which extend to the free end of the operculum. While thus serving as a plug to the aperture, the operculum would also appear to perform a respiratory function and it is filled with fluid. The branchia bearing the operculum tapers little, and the pinnæ pass up to its termination. A constriction then occurs, followed by the slightly enlarged though short opercular pedicle, which is again slightly constricted at its junction with the operculum. In an example from St. Peter Port the operculum showed no branching filaments, so that this may be occasional or, perhaps, due to a parasitic growth.

The body of the preserved animal is somewhat stout and short, the posterior region being especially massive, and it tapers only a little to the slightly flattened tail. The anterior region has a broad alar membrane, whilst the mid-dorsum is distinguished by a long conical elevation with the apex directed forward and a median furrow, the rest of the dorsum being more or less convex, except in the instance where the hollows were filled with ova. The ventral surface is rather convex than flattened, but it has a median groove from end to end with the exception of the break at the alar fold.

The collar-bristles form two conspicuous tufts, slanting obliquely forward and outward from a point a little in front of the bases of the first lateral tuft. They appear to have the same structure.

The anterior region has six lateral setigerous processes on the ventral side of the alar membrane, and six elevated rows of hooks to their ventral edge. All the bristles are directed upward and backward, and have a uniform structure, viz., a straight shaft, narrowed at the insertion, then remaining

cylindrical to the curvature at the tip, after which it tapers to a fine point. Serrated wings commence a little below the curvature, widen, and then diminish distally. Bristles appear to be absent in the anterior part of the posterior region, only about twelve to fifteen of the terminal segments having a pair of bristles on each side. The more anterior of these have short straight shafts and sickle-shaped tips, the broad tapering blade having its edge serrated. Toward the tip of the tail, however, the terminal blade is knife-shaped and less curved, a slight enlargement occurring at the end of the shaft. Faint striæ in all cross the tip obliquely from the serrations.

The anterior hooks are very diaphanous, with a minutely serrated anterior margin ending inferiorly in a slightly projecting and modified (blunt) main fang, below which a gulf occurs above the prow. The crown is rounded, and the posterior outline has a deep indentation. The body of the hook is faintly striated from the anterior face to the base. The posterior hooks do not differ except in size.

The collar in *Ditrypa arietina*, O. F. Müller, the eighth species, though deep, is very thin and its edges lacinated, whilst its surface is marked by the linear streaks caused by the adpressed branchiæ. It is fissured in the mid-dorsal line, but appears to be continuous from side to side across the ventral surface. No alar membrane is visible dorsally, though a trace of it probably exists.

The branchiæ are of considerable length, arranged in two semicircles of about a dozen filaments in each, and appear to adhere closely together, as if they were bound by a delicate web, though this has not been clearly made out except at the base. The filaments taper from base to apex, and end in a short process which scarcely projects further than the adjoining pinnæ, though it is twice as thick and presents a more distinct central space, whilst its surface has cilia. The pinnæ are long, in a double row, and are so arranged distally that they form a nearly even series, and thus give a character to the tip of the branchiæ. Like the filament, they possess no skeletogenous elements, though in the former the cuticle is thick and tough. The free terminal process of the filaments may have special branchial functions when the animal withdraws into its tube, for they project all round in the space below the opercular plug.

The pedicle of the operculum is long, and springs from the dorsal edge of the left branchial fan, and it remains nearly cylindrical to the tips of the branchiæ, where it

dilates into the long and shapely vase with the yellowish-green or dull yellow calcareous plate, 1.20 mm. in diameter, at its tip. The projection of the operculum proper beyond the terminal processes of the branchiæ is noteworthy. In the ordinary spirit-preparations the pedicle lies in the midst of the branchial filaments, and is thus in contrast with the condition usually seen in other forms. The distal opercular plate is flat and brittle, presenting under the microscope a deep yellow hue and a minutely cellulo-granular aspect, the margin, however, being hyaline. The pedicle is flattened inferiorly, but toward the base of the opercular vase it is rounded.

