

# A NEW GENUS AND SPECIES OF MARINE LEECH, *Glyptonotobdella antarctica*, FROM AN ANTARCTIC ISOPOD

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ABSTRACT. A description is given of a leech found to be a common ectoparasite of *Glyptonotus antarcticus* (Isopoda) in the South Orkney Islands. During a study of the biology of this species between 1966 and 1968, leeches were encountered in every month of the year mostly in water deeper than 40 m. where 95 per cent infestation was observed; they were seldom found free-living and never on an alternative host. The leech resembles *Crangonobdella* and *Myzobdella* which also infest Crustacea, in possessing 12 annuli per segment, fused posterior caeca and a much-reduced coelomic system. Phylogenetic relationships are discussed.

In the course of marine biological studies at Signy Island (lat. 60°43'S., long. 45°38'W.), South Orkney Islands, from February 1966 to February 1968 (White, 1970), many samples of the large isopod *Glyptonotus antarcticus* (Eights 1852) were collected from the epibenthos of Borge Bay and Factory Cove by a variety of methods, including Agassiz dredge, beam trawl, trapping and Scuba diving. Leeches were frequently encountered adhering to the exoskeleton of the isopod.

Specimens were preserved in neutralized formol saline or Bouin after narcotization with menthol or isotonic magnesium chloride. Low environmental temperatures (−1·9 to +1·5° C) retarded the action of the narcotics causing some individuals to become distorted by violent preservation.

*Stibarobdella australiensis* was taken infrequently (see Appendix) but most leeches were of an unknown species clearly related to the group of genera including *Crangonobdella*, *Myzobdella*, *Illinobdella* and *Hemibdella*. These forms are characterized by a more or less cylindrical body with both suckers smaller than the greatest body width. Pulsatile vesicles are lacking but 12-annulate somites and a centrally positioned mouth and fused posterior crop caeca are present. The leech from *Glyptonotus* most closely resembles *Crangonobdella* and *Myzobdella*, both of which have a greatly reduced coelomic system in addition to the above characters. Nevertheless, it differs from these in several important characters, e.g. the absence of oesophageal pouches, conducting tissue and a copulatory zone, six pairs of testes, one pair of eyes and the absence of distinct body ocelli.

Therefore, with reservations and pending further work on the taxonomy of the Piscicolidae, a new genus, *Glyptonotobdella*, is proposed to include this new species.

M.G.W. contributed the section on biology, and discovered, collected and examined the leeches while studying at Signy Island during 1966–68 as a member of the British Antarctic Survey. The anatomical description and systematic discussion was contributed by R.T.S.

## BIOLOGY

The distribution of the large isopod host, *Glyptonotus antarcticus*, is thought to be circum-polar, ranging in depth from the intertidal belt to at least 585 m. throughout the area south of the Antarctic Convergence. It has been recorded by various authors from South Georgia, the South Sandwich Islands, South Orkney Islands, South Shetland Islands and the Antarctic Peninsula in the western Antarctic, and the Ross Sea and Haswell Islands in the eastern Antarctic. It has been the subject of biological observations by Collinge (1918), Sheppard (1957), Dearborn (1967) and others, but the occurrence of leeches on the exoskeleton of this

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species has not been reported previously and they may prove to be confined to the South Orkney Islands.\*

In life, the leech is invariably found on the ventral surface of *Glyptonotus*. The point of attachment, by means of the posterior sucker, is most usually between the pereopods (Fig. 1) though infrequently they have been observed at the dorsal surface or on the pereopods, uropods or telson. Occasionally, individuals were observed with the anterior sucker closely adpressed to thin regions of the host integument (between somites and at limb bases). This attitude, when maintained for some time, was thought to indicate feeding.



Fig. 1. *Glyptonotus antarcticus*. Ventral aspect with leeches adhering to the exoskeleton between the pereopods. (Three posterior pairs of pereopods have been removed.)

\* Members of the Scottish National Antarctic Expedition made a number of collections from the benthos near their winter quarters on Laurie Island, South Orkney Islands. They recorded their natural history observations in a diary and D. W. Wilton (Wilton and others, 1908, p. 29) remarked on the contents of a dredge sample on 26 June 1903 "... two isopods [*Glyptonotus antarcticus*], apparently a pair, ... and three worms with suckers were found on the under surface of the larger isopod." This observation is probably of the same species of leech but there is no further account in the expedition's more detailed scientific reports.

Dr. J. H. Dearborn (personal communication) observed a single leech adhering to the ventral surface of a specimen of *Glyptonotus antarcticus* at McMurdo Sound during the winter of 1961 which he described as smaller than 15 mm. long and coloured brown with dirty white to white bands. This specimen was not preserved and consequently its taxonomic status cannot be discussed until further specimens become available.

96·8 per cent of the individuals of *Glyptonotus* collected from water deeper than 40 m. were infested by the leech, whereas collections from less than 20 m. showed only 6–22 per cent infestation (Table I). Adult male and female *Glyptonotus* were infested to a similar degree and the leech was found on the isopods during every month of the year with no obvious seasonal variation in numbers.

TABLE I. PERCENTAGE INFESTATION OF THE ISOPOD *Glyptonotus antarcticus* COLLECTED FROM DIFFERENT DEPTHS

Sex	Total caught	Number infested	Percentage infested
<i>Depths of 40 m. or more</i>			
Male	952	715	95·0
Female	317	307	96·8
Juvenile	10	0	0
All groups	1,079	1,022	94·7
<i>Depths of 20 m. or less</i>			
Male	155	34	21·9
Female	120	8	6·6
Juvenile	36	0	0
All groups	311	42	13·5

Although various fish and crustacean species caught at Signy Island were examined for the parasite, *Glyptonotobdella antarctica* has not been observed on any other host. Free-living individuals were rarely encountered during February, March and September, adhering to algae in collections of epibenthos recovered in an Agassiz dredge.

Progression by looping was normal and the leech has not been observed swimming. The posterior sucker was usually placed behind the anterior sucker before a step was made but sometimes the posterior sucker was slid along the anterior ventral surface before adhering to the substrate. When *Glyptonotus* was lifted from the water during hand collections the leeches became active but did not ordinarily move to an alternative host. However, when a host animal became moribund or died in the laboratory a new host was actively sought.

