

MORPHOLOGY AND ANATOMY OF
AVDEEVIA ANTARCTICA, NEW GENUS, NEW SPECIES
(COPEPODA: HARPACTICOIDA: TISBIDAE),
PARASITIC ON AN ANTARCTIC CEPHALOPOD

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ABSTRACT

The external morphology and internal anatomy are described of the female of *Avdeevia antarctica*, a new genus and species of harpacticoid copepod, parasitic on the Antarctic octopodan cephalopod *Megaleledone senoi*. It is distinguished from related genera of the subfamily Cholidiinae by its proportionately much larger body and reduced number of legs. The species is attached to the gill of its host and feeds upon the blood.

The parasitic copepod to be described in the present paper was collected from the gills of an octopodan cephalopod by Mr. Tim Stranks, Museum of Victoria, Melbourne, Australia. Together with two infested gills, they were placed at our disposal by courtesy of Dr. F. G. Hochberg, Department of Invertebrate Zoology, Santa Barbara Museum of Natural History, California, U.S.A. The specimens represent a new genus and species of the subfamily Cholidiinae, family Tisbidae, order Harpacticoida.

MATERIALS AND METHODS

Eighty female copepods from two gills of two octopods, *Megaleledone senoi* Taki, 1961: (1) an immature male octopod, 190 mm ML, NMV F60487, Prydz Bay, Antarctic Sea, 66°59.9'S, 75°00.9'E, depth 385-388 m, RSV *Aurora Australis*, cruise AA91, station 86, Orange Roughy otter trawl, 22 February 1991. (2) a mature male octopod, 260 mm ML, NMV F60488, same area, 66°59.9'S, 74°22.7'E, 431-439 m, station 87, trawl as above, 23 February 1991.

No male copepods were discovered.

The specimens were preserved in Formalin. Two females were embedded in historesin (Technovit 7100 "Kulzer") and 2 other specimens (1 in situ on the gill) embedded in Araldite by routine methods. Complete serial sagittal and horizontal sections, 1.5 μ m Araldite and 3 μ m historesin, were stained with methylene blue-azure II and toluidine blue, respectively. Sections were examined with a Leitz Diaplan photomicroscope. For SEM studies 5 other specimens were postfixed in 3% glutaraldehyde in 0.1 M phosphate buffer with subsequent fixation in OsO₄ in the same buffer. Specimens were then dehydrated in acetone, critical-point dried with CO₂, gold-coated, and examined with a Jeol SEM 840 microscope.

Avdeevia antarctica, new genus,
new species

Description of the Female

Type Material.—Holotype (from station 86), ovigerous female, 4.2 mm long, 2.2 mm high (Fig. 2), together with the rest of the material (paratypes) deposited in the Museum of Victoria, Melbourne, Australia.

Position.—Body enclosed partly within folded surface of gill filaments, its posterior three-fourths being raised above gill, with ovisac protruding into mantle cavity. On receipt, some parasites dropped off, leaving distinct imprints in gill's surface (Fig. 1). Counting these also, total number of copepods per gill estimated as 25 and 55, respectively. Both lateral and medial surfaces infested.

External Morphology (Figs. 2, 3).—Body irregularly bean-shaped with convex dorsal side and somewhat compressed laterally; ventrolaterally many smaller transverse wrinkles not indicating segment borders. Specimens of similar size. Length and dorsoventral height of holotype 4.2 and 2.2 mm, respectively. In 5 specimens chosen at random length varying between 3.2 and 4.0 mm, and dorsoventral height between 2.0 and 2.3 mm. Width in larger specimens approximately 1.5 mm. Mouth and all appendages located close together within short (about 425 μ m long), deep, and narrow ventral depression anteriorly (Fig. 3A, B). Anus (seen only in sections) located at posterior



Fig. 1. *Avdeevia antarctica*, new genus, new species. Infested gills of host, *Megaleledone senoi* Taki. Parasites appear as whitish bodies; arrows indicate deep imprints of lost parasites.

end. In front of anus another funnel-shaped depression, at bottom of which opening of two oviducts and *receptaculum seminis* (Fig. 3A, B). Many of larger specimens ovigerous, with single ovisac protruding from genital depression, borne on solid stalk. Smaller specimens also carrying eggs. Egg approximately 100 μm in diameter. Egg sac sausage-shaped and often as long as the body. Egg sacs apt to break and only very few preserved intact. Color, in preserved state, whitish.

Single minute drop-shaped spermatophore (125 \times 50 μm) attached by stalk to each of dozen ovigerous females examined.

Due to their comparatively minute size and cryptic position, no appendages revealed by either sectioning or immersion in clearing agents. Appendages detected and their shape analyzed only with SEM. Even using this technique, relative position of appendages not distinguishable. However, mandibles, maxillules, maxillae, and maxillipeds placed very close together as in other Cholidiynae.