The body, which is 13-16 mm. or more in spirit, has not been observed in the free condition, all being moulded by the tube into a cylindrical form anteriorly, and only a little tapered toward the tail, which has a short, conical outline. The anterior region is distinguished by the six pairs of bristles laterally, by an anterior achetous segment, and by the fillet with a median notch ventrally—the representative of the broad fold in most Serpulids. The posterior region consists of numerous (50-55) narrow segments, most of which are devoid of bristles, and it terminates in a somewhat broad flattened tail, with two rounded and sometimes prominent anal papillæ (cirri). The first segment anteriorly contains the two excretory organs, the canals of which unite to open between the two branchial lobes.

The anterior bristles dilate a little above the insertion, the shaft then being cylindrical to the commencement of the tip, which tapers to a delicate point and has narrow wings. The posterior region presents only one or two simple tapering bristles in each segment toward the tail. These bristles are usually slightly curved.

The anterior hooks are numerous (220, *De St. Joseph*) in each row which runs ventrally from the bristle-tuft. The crown is small, the anterior edge covered with many (twenty to twenty-two, *De St. Joseph*) regularly arranged sharp teeth, and the main fang is well developed, though not sharp; whilst beneath it is a shallow gulf or notch with a mere rudiment of a prow before merging into the inferior border, which is nearly straight. The posterior outline presents only a trace of an incurvation, and the striæ on the body of the hook incline from the front obliquely toward it. The entire hook is thin and translucent. The posterior hooks are fewer in number in each row, and

considerably smaller, but their structure is the same. All the hooks when in position have their teeth directed forward.

The tube is vitreous throughout the greater part of its thickness, but the inner lining is opaque white, and its shape is that of a long and sharp-pointed elephant's tusk. The anterior aperture is neatly rounded, but not dilated, whilst by the gradual thinning of the outer layer a character is given to it. The posterior end presents a minute aperture. It measures from 25 to 35 mm. in length, and its wider region in front is from 2 to 2·3 mm.

Various structures affect the external surface of the tube, such as corals, other Serpulids (for example, *Hydroides*, *Serpula vermicularis*, and *Spirorbis*), Polyzoa, and Sponges. It is a favourite site for Lepraliæ. A southern variety from Bona Bay is considerably smaller, the largest being 25 mm. long, is characterized by its brownish hue. In the Zetlandic examples comparatively few abnormalities occur amongst hundreds. Occasionally a constriction of the shell is observed toward the wide anterior region, or the rings of growth here and there are unusually prominent. Under favourable conditions the delicate posterior end with its greater curvature is entire, forming a needle-like commencement to the tube. Rarely, as in certain Zetlandic examples, a lateral ridge on each side runs from the anterior aperture to the posterior end.

A rather rare species is *Spirorbis caulleryi*, sp. n., from the under surface of stones in tidal pools in Guernsey and Herm, and in this the cephalic collar is normal and forms a sheath for the branchiæ, which are seven or eight on each side.

The body is typical in outline, and has seven bristled segments. The first or collar-series consists of bristles which have no distinct gap at the base of the tapered terminal blade or a modified one. The former kind occurs in one group, the straight shaft slightly dilates at the shoulder, from which the tip is bent backward and coarsely serrated, the serrations next the shoulder being perhaps less distinct than those which follow. The other group presents a distinct differentiation of the base of the terminal blade, the separated part at the shoulder having finer serrations, the edge beyond (bearing the distinct serrations) being separated by a distinct step. The base of the blade has five or six teeth at least in lateral view, and in antero-posterior view this part appears to form a spiked collar to the anterior edge of the bristle. The serrations on the terminal blade vary, some having fine, others coarse points. The second bristle-tufts of the region

have straight shafts and tapered winged tips bent at a slight angle. The bristles of the third tuft have in the peculiar group a slightly curved tip (sickle-shaped) with the serrations only at the tip, as described by Caullery and Mesnil in *Spirorbis cancellatus*. The bristles of the posterior region have broad tapering tips, bent nearly at a right angle, with the edge coarsely serrated.

The branchiæ are about four in number on each side, and do not offer any noteworthy peculiarity.

The operculum is circular and hollowed out distally like a saucer, with a short stalk or process like a reversed cone. In young examples it is circular, forming a saucer-shaped disc, but in the older forms it is sometimes nail-shaped—that is, the circular shape is lost by an extension of one edge toward the stalk. Externally is the clear outer investment of the rim of the operculum, within which is a radially arranged layer at right angles to it; then follows a broad belt of circular fibres with strong longitudinal fibres converging to the stalk. The calcareous investment is very brittle.