#### GENERIC CHARACTERS

##### *Glyptonotobdella* gen. nov.

Body cylindrical without divisions into trachelosome or urosome. Each sucker is narrower than the greatest width of the body. Skin smooth except for 10–12 pairs of small lateral prominences on segments posterior to XII. No pulsatile vesicles. Coelomic system greatly reduced, leaving only the ventral lacuna. Mid-body segments 12-annulate but may be further divided temporarily into 14 or even 16 annuli. Mouth central. Posterior crop caeca fused with five fenestrae immediately behind ganglia XIX–XXIII. Lacking oesophageal diverticula, conducting tissue and a copulatory zone.

*Type species.* *Glyptonotobdella antarctica* sp. nov. *Diagnostic characters.* Size 3·5–18·0 (10·5) mm. One pair of cephalic eyes. Six pairs of testes. Body pigmented with conspicuous red-brown transverse stripes (except in small individuals). *Known distribution.* Signy Island, South Orkney Islands, Antarctica. *Host.* *Glyptonotus antarcticus* (Eights). Type series deposited in the British Museum (Nat. Hist.). *Reference numbers.* Holotype: B.M. (N.H.) Reg. No. 1969.1.1; paratypes: B.M. (N.H.) Reg. No. 1969.1.2–20.

## EXTERNAL CHARACTERS

*General morphology*

Individuals varied in length from 3.5 to 18 mm. A collection of 132 specimens, made on 24 January 1968 in Borge Bay, ranged from 3.5 to 14 mm. and had a bimodal distribution, with peaks at 6.0 and 10.5 mm. probably representing two age groups. The holotype was 10.2 mm.

The body shape of the holotype is narrowly fusiform with no preputial collar or other clear distinction between the urosome and trachelosome (Fig. 2a). It is almost cylindrical at either

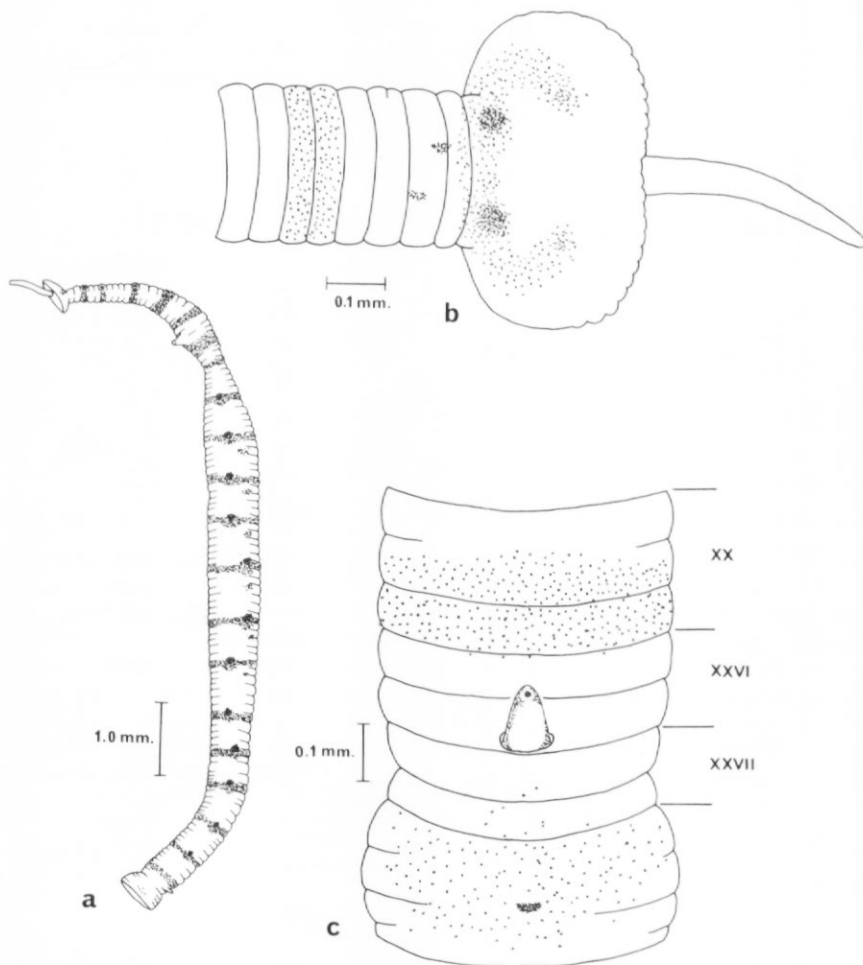


Fig. 2. *Glyptonotobdella antarctica*. Holotype.

a, lateral view of type specimen, 10.2 mm. long; b, dorsal view of anterior sucker with protruding proboscis; c, dorsal view of posterior sucker with protruded anus.

end, being 0.28 mm. in diameter anteriorly and 0.42 mm. posteriorly. The testicular region (segments XIII–XVIII) is slightly flattened dorso-ventrally. At segment XI the body widens to 0.47 mm. then narrows to 0.36 mm. at segment XII before becoming wider in the testicular region. The widest part of the body, 0.72 mm., is at segment XIV. Just behind the anus (segment XXVI) is a slight constriction to 0.42 mm. in diameter. The other specimens have this same narrow elongated shape, but those that were engorged with food were more rounded posteriorly, even to the point where a distended urosome is distinguishable from a narrow

trachelosome (Fig. 6). Most specimens were more tapering than the type specimen, without the conspicuous bulge in the genital region.

Metameric concentrations of clitellar gland cells can be seen through the body wall dorsally and laterally in mature individuals, particularly in the intertesticular regions. There appear to be two types of these cells, one containing greenish granules, the other whitish granules; each is equally interspersed to give the body a somewhat stippled appearance. The whitish outlines of the six pairs of testes in segments XIII–XVIII can also be seen through the body wall of most individuals.

The gut of a number of specimens was considerably engorged with a brownish or greenish substance, from the anterior part of segment XII almost to the anus, and the crop caecae were expanded laterally into the intertesticular parts of segments XIII–XVIII. The metameric pigmentation pattern and sometimes the lateral protuberances were obscured in the majority of individuals and in some specimens the testes were pressed against the body wall to appear as whitish bulges resembling lateral pulsatile vesicles. Similarly, the ganglia were sometimes pressed against the ventral body wall.

The male bursa of the holotype is everted conically in an anterior direction from a swollen base 0.28 mm. in diameter. The rim of the tip, 0.14 mm. in diameter and 0.17 mm. from the surface of the body, is covered with many swollen papillae-like structures. No female gonopore or any external sign of a copulatory zone was discernible in this specimen.

An everted male bursa is common among specimens of this species, especially where they appear to have been distorted during preservation (Fig. 3a), as in the genera *Platybdella* and *Myzobdella*. According to Selensky (1915), the bursa of *Crangonobdella murmanica* is everted

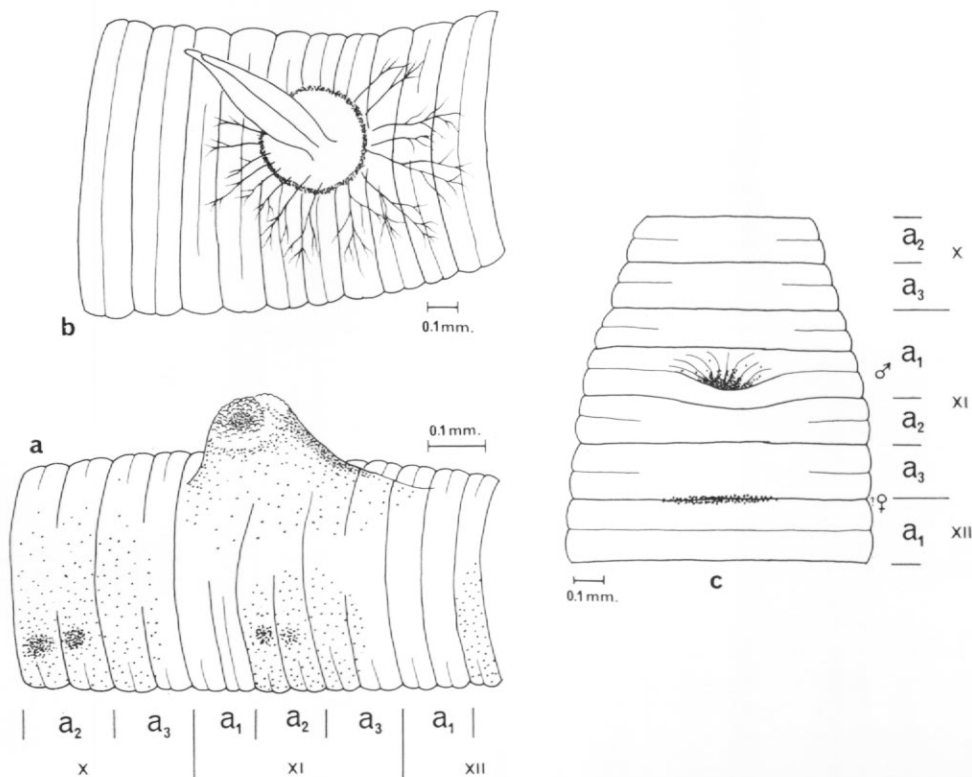


Fig. 3. *Glyptonotobdella antarctica*. Paratypes.

a, everted male bursa; b, ventro-lateral view of implanted spermatophore; c, male and female (possible) gonopores in an individual without an everted male bursa.

only exceptionally. The male gonopore of most specimens was located at or near XI  $c_3/c_4$  but in some individuals it was one tertiary annulus to the posterior at XI  $a_1/a_2$ . The atrium was not everted and the male gonopore was represented by a large, conspicuous transverse slit in practically all mature specimens (Fig. 3c). The male gonopores of juvenile individuals were small and difficult to discern. A mid-ventral dark area, which may have been the female gonopore, was found in one large specimen at segment XI/XII, slightly more than two primary annuli behind the everted male gonopore. In no specimen was the female gonopore or an external copulatory zone determined with certainty.

The anus of the holotype at XXVI  $a_3$  is positioned on a small rounded, anteriorly protruding cone, 0.08 mm. wide at the base (Fig. 2c). This character is typical of specimens that appear to have been preserved without total narcotization.

#### Annulation

The annulation was determined by examination of external pigmentation and the position of the ganglia (Fig. 4).

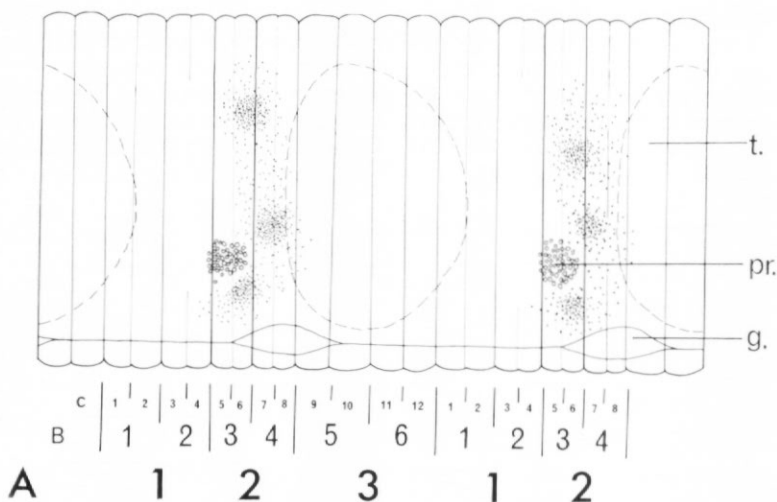


Fig. 4. *Glyptonotobdella antarctica*. Lateral view of annulation, segmentation and relative positions of ganglion (g.), testis (t.) and lateral protuberance (pr.) in a typical complete segment of an adult individual. A, B and C are the primary, secondary and tertiary annular divisions of a segment, respectively.