The tube is vitreous and peculiarly coiled, so that the aperture is on the summit of the spire. The whorls are boldly ridged, and the ridges affect the shape of the aperture, which is sometimes transversely elongated. The whorls form a conical mass with a flattened under surface, in the centre of which is the primary coil. The shape is thus like an irregular blunt cone, and the shell is very hard and glistens like pinkish porcelain.

The *Spirorbis violaceus* of Leviusen somewhat resembles the bluish *S. vitreus*, O. Fabr., from the Arctic seas, as usually observed on pebbles and stones, the aperture in both tubes being on the summit of the coils; but the camerated condition of the sulci of the outer whorls in the Arctic form is not seen in the southern type. Both differ essentially from the present species.

It also diverges from the *S. violaceus* of Leviusen in having a more or less distinct gap above the crenulate web at the base of the tip of the collar-bristles, and in the same way differs from the older specimens mentioned and figured by Caullery and Mesnil. No simple serrate tip was observed in any example, though some have a differentiated base without a distinct gap. The operculum does not differ materially from the figures and descriptions of *S. violaceus* given by the French authors just mentioned, the ringed condition and saucer-shaped tip being evident.

The next, or tenth, form, *Spirorbis spirillum*, L., is everywhere abundant round the British shores on zoophytes, Fuci, algæ, *Corallina officinalis*, *Flustra*, and other structures. The collar agrees with that in other Spirorbids in being widely split posteriorly, but continuous in front. Its connection with the membrane of the anterior setigerous region is also normal. The branchiæ appear to be few, viz., four on each side, and the terminal processes of the filaments are short, so that they do not project beyond the pinnæ, which thus form a more or less even tip, since the distal pinnæ are short.

The operculum forms a shallow vase with a foot or process beneath, the edge of the latter being crenate. There is no space for opercular embryonic development in this species.

The body is widest in front, and gradually tapers to the tail which is normal. The collar-bristles are characterized by the absence of the gap near the base of the terminal blade. They are comparatively small, have long straight shafts, which dilate on reaching the distal shoulder, the terminal region being sharply bent backward, tapered to a fine point, and rather coarsely serrated along the edge especially at the base. The other bristles conform to the usual type. The figure of the collar-bristle, as given by Miss Pixell*, from the Pacific Coast of North America, diverges considerably from the British form, the tip being shorter and broader.

The second fascicle consists of simple winged bristles.

The posterior bristles have the tips bent at an angle or "kneaded," and usually project little in the preparations.

Few forms appear to have had greater vicissitudes in nomenclature than the next, or eleventh, species, viz., *Spirorbis granulatus*, L., a form which essentially differs from the *Spirorbis granulatus*, L., of Caullery and Mesnil †, from Greenland and Nova Zembla, since the globular form of the operculum, as figured by the French authors, no less than its ovigerous character, separate it from the present species, which, as Fleming ‡ truly said in 1825, occurs "on old shells, but more frequently on the underside of loose stones about low-water mark, very common." It is especially abundant on the rocks and stones in rock-pools at St. Andrews. The branchiæ are pale, ten in number, and the cuticle of the filaments is thin, so that the hypodermic elements form the main support.

* Proc. Zool. Soc. 1912, pl. lxxxviii. fig. 8 c.

† Bull. Soc. France, Belgique, t. xxx. p. 216, pl. x. fig. 26.

‡ Edinb. Philos. Journ. vol. xii. p. 244.

The filaments taper from base to apex, and end in a somewhat long non-ciliated process containing a blood-vessel and which in life projects beyond the pinnæ, though in the preparations the long terminal pinnæ extend even beyond it. The pinnæ are long throughout, and are richly ciliated. No skeletogenous elements are present in these or in the filaments, which, however, have a band of muscular fibres passing from the base to the tip, but they do not appear to enter the terminal process. The entire branchial system, indeed, is eminently contractile and under voluntary control. The cilia on the pinnæ are large and long, and appear to be under the control of the animal, since they remain quiescent for a time and then commence to vibrate rapidly. The branchiæ on the approach of danger are shortened, grouped together, and drawn in, the operculum following and closing the tube. The pinnæ have a dotted aspect from the grouping of the cilia in tufts, though this may only be apparent; moreover, the movement of each pinna is independent of the others, so that it bends downward, jerks inward, and performs various motions with celerity and accuracy. The wall is composed of firm mucoid (hypodermic) cells and a greenish blood-vessel occurs in the centre, the fluid therein being devoid of corpuscles. In contraction the pinnæ are, by their muscular elements, only slightly shortened and narrowed, so that when the branchial apparatus is again unfolded the elastic nature of the tissues readily restores them to the former size.