The anterior sucker and the anterior part of the neck are by convention composed of segments I–VI. Segment VII is tri-annulate,  $b_{1-2}$ ,  $b_{3-4}$ ,  $b_{5-6}$ ; VIII, penta-annulate,  $b_{1-4}$ ,  $b_5$ ; IX–X, tri-annulate,  $b_{1-2}$ ,  $b_{3-4}$ ,  $b_{5-6}$ ; XI, basically tri-annulate, ( $b_1 + c_{3-4}$ ),  $b_{3-4}$ ,  $b_{5-6}$ . The primary annulus of segment XI is unusual in being subdivided into secondary annuli, and  $b_2$  is faintly subdivided further into  $c_{3-4}$ , between which is usually located the male gonopore. In the holotype the annular formula of segment XII is quadri-annulate,  $b_1$ ,  $b_2$ ,  $a_2$ ,  $a_3$ , but in most individuals it is tri-annulate,  $b_{1-2}$ ,  $a_2$ ,  $a_3$ , and in some, bi-annulate,  $a_1$ ,  $a_{2+3}$ . In the holotype, segments XIII–XXII each consist of six secondary annuli,  $b_{1-6}$ , of varying widths and each of these is subdivided into more or less equal parts,  $c_{1-12}$ , by semi-permanent tertiary grooves of varying depths so that the segments are actually 12-annulate (Fig. 4). The annuli  $b_5$  and  $b_6$ , which contain the testes in segments XIII–XVIII, are the two largest and most deeply subdivided secondary annuli, whereas  $b_2$  is the least well subdivided annulus. The lateral protuberances are located on  $c_4$  and  $c_5$ . Some pigment distributed metamericly occurs at  $b_3$  and  $b_4$  ( $c_{5-8}$ ).

Unlike the holotype, the lateral protuberances of most specimens are not subdivided by the primary groove,  $a_1/a_2$  ( $c_4/c_5$ ) but rather are situated on annulus  $b_3$  ( $c_{5-6}$ ). The testes of mature specimens are located primarily in  $b_{5-6}$  ( $c_{9-12}$ ) and slightly into  $c_8$ . They also extend well into

$c_1$  of the posterior segment. The testes of juvenile individuals end at  $c_{12}$  and do not penetrate into the posterior segment. Each ganglion in the testicular region is located primarily in  $c_{7-9}$  but behind that region they are often located in  $b_{3-4}$  ( $c_{5-8}$ ). In some especially large individuals there may be faint indications of quaternary sub-divisions particularly at  $c_{9-12}$ , as in *Johanssonia*, *Carcinobdella*, *Myzobdella* and probably *Crangonobdella*.

Segment XXIII is quadri-annulate,  $b_{1-2}$ ,  $b_{3-4}$ ,  $b_5$ ,  $b_6$ ; XXIV, tri-annulate,  $a_1$ ,  $a_2$ ,  $b_{5-6}$ ; and of XXV, bi-annulate,  $a_{1-2}$ ,  $a_3$ . Segment XXV is followed by two annuli which are considered to be XXVI  $a_{1-2}$ ,  $a_3$ . The anus is usually located at the posterior edge of XXVI  $a_3$ , apparently just anterior to what is accepted as segments XXVI/XXVII. Behind XXVI  $a_3$  are two annuli which are taken to be XXVII  $a_{1-2}$ ,  $a_3$ , the latter annulus being associated with the posterior sucker. Segments XXVIII-XXXIV form the remainder of that sucker. Juvenile individuals have fewer sub-divisions, usually lacking the tertiary sub-divisions so characteristic of the complete somites of adults.

#### Pigmentation

In life, small individuals appear white and are in fact translucent, since the gut contents can be seen clearly. Larger individuals assume a yellow ochre background coloration and the largest specimens are barred with a darker red-brown pigment.

The faded holotype (Fig. 2a) is marked by transverse bands of reddish brown pigmentation which, in completely subdivided segments, occur primarily on annuli  $b_3$  and  $b_4$ . On incompletely subdivided segments, both anteriorly and posteriorly, there is a tendency for the pigment to be positioned more posteriorly on the  $b_4$  and  $a_3$  annuli, or just on the latter primary annulus. The pigment is most distinct in the neck region, where each band encircles the neck more or less completely. The pigment concentrations are greatest just posterior to the lateral protuberances in the testicular and intestinal regions but fade dorsally and still more ventrally. The posterior sucker of a few individuals which had been preserved exceptionally well had a pattern of 14 radially distributed pigment stripes (Fig. 5c). These stripes fade in preservatives and in most individuals all that remain are radiating pigment spots, similar to ocelli, on one to three of the circular ridges on the posterior sucker. The stripes are better developed in the living organism but the posterior sucker never seems to possess the well-developed ring of 14 ocelli which is characteristic of *Crangonobdella murmanica*.

#### Lateral protuberances

On the  $b_{2-3}$  annuli of segments XIII-XXIII of the holotype there are conspicuous, slightly elevated, lateral protuberances containing white granular reserve cells readily observed through the epidermis. The initial four protuberances on XIII-XVI, which are in a longitudinal series contiguous with those on XIX-XX, are somewhat ventral to the lateral line. The protuberances on segments XVII-XVIII, which are in a series contiguous with those on segments XXI-XXIII, are dorsal to the lateral line. Posteriorly, the protuberances gradually become smaller and less conspicuous, especially from segments XXI-XXIII. In the larger well-preserved specimens, protuberances were also found on segments XXIV-XXV.

No other types of protuberance, tubercle, pulsatile vesicle or papilla were observed on any of the specimens.

The relative spatial distribution of these lateral protuberances is a reliable, almost invariably, characteristic of this species, those especially noticeable being the more dorsally placed protuberances on segments XVII-XVIII and the more ventrally placed ones on segments XIX-XX. These protuberances can be seen in transverse section to consist primarily of dermal thickenings or concentrations of large, often flask-shaped cells. They are not part of the coelomic system or vascular network. According to Selensky (1915), small lateral prominences or slightly raised areas are also found on the  $c_6$  annuli of *Crangonobdella murmanica* but they are never as well developed as in *G. antarctica*.

#### Anterior sucker

The shape of the sucker varies but the posterior side is usually somewhat wider than the anterior, producing an ovate-trapezoid form. The deepest part of the cup is a transverse

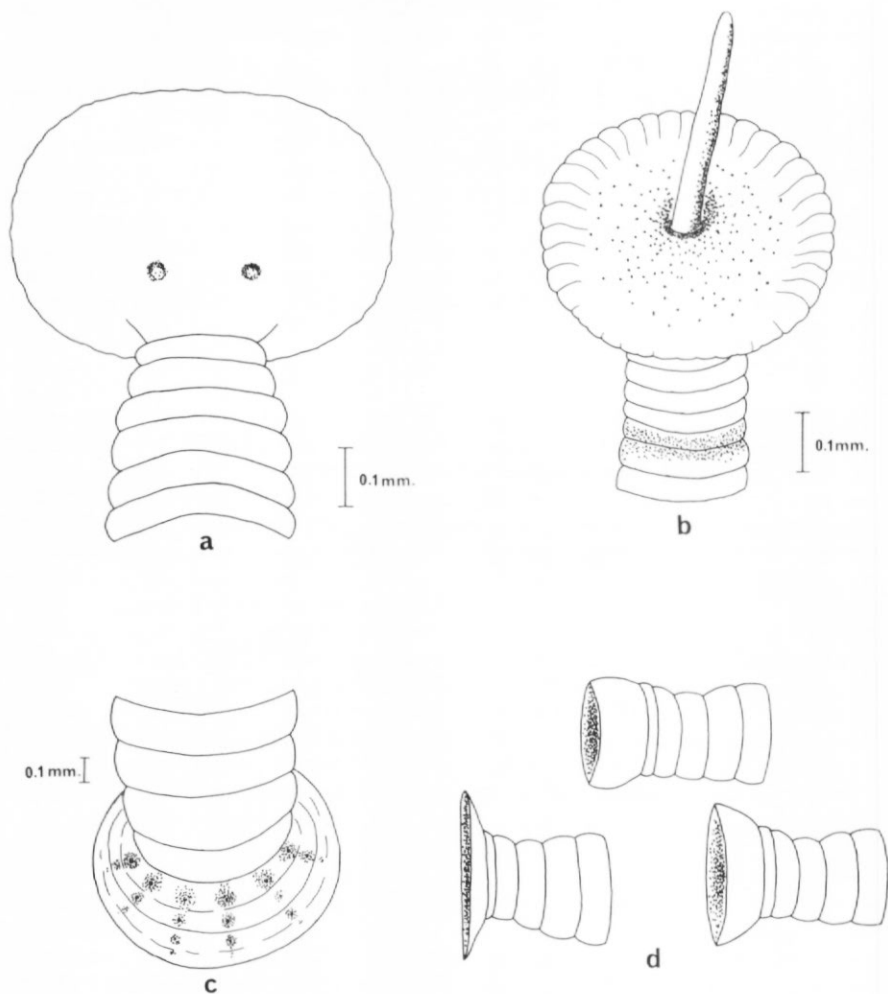


Fig. 5. *Glyptonotobdella antarctica*. Paratypes.

a, dorsal view of anterior sucker with characteristic single pair of eye spots; b, ventral view of anterior sucker with protruding proboscis; c, dorsal view of posterior sucker with radiating pigment pattern; d, lateral view, showing individual variations of shape of posterior sucker.

groove between the mouth and the anterior margin. Only one pair of eyespots was found (Fig. 5a) in most preserved and living specimens.

The oral sucker of the holotype is a shallow cup with only a slight marginal rim, that of the anterior and posterior margin is least developed (Fig. 2b). The sucker is ovate-rectangular, 0.36 by 0.53 mm. with the longest diameter transverse to the body, and it is situated at an angle of about  $30^\circ$  to the longitudinal axis of the neck but, nevertheless, the postero-ventral margin of the sucker is well developed. The proboscis protrudes 0.56 mm. from the mouth, which is near or slightly anterior to the centre of the sucker (Fig. 5b). It has a relatively blunt tip, which is only slightly narrower than its base, that being 0.07 mm. in diameter. There is a single pair of widely separated cephalic eyes located 0.25 mm. from the anterior margin of the sucker and 0.17 mm. from each other. There is a pair of pigment concentrations just discernible antero-lateral to the major pair of eye spots and an even more obscure pair of nuchal pigment concentrations.



*Posterior sucker*

The posteriorly projecting caudal sucker of the holotype is deeply cupped (Fig. 2c), being 0.28 mm. deep and 0.53 mm. at its widest diameter just anterior to the posterior margin, which is wider than the posterior part of the body at its junction with the sucker (0.42 mm.). The sucker is scarcely pigmented but there is a small obscure pigment spot just to the right of the midline on the anterior rim of the third largest caudal ridge.

The form of the posterior sucker varies, as in *Crangonobdella*, from the deeply cupped shape found in the type specimen to an expanded flattened disc (Fig. 5d). This variation is probably due to differences at preservation, flattened suckers being usually found in individuals that