The operculum is funnel- or vase-shaped, hollow at the tip, and gradually dilating from the stalk upward. The distal plate is calcareous (effervescing under HCl) and the muscular fibres pass from the pedicle to the enlarged opercular region, in which they spread out in a fan-like manner to be attached to the distal cup. No trace of a central cavity exists in this form, though a calcareous mass occurs in the centre below the operculum, and its shape differs from that in the developing young of other forms.

When removed from its tube the anterior region of the body is pale, but the rest is of a pale grass-green. It is widest anteriorly, and tapers posteriorly to a bluntly conical tail, a rounded papilla being on each side of the anus. The anterior region has four pairs of bristle-bundles, whilst the posterior region consists of nineteen or twenty segments. No cilia were observed on the anterior region, but they occurred dorsally on the swollen greenish posterior region, and were vigorous toward the tail—indeed, by far the greater part of the body is supplied with cilia.

The coelomic space is richly ciliated, and thus the contained cells and granules are kept in active motion, a stream of them proceeding posteriorly, and, it may be, escaping by a rupture of the body-wall.

The intestinal canal is enlarged immediately behind the anterior region, and such may represent the stomach, for a gizzard-like portion is marked off by constrictions in front of it. It is ciliated from this region to the vent, and elongated collections of particles are often observed in motion in the interior of the gut.

Two brownish-green granular glands lie obliquely on each side of the gizzard-like portion of the alimentary canal.

The first or collar-bristles differ from those which succeed not only in size but in direction and structure. Each consists of a long straight shaft, slightly dilated and flattened as it approaches the tip which is curved backward, and with fine serrations at its rounded base, their size, however, increasing as the gap is approached, three or four being especially prominent next the notch, then the blade has a smooth portion, after which the edge is finely serrated to the delicately tapered extremity. Amongst these are a shorter series of more slender bristles with simple tapering tips. This bristle-tuft is directed forward nearly in a line with the long axis of the body, and the bristles are larger and longer than those which follow. The three sets of paired bristles which succeed are simple and spear-shaped, with slightly curved tips, the third or last pair having the tips of the bristles somewhat broader.

The posterior bristles are placed in pairs on each edge of the segments of the region, and in outline they somewhat resemble an ancient long-toed boot with the sole (edge) serrated. They diminish in size from before backward.

The greenish circulatory fluid is carried forward by a dorsal vessel, which is often curved in each segment over the alimentary canal, and backward by a ventral trunk.

In an example from St. Andrews, in which the collar-bristles had apparently been broken, the terminal blade was finely tapered and translucent without evident trace of serrations, whilst the basal web was coarsely spinose.

The anterior hooks have a long and minutely serrate anterior edge, but the main fang inferiorly is short in lateral view, and when looked at on end is flattened and bifid. The posterior hooks do not differ in structure, but are smaller.

Very abundant likewise in British waters is *Spirorbis*

borealis, Daudin, the twelfth species, and it swarms equally on the blades of the *Fuci* rocks and *Laminariæ* in the south as on those in the north. This species also has many synonyms, from the *Serpula spirorbis*, L., the *Vermiculus exiguus albus nautiloides* of Lister, the *Planorbis minimus* of Peters, to *Spirorbis communis*, *S. reversa*, *S. baltica*, and *S. linnei* of others.

The collar is open as usual in the mid-dorsal line, but continuous ventrally, and it joins the membrane of the anterior setigerous region which De St. Joseph has occasionally found of a bluish tint. The membrane passes ventrally behind the last bristle-tuft and fuses with that of the opposite side. At the base of the branchiæ are two minute eyes on the dorsum.