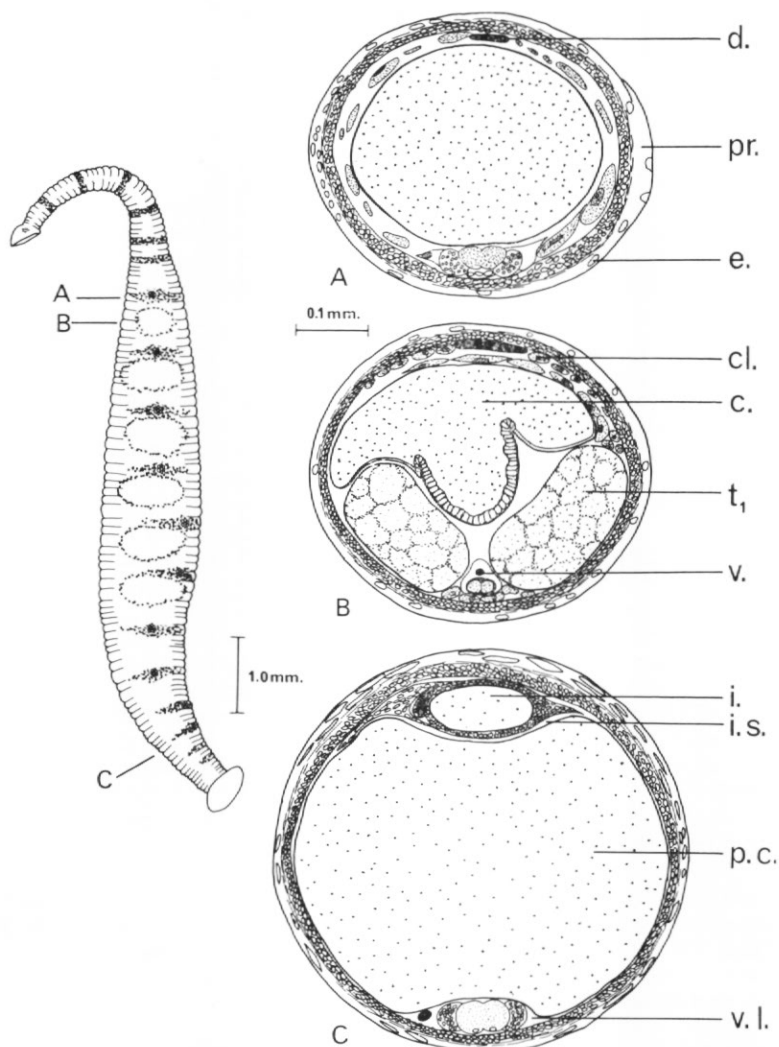


Fig. 6. *Glyptonotobdella antarctica*. Left: specimen of a recently fed paratype, 10.4 mm. long, showing positions of bulges caused by the six pairs of testes which superficially resemble pulsatile vesicles. Right: transverse sections through the sites indicated at left. Section A is through ganglion XIII; section B is at XIII/XIV, through the first pair of testes; section C is through ganglion XXII at the region of the fused posterior crop caeca. *d.* dorsal blood vessel; *pr.* lateral protuberance; *e.* epidermal gland cell; *cl.* clitellar gland cell; *c.* crop; *t<sub>1</sub>* first pair of testes; *v.* ventral blood vessel; *i.* intestine; *i.s.* intestinal sinus; *p.c.* fused posterior crop caeca; *v.l.* ventral lacuna.

were fixed attached to the substrate, deeply cupped suckers in those preserved without sufficient narcotization, and the intermediate condition in those fixed when unattached and relaxed.

#### INTERNAL CHARACTERS

This section is based on the histological examination of eight representative individuals, cut at 10  $\mu\text{m}$ . and counterstained with Ehrlich's haematoxylin and eosin.

#### *Body wall*

The epidermis consists of a single layer of columnar cells, 6 by 11  $\mu\text{m}$ . Flask-shaped secretory cells have a maximum diameter of 13–29  $\mu\text{m}$ ., with nuclei 5  $\mu\text{m}$ . in diameter. Flattened dermal cells, 11 by 38  $\mu\text{m}$ . with nuclei 4.6–5  $\mu\text{m}$ . in diameter, contain eosinophilic granules. These cells are localized and generally scarce so that the hypodermis is unusually thin, 4–20  $\mu\text{m}$ . The circular, oblique and longitudinal muscles are well developed and together constitute a conspicuous layer 13–22  $\mu\text{m}$ . thick.

#### *Coelomic system*

The coelomic system is greatly reduced (Fig. 6A–C) as it is in the genera *Crangonobdella*, *Myzobdella* and *Platybdella*. The ventral sinus, which surrounds the nerve cord and the ventral blood vessel, is especially prominent in the region of ganglia where small wing-like projections extend dorso-laterally. Small sinuses are also associated with the ovisacs and the testisacs. A small sinus surrounds parts of the intestine but no dorsal or lateral sinuses are associated with the poorly developed dorsal blood vessel.

#### *Digestive system*

The proboscis is enclosed in a tube with a narrow triangular lumen and extends posteriorly to segment IX (Fig. 7a). The salivary gland cells are more or less paired and contain large secretory lacunae with granular brownish secretions which can be traced to the 8–10 paired salivary ducts extending throughout the length of the proboscis. The oesophagus enlarges laterally just posterior to the proboscis. Oesophageal diverticulae, well developed at segments X/XI in *Crangonobdella murmanica* and *Myzobdella lugubris*, were not observed in this species. The gut lumen narrows at segments X to XI and expands laterally at XII, anterior to the first pair of testes. It narrows ventrally in the testicular regions of segments XIII to XVIII but the part dorsal to the testes remains laterally expanded (Fig. 6B). The gut is circular in cross-section in the intertesticular regions, expanding to fill most of the body cavity (Fig. 6C). The intestine and the posterior crop caeca originate just posterior to ganglion XIX, where the crop caeca are attached to the gut by a short narrow tube which projects posteriorly into the expanded lumen of the intestine. From segments XIX to XXIV the intestine has poorly developed lateral caeca. The posterior crop caeca, which extend from segment XIX to XXVI, are completely fused except for five fenestrae through which dorso-ventral muscles or strands of connective tissue pass. Each is just posterior to the ganglia of segments XIX–XXIII (Fig. 7b), as in *Crangonobdella*, *Johanssonia*, *Oxytonostoma* and other genera, and the degree of fusion is not subject to individual variation as it is in *Oceanobdella blennii* and *Platybdella anarrhichae*.

In flattened whole mounts the intestine may become a distorted tube. The guts of the majority of sectioned specimens were dilated with a granular eosinophilic substance which closely resembled the contents of the haemolymph of the presumed host, *Glyptonotus antarcticus*. The granules were unlike the nucleated fish blood cells that are characteristic of the gut contents of psicicolids which parasitize fish.

#### *Reproductive system*

A large wide atrium is present between segments XI and XII (Fig. 7a); the atrial cornua are deflected anteriorly, each narrowing into a ductus ejaculatorius at the region of ganglion XI, to enlarge again into a swollen sperm-filled bulbus ejaculatorius extending anteriorly to segment X before bending ventrally and posteriorly to become the vas deferens at segment XI. The six pairs of testisacs, just posterior to the ganglia in each of the segments XIII–XVIII, are