The branchiæ are four on each side, each filament having a short, slender, and slightly tapered terminal process, and bearing from sixteen to twenty pairs of rather long ciliated and nearly cylindrical pinnæ, which do not arise quite opposite each other. Their colour is dull yellow, with a tinge of green from the blood-vessels. They are sensitive organs, receding with a jerk into the tube on being touched.

The operculum, derived from the first left branchia, is saucer-shaped, with a massive peduncle, is calcareous and often infested by diatoms and other structures. De St. Joseph found *Cothurina maritima* growing on the operculum, and reproducing by fissiparity.

The body is dark brown in front from the alimentary canal, reddish-orange posteriorly, and 3 to 4 mm. in length. The anterior region has three bristled segments, the first series having characteristic tips. The first part of the posterior region of the body is not segmented, though ciliated, the total number of segments being 18-32, and terminated by the anus with a rounded papilla on each side. Each segment has two geniculate bristles. In the first segment are two excretory organs, from which ciliated canals join to form a single duct opening at the base of the branchiæ.

De St. Joseph describes the alimentary apparatus as composed of an œsophagus in the anterior region, a large, brown cylindrical stomach immediately behind, followed by a sinuous intestine. He found spicules of sponges, diatoms, amongst others *Sphenosira catena* in the stomach, all probably carried in by muddy currents. A blood-sinus encircles the canal, with lateral branches and cæca in each segment.

The first bristles arise from a nearly cylindrical setigerous process, and differ in detail from those of *Spirorbis granu-*

latus. The shafts are less robust, though straight, and they also dilate distally into a flattened process at the commencement of the tip, but no fine serrations occur on the convex edge, the whole being occupied by two to five (Levinson shows seven) rather coarse serrations, which slightly increase in size from below upward in lateral view, the striæ on the flattened end of the shaft making them conspicuous. Then the smooth edge of the "bite" occurs as it rises to the somewhat bellied blade beyond, which, however, soon tapers to a delicate extremity, usually with a marked curvature. The bellied condition of the blade beyond the "bite" is a diagnostic feature in comparison with the bristles of *Sp. granulatus*, as also is the comparatively coarse edge, the serrations on which point upward and outward, so that a certain uniformity prevails. The basal part, moreover, is separated only by a slight "step" from the distal, and the serrations on it sometimes show a slightly different angle. Such, however, diverges from the figure of the bristle given by De St. Joseph, in which the distal serrations are at right angles to the axis of the tip, an error probably due to an indifferent microscope. The "step" of this bristle shows a distinct character when compared with the gap generally present in the collar-bristles. The shorter bristles are simple tapering forms.

The bristles of the second setigerous process are simple straight forms, the tapered tips of which are bent backward and provided with wings. The four anterior bristles of the third series agree with the foregoing in the finely-tapered winged tips, but the posterior five have broader sickle-shaped tips, with a smooth wing at the base, though the forward curve of the sickle-like blade shows long serrations so that they are pectinate, the tip being finely attenuate.

The anterior hooks are in rows of 23-55. Each forms an elongate plate, narrower at one end than the other, the anterior edge armed with about forty fine teeth. The main fang is blunt. The posterior hooks are similar, but smaller, and the number in the rows is considerably less (6-18).

The sinistral tube is shaped like the shell of a *Nautilus*, with a deep umbilicus on the free surface, and its main bulk is composed of the last coil, which often hides the earlier coils, though, in some, these are distinct in the centre. The surface of the last coil is slightly bevelled and marked by transverse lines of growth. The aperture is circular, though a process of the tube projects beyond it on the surface of the sea-weed. The tubes sometimes occur in rows and on both surfaces of the *Fucus*. De St. Joseph

met with *Folliculina ampulla* in the interior of a tube and the ova of *Automolos unipunctatus*, Graff (*Monocelis unipunctatus*, Erst.), and Turbellarians are not uncommon in tubes from St. Andrews and Lochmaddy.

The next, or thirteenth, species, which was probably included by Sacchi as *Serpula spirorbis* in his 'Catalogue of the Shells of Naples,' has been well known since Claparède described it as *Pileolaria militaris* in his volume on the Annelids of Naples. It is a southern type and, so far as known, has hitherto been confined in the British area to the Channel Islands, though Caullery and Mesnil found it not infrequent on the shores of France, and Langerhans mentions a form (his *Spirorbis granulatus*, L.) which these authors consider to be only a variety from Madeira. It is rarely met with in the Channel Islands.