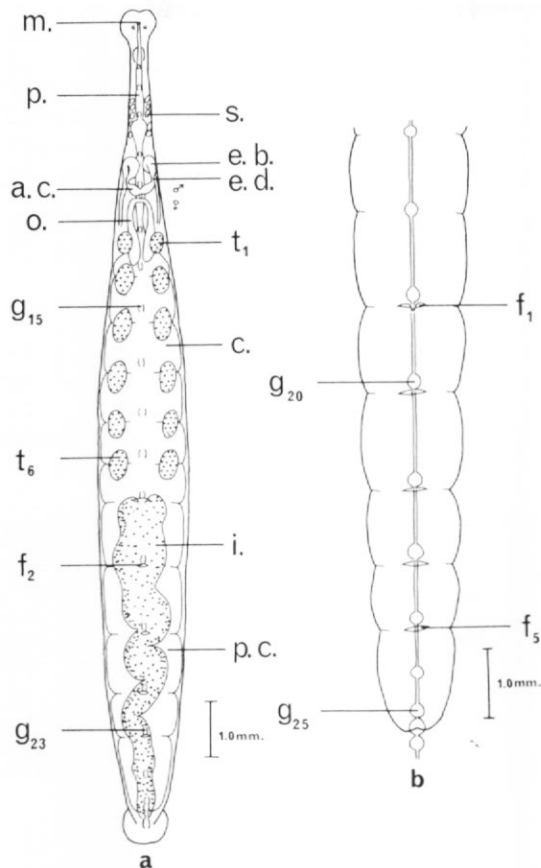


Fig. 7. *Glyptonotobdella antarctica*. Reconstruction of the digestive and reproductive systems (a) and the fused posterior crop caeca (b). *m.* mouth; *p.* proboscis; *s.* salivary gland cell; *e.b.* ejaculatory bulb; *e.d.* ejaculatory duct; *a.c.* atrial cornu; *o.* ovary; *c.* crop; *i.* intestine; *p.c.* fused posterior crop caeca; *t*<sub>1-6</sub> first to sixth pair of testes; *g*<sub>15-25</sub> fifteenth to twenty-fifth ganglion; *f*<sub>1-5</sub> first to fifth fenestra.

positioned against the ventro-lateral wall at an angle of almost 45°. The first pair in segment XIII (Fig. 6B) is not found in *Crangonobdella murmanica* nor *Myzobdella lugubris*. The number and size of the testes are constant, except that the first pair is somewhat smaller than the other five pairs.

The female gonopore is relatively inconspicuous in cross-section and difficult to discern externally. The ovisacs extend through segment XIII to XIV in mature individuals (Fig. 7a) and in some as far as the second pair of testisacs at XIV/XV. They may not reach the posterior of segment XIII in immature specimens. Mature individuals contain mature ova, at least 65 µm. in diameter and closely associated with nurse cells. No distinct copulatory zone or vector tissue could be distinguished externally or internally.

Large clitellar cells, 100–130 µm. in diameter, are found between the gut and the body wall, primarily in segments XIV–XXI. Similar cells resembling the praeclitellar cells of other piscicolids occur at segment IX. The clitellar gland cells contain two types of secretions, one with coarse granules and the other with fine eosinophilic granules similar to those found in *Oceanobdella blennii*. The secretory ducts from these two types of cell can be traced to the clitellar region, where they usually open to the exterior in contiguous pairs in segments XI to XII.

Fertilization is by hypodermic implantation of spermatophores. One mature individual,

12 mm. long, collected on 24 January 1968, was found with a double-horned whitish spermatophore, 0.56 mm. long, implanted ventro-laterally in the right side, four primary annuli behind the male gonopore (Fig. 3b). The swollen circular area at the site of implantation, 0.31 mm. in diameter, was the centre of dendritic rays which radiated for 0.3 mm. The horns of the spermatophore were straight, of almost equal size and touching for most of their length. One other adult had a spermatophore attached to the ventral surface, lateral to the mid-line, and a few others had circular crenated patches near the lateral and ventral surfaces suggestive of earlier implantations. Dislodged spermatophores were found in vials of other specimens collected during January which suggests that fertilization can occur during this month.

Cocoons have not been observed on *Glyptonotus* nor noted on other substrates.

## DISCUSSION

The relationship between *Glyptonotobdella* and the related genera *Crangonobdella*, *Myzobdella*, *Illinobdella* and *Hemibdella*, is not clear as further systematic work is required. Table II, which is based on Selensky (1923, 1931), Meyer (1940, 1946) and Moore (1946), summarizes the morphological, behavioural and anatomical affinities of allied species.

TABLE II. COMPARISON OF SELECTED CHARACTERS OF PISCICOLIDS KNOWN TO INFEST CRUSTACEANS AND ALLIED FORMS

	<i>Glyptonotobdella antarctica</i>	<i>Crangonobdella murmanica</i>	<i>Myzobdella lugubris</i>	<i>Illinobdella moorei</i>	<i>Hemibdella soleae</i>
Crustacean host	+	+	+	-	-
Fusiform body	+	+	+	+	+
Suckers each narrower than body	+	+	+	+	+
Mouth central	+	+	+	+	+
Pairs of eyes	1	3	1	1	0
Annulation	12	12	12	12	12
Transverse pigment pattern	+	+	-	-	-
Pulsatile vesicles	-	-	-	-	-
Copulatory zone	-	+	+	?	+
Coelomic system reduced	+	+	+	+	-
Oesophageal pouches	-	+	+	+	+
Fused posterior crop caeca	+	+	+	+	+
F.P.C.C. with 5 fenestrae	+	+	-	-	-
Pairs of testes	6	5	5	5	5
Bulbus ejaculatorius to segment X	+	+	-	-	+

+ Present.

- Absent.

The occurrence of piscicolids on arthropods is uncommon. The relationships vary from true parasitism in a few species to temporary and perhaps fortuitous attachment in others. It is probable that some of these species may be closely related phylogenetically, with the degree of affinity reflected by their degree of dependence on an arthropod host.

Selensky (1914), Meyer and Barden (1955), and Epshtein (1961, 1962) recorded 11 piscicolids from arthropods: *Crangonobdella murmanica* Selensky 1914; *Myzobdella lugubris* Leidy 1851; *Carcinobdella kanibir* Oka 1910; *Notostomobdella cyclostoma* (Johansson 1898); *N. laeve* (Levinsen 1882); *Mysidobdella oculata* Selensky 1927; *Platybdella fabricii* Malm 1863; *P. olriki* Malm 1865; *P. quadrioculata* Malm 1863; *Johanssonia pantopodum* (Selensky 1914) and *Oxytonostoma arctica* Johansson 1898. Of these, Vasilyev (1939) indicated the probable identity of *Carcinobdella kanibir* and *Notostomobdella cyclostoma*, and Epshtein (1961, 1962) tentatively synonymized *Oxytonostoma arctica* with *Johanssonia pantopodum*, and *Crangonobdella murmanica* with *Platybdella fabricii*. Many of these and other closely related species have internal and external characters in common.