The operculum is comparatively large, helmet-shaped, and ornamented with denticulated ridges and accessory processes. The cavity of the helmet performs the function of a brood-pouch, and, in those captured in July and August, was filled with large eggs and embryos—the breeding-season at Naples being somewhat earlier, viz., in June and July. It differs from such as *Spirorbis pagenstecheri*, De Quatrefages, in so far as the opercular helmet is ready to receive the ova without further addition or alteration. Its specific name has reference to the helmet-like condition of the operculum, which is ornamented with characteristic ridges.

The branchiæ have comparatively thick filaments which end in a long and slender process. The body is typical in outline, has a deep reddish hue, and the same colour tinges the branchiæ, the collar, and the anterior membrane (*Caullery and Mesnil*). Anterior region of three-bristled segments.

The first or collar-bristles are characterized by their size, the coarseness of their serrations, the presence of a distinct gap, and their yellow colour. Moreover, they are boldly curved at the tip, so as almost to resemble "kneed" bristles. They are accompanied by a series of simple bristles, which are widest, though they do not quite reach the size of the former bristles, at the base and gradually diminish to a delicate hair-like tip. The next bristle-tuft has capillary bristles with finely serrated rings, the shaft in each being nearly cylindrical or very slightly tapered.

The sixth species of *Spirorbis* is one originally described by Miss Pixell from the shores of British Columbia, and which Mr. Southern procured in Blacksod Bay on the West Coast of Ireland, and I am indebted to him for examples.

In this the cephalic collar is well developed, forming a sheath for the base of the tentacles. The filaments of the branchiæ, which are fourteen in number, terminate distally in a tapering subulate process, which extends considerably beyond the pinnæ. The nail-shaped operculum presents a minutely cellular or reticulated structure, when viewed by a high power from above, and a series of concentric rings. A considerable process or talon occurs beneath it, the lower edge of which varies in outline—sometimes being irregular, at other times smooth. The distal concavity frequently contains mud and minute algæ.

The body has the typical coil, three bristled segments occurring in front and twenty to thirty posteriorly. The most powerful muscle seems to be that on the concave side of the coil. The collar (first) bristles have straight shafts dilating into a broad web at the base of the tip, which is bent backward, is of moderate length, finely tapered, and minutely serrated. The basal web is striated, each of the striæ ending in a sharp point, whilst the distal blade slants obliquely to the serrated edge. The second tuft has bristles with rather broad wings, and the blade tapers rather suddenly to a very fine point, so as to give a character to the bristle. The third tuft has both winged and sickle-shaped bristles, the edge of the latter being serrated.

The posterior bristles are minute, and project little beyond the surface. They are geniculate at the tip, being bent nearly at a right angle to the shaft and coarsely serrated. The anterior hooks are stated by Miss Pixell to be of ordinary shape, with about twenty teeth. The tube is described by Miss Pixell as dextral, large and flat, thick and opaque, slightly roughened, but without definite growth-lines. A slight median ridge and sometimes one on either side; the aperture has, however, an entire margin and measures 2 mm. across. The Irish examples from Blacksod Bay, kindly forwarded by Mr. Southern, were in dense clusters on stones and shells, sometimes only the aperture being visible, whilst the tube itself formed a lax spiral, quite different from the original account of Miss Pixell, though it is still large. In lateral view the elongated spires of some of the masses gave an unusual depth to the Spirorbid coating. Some examples, indeed, formed an elongated spiral tube, after the manner of the horn of the Indian Antelope, or even that of the Koodoo. Originally the tube appears to be small and flat, then, as the annelid increases in size, the tube thickens, becomes loosely spiral, and keeps pace with the growth of sponges or other

encrusting growths, so that its rounded and dilated aperture (trumpet-like in some) is free. From Miss Pixell's description, the tubes follow another mode of growth under different circumstances.

A single example of the last species, viz., *Spirorbis pusilloides*, De St. Joseph, kindly sent by Mr. Southern, has alone been under examination, and the collar-bristles in this instance had no gap above the web, and might pass for those of *S. spirillum*. Mr. Southern, however, states that he has seen all intermediate forms between this and the typical form with the differentiation at the base of the blade. Caullery and Mesnil also found a simple geniculate condition of the collar-bristles in preparations forwarded by Baron De St. Joseph. Whether the violet pigment on the gut of *S. pagenstecheri* and the red on *S. pusilloides* denotes more than variation is uncertain. The species was first described by De St. Joseph under the name of *Mera pusilla**, but Miss Bush†, seeing that the specific name was used by Rathke in 1836 for a species from the Black Sea, proposed the present title. It chiefly occurs on shells of oysters, though Southern found it on mussels and *Truchi*.

Two forms, familiar in the literature of the subject, are not entered here, viz., *Spirorbis heterostrophus*, Montagu, and *Spirorbis carinatus*, Montagu, since both are probably included in the forms dealt with, and, at any rate, the uncertainty can only be removed by a careful examination of fresh animals. Miss Bush and others do not seem to have formed a definite opinion about either.

Montagu (1803)‡ describes *Spirorbis heterostrophus* as having "a strong, spiral shell, of a dirty white colour, with two or three reverse volutions placed laterally, furnished with three longitudinal ridges, one along the back, and another on each side, roughly wrinkled transversely; the base is flat and somewhat spreading; aperture orbicular, and invariably placed opposite the sun's apparent motion. Diameter not a line."

He procured it on oyster and other shells and on algæ. It is readily distinguished from *S. spirorbis* by the longitudinal ridges, and by the contrary turn of the volutions. Under slate-stones at Kingsbridge Bay in great abundance (covering

* Ann. Sc. Nat. 7^e sér. xvii. p. 351, pl. xiii. figs. 388-392.

† 'Tubicolous Annelids from the Pacific' (Harriman), Alaska Exped., 1908, p. 250.

‡ Test. Brit. vol. ii. p. 50?

the surface), between tide-marks. He thought the sub-saline quality of the water so far up this inlet, at ebb-tides, not congenial to other forms. The tube at first sight resembles that of *S. granulatus*, but appears to be coiled from right to left, whereas that of the common form is sinistral. It shows a deep groove on the summit and two ridges. Occasionally the aperture of the tube is turned upward. All the specimens are of one size and small, so that they may not be adult.

Montagu* found *Spirorbis carinatus* common on *Arca pilosa* and *Pinna ingens* on the south coast, and describes it as having "a dull, opaque, white, spiral shell; the outer 'whirl' rising into a carinated ridge on the top; the middle concave, sometimes pervious; the interior volutions inconspicuous; base a little spreading; aperture round. Size about half that of the *S. spirorbis*, from which it is readily distinguished by the angulated shape of the exterior 'whirl,' which is formed like *S. triquetra*, but always regularly spiral." Fleming† adds little to the original description, though he states that the "surface is transversely wrinkled, the whole less regular than the preceding (*S. granulatus*), with the aperture more ascending." His examples appear to have come from Shetland. Miss Bush‡ thinks Fleming's form approaches *S. quadrangularis*, Stimpson, adding, "but it is not improbable both species occur on the English coast." She alludes to two forms, one dextral from Guernsey and Ireland, the other sinistral from England, but comes to no definite conclusion.

The tubes from Exmouth (1822) are small, and have a reversed coil (sinistral) to that of *Spirorbis heterostrophus*. The inner side of the last whorl is broadly grooved, whilst a ridge runs along the top of the coil. The aperture is round, the centre is either filled up by the early coils or is blank—forming a large umbilicus. It resembles a young *Spirorbis granulatus*, but only one groove is distinct. Levisen, again (1883), shows two ridges in his figure, and is of opinion that it is synonymous with *S. quadrangularis*, Stimpson.

In the British Museum § a specimen labelled "*Spirorbis carinatus*, Montagu," is attached to a Polyzoon like a large *Salicornaria*, from Greenland (*Copenhagen Museum*). The specimen has branchiæ with long, tapering, terminal

* Test. Brit. ii. p. 502 (1803).

† Edinb. Philos. Journ. vol. xii. p. 244.

‡ 'Tubicolous Annelids from the Pacific,' p. 249.