Of known piscicolids reported from Antarctic seas, *Glyptonotobdella antarctica* most closely resembles "*Oxytonostoma*" *varituberculata* Moore 1938, which was collected from the coast of the eastern Antarctic at lat. 66°55'S., long. 145°21'E., from 288–300 fathoms (527–549 m.) and lat. 66°08'S., long. 94°17'E., from 120 fathoms (220 m.). These species are similar morphologically but *O. varituberculata* is readily distinguishable by the presence of 30 sensory papillae on the marginal rim of the oral sucker, numerous small papillae on each tertiary annulus and large tubercles in six longitudinal rows on the secondary annuli. Unfortunately, the host of this species was not recorded.

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#### REFERENCES

- COLLINGE, W. F. 1918. Some observations upon two rare marine isopods. *J. zool. Res.*, **3**, Nos. 2 and 3, 63–78.
- DEARBORN, J. H. 1967. Food and reproduction of *Glyptonotus antarcticus* (Crustacea: Isopoda) at McMurdo Sound, Antarctica. *Trans. R. Soc. N.Z.*, Zoology, **8**, No. 15, 163–68.
- EPSHTEIN, V. M. 1961. Obzor rybikh piyavok (Hirudinea, Piscicolidae) severnykh morei SSSR [A review of the fish leeches (Hirudinea, Piscicolidae) from the northern seas of the U.S.S.R.]. *Dokl. Akad. Nauk SSSR*, **141**, No. 6, 1508–11.
- . 1962. Obzor rybikh piyavok (Hirudinea, Piscicolidae) Beringova, Okhotskoto i Yaponskogo morei [A survey of the fish leeches (Hirudinea, Piscicolidae) of the Bering Sea, the Sea of Okhotsk and the Sea of Japan]. *Dokl. Akad. Nauk SSSR*, **144**, No. 5, 1181–84.
- MEYER, M. C. 1940. A revision of the leeches (Piscicolidae) living on freshwater fishes of North America. *Trans. Am. microsc. Soc.*, **59**, No. 3, 354–76.
- . 1946. Further notes on the leeches (Piscicolidae) living on freshwater fishes of North America. *Trans. Am. microsc. Soc.*, **65**, No. 3, 237–49.
- , and A. A. BARDEN. 1955. Leeches symbiotic on Arthropoda, especially decapod Crustacea. *Wasmann J. Biol.*, **13**, No. 2, 297–311.
- MOORE, J. P. 1938. Leeches. *Scient. Rep. Australas. Exped.*, Ser. C, **10**, Pt. 3, 1–15.
- . 1946. The anatomy and systematic position of *Myzobdella lugubris* Leidy (Hirudinea). *Notul. Nat.*, No. 184, 1–12.
- SELENSKY, W. D. 1914. Ueber einige auf Arthropoden schmarotzende Ichthyobdelliden. *Zool. Anz.*, **44**, Nr. 6, 270–82.
- . 1915. *Izsledonanya po morfologii i sistematiky Hirudinea. I. Organizachia Ichthyobdellidae* [Etudes morphologiques et systematiques sur les Hirundinees. I. L'organisation des Ichthyobdellides]. Petrograd, Pervaia Zhenskaia Tipografya. [English translation by J. P. Moore and M. C. Meyer.]
- . 1923. *Crangonobdella murmanica* n.g. n.sp., eine auf Sclerocrangon schmarotzende Ichthyobdellide. *Zool. Jb.* (Systematik, Ökologie und Geographie der Tiere), **46**, Nr. 5, 397–488.
- . 1931. Ueber die Gattung *Hemibdella* nebst einigen allgemeinen Bemerkungen über die Organisation der Ichthyobdelliden. *Pubbl. Staz. zool. Napoli*, **11**, No. 1, 1–21.

- SHEPPARD, E. M. 1957. Isopod Crustacea. Part II. The sub-order Valvifera. Families: Idotheidae, Pseudidotheidae and Zenarcturidae fam. n. With a supplement to Isopoda Crustacea, Part I. The family Serolidea. 'Discovery' Rep., **29**, 141-98.
- VASILYEV, E. A. 1939. [The Ichthyobdellidae of the Far East.] *Trudy karel. gos. ped. Inst.*, Biol. Ser., **1**, 25-68.
- WHITE, M. G. 1970. Aspects of the breeding biology of *Glyptonotus antarcticus* (Eights) (Crustacea, Isopoda) at Signy Island, South Orkney Islands. (In HOLDGATE, M. W., ed. *Antarctic ecology*. London, Academic Press, 279-85.)
- WILTON, D. W., PIRIE, J. H. H. and R. N. R. BROWN. 1908. Zoological log. *Rep. scient. Results Scott. natn. antarct. Exped.*, **4**, Pt. 1, 103 pp.

## APPENDIX

? *Stibarobdella australiensis* (Goddard 1909)

Among the numerous specimens of *Glyptonotobdella antarctica* found on *Glyptonotus antarcticus* were a few individuals of another species, ranging in length from 6.5 to 22 mm. The dimensions of the largest individual were: length 22 mm., maximum width 1.8 mm., width of oral sucker 0.58 mm., caudal sucker 0.97 mm., neck 0.28 mm.

This animal resembles *Glyptonotobdella* in the following characters: an eccentrically positioned anterior sucker and centrally positioned posterior sucker, each of which narrower than the maximum body width, a slender fusiform body without well-defined neck and body regions, central mouth, a swollen bulbus ejaculatorius which extends anteriorly to segment X, six pairs of testes, a winding intestine, a fused posterior crop caeca with five fenestrae, one pair of eye spots on the cephalic sucker and a transverse pigment pattern.

It differs from *Glyptonotobdella* by possessing complete body segments which are triannulate, variously subdivided in the neck region, and with conspicuously pointed tubercles. The  $a_1$  and  $a_3$  annuli have eight tubercles: dorsal paramedial, supramedial, sub-marginal and ventral paramedial pairs, whereas the  $a_2$  annulus has only six tubercles each lateral in position to the  $a_1$  and  $a_3$  tubercles.

In details of size, annulation and tuberculation, this leech most closely resembles the incompletely described *Stibarobdella australiensis* (Goddard 1909) and less closely *S. tasmanica* (Hickman 1946). In general form, pigmentation and tuberculation it is similar to *Pontobdella rugosa* Moore 1938 collected at lat. 65°42'S., long. 92°10'W. but this species is conspicuously quadriannulate.