§ I am indebted to Dr. Harmer, Dr. Calman, and Mr. Tate Regan for their courteous aid in the examination of this and other specimens.

processes, an operculum, the calcareous plate of which is rounded, whilst the anterior region has three pairs of bristles. The collar-bristles have the rather long triangular web at the commencement of the tip furnished with numerous small serrations, only the upper one or two being larger, a rather shallow gap above it, and a tapering blade with a finely serrated edge. These bristles thus approach those of *Spirorbis granulatus* and *S. borealis*. The third series appears to have sickle-shaped bristles. The tube has three sharp ridges and two grooves, the ridges differing from those of *S. granulatus* in their spinous edge, and the median ridge in some becomes deeper at the aperture, so that it forms a conspicuous keel, with a small sharp point over the circular aperture.

4. On a *Placostegus* from the 'Porcupine' Expedition of 1870.

The examples were dredged six miles from shore off Cape de Gatte in 60–160 fathoms in the 'Porcupine' Expedition of 1870, attached to small stones. It is distinguished from the northern *Placostegus tridentatus* by the longer and more slender tube, which may be curved here and there but not coiled, and by the presence of three coarsely serrated ridges (a dorsal and two lateral). The three spines at the aperture also differ in character, since they are longer and curved outward.

The thin diaphanous collar seems to have the same arrangement as in *P. tridentatus*, but the branchiæ are proportionally longer and less numerous, viz., 11–12 in each fan, the filaments taper a little from base to apex, where a longer terminal subulate process than in the former species occurs. The long pinnæ, however, continue to its base. The opercular stalk is slender and remains nearly of the same diameter to the base of the vase-shaped operculum, which, though smaller, is more elegant in shape than in *P. tridentatus*. The truncated distal end is hollow and horny, the rim only being yellowish.

The body is long and narrow, with six bristled segments anteriorly, and numerous posterior segments which are flattened toward the tail and end in an anus with a distinct and rounded papilla at each side. The six setigerous processes anteriorly have tufts of the same kind, viz., bristles with straight shafts, very slightly bent tips with narrow wings, in which respects they do not materially differ from those of *P. tridentatus*. Posteriorly bristles seemed to be absent

until near the tip of the tail, where each segment has a single, long, slender, tapering bristle or two. The brush-like bristles, however, are not absent, since they occur toward the posterior end, in front of the simple forms. Each has a slender straight stem, which dilates distally into the flattened spinous tip, one side of which has a minute whip or pointed process, the tip being thus asymmetrical. The anterior hooks appear to be proportionally smaller and broader than in *P. tridentatus*, and the modified main fang is indistinct. In both the serrations of the anterior edge resemble transverse grooves of a file, but they are perhaps broader and more distinct in the present form. The posterior hooks are slightly less, but agree in structure with the foregoing.

The tube is small, elongated, tapered posteriorly, and fixed to small pebbles. The dorsal and two lateral spinous ridges are diagnostic when compared with the tube of *P. tridentatus*, for the spinous processes on each are isolated and prominent, as well as occasionally curved, as are also the three anterior spines. Moreover, the entire tube is more transparent than in *P. tridentatus*, and the spines especially so. It may represent, however, only a variety of *P. tridentatus*, J. C. Fabricius.

XIX.—*Parapherusa crassipes* (Haswell), an Amphipod of Australasian Seas. By CHAS. CHILTON, M.A., D.Sc., LL.D., F.L.S., C.M.Z.S., Professor of Biology, Canterbury College, New Zealand.

[Plates VIII.-X.]

IN 1879 Haswell described a new genus and species of Amphipod from Clark Island, Port Jackson, New South Wales, giving it the name of *Harmonia crassipes*, the name being misprinted *Harmomia* on the original page (p. 330), but correctly spelt in the explanation of the plates (p. 349). In 1880, in his 'Preliminary Report on the Australian Amphipoda,' he used the name *Chloris* in referring to this genus. It was included in the 'Catalogue of the Australian Crustacea' published in 1882 under the name *Harmonia crassipes*. In 1883 I recorded the species from Lyttelton, New Zealand, and added a description of the female, which had not been described by Haswell. In establishing the genus Haswell stated that it had affinities with *Eurystheus*