Antennule (Fig. 3C) 7-segmented, armature formula: 1, 9, 6, 4 + 1 aesthetasc, 1, 1, and 8. All setae naked. Antenna (Fig. 3D) with separate coxa and basis. Exopod 1-segmented, with 2 naked setae. Endopod 2-segmented, first segment unarmed, second segment with 3 geniculate setae, 1 normal seta, and 2 knife-shaped spines.

Labrum shield-shaped. Gnathobase of mandible (Fig. 3E) with group of short pointed teeth (Fig. 5A). Mandibular palp uniramous and 2-segmented, consisting of basis and 1-segmented endopod with 4 long naked setae of equal length. Maxillule (Fig. 3F) with reduced arthrite and 1-segmented palp; arthrite with 1 normal and 1 smaller pectinate spines, palp with 4 setae. Maxilla (Fig. 3G) 2-segmented, first segment unarmed, probably representing syncoxa. Second segment (allobasis) claw-shaped with series of spinules along its inner edge. Maxilliped (Fig. 3H) 3-segmented with short syncoxa, long basis, and claw-shaped last segment (endopod).

Only 2 pairs of legs present (Fig. 3I, J) in

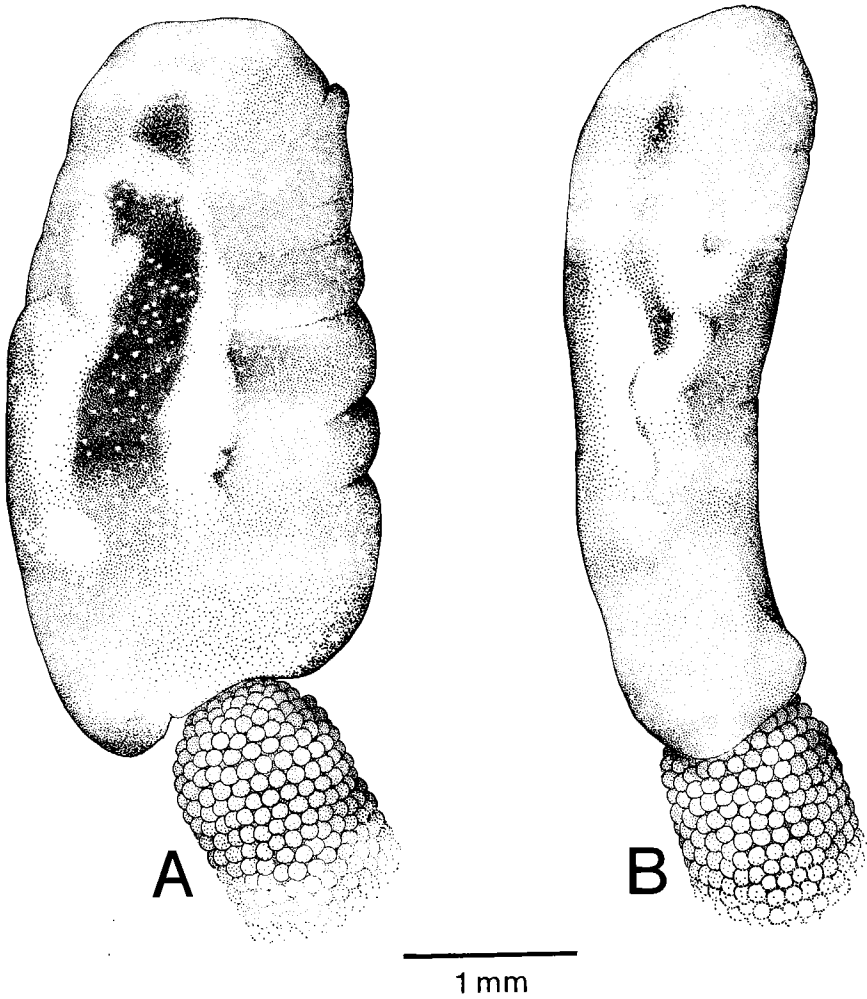


Fig. 2. *Avdeevia antarctica*, new genus, new species. Holotype, ovigerous female seen from right (A) and dorsal side (B). Ovaries whitish, midgut dark. Drawn by B. Beyerholm.

comparison with related species representing leg 1 and leg 2 (Fig. 3I, J). Leg 1 with 3-segmented exopod and much longer 2-segmented endopod; leg 2 with 2-segmented exo- and endopods. Setation formula:

P1 protopod I-1	exp	I-0; 0-0; I, 3, I
	end	0-1; III
P2 protopod I-0	exp	I-0; II, 2
	end	0-1; 4

Anatomy.—Cuticle extremely thin everywhere on body (less than 1 μm), thickest (up to 6 μm) in genital region.

All organs surrounded by loose large-meshed connective tissue giving way to irregular layer of hemocoelic lacunae immediately under skin and larger lacunae around ovary and oviducts (Fig. 4). Striated muscle fibers, criss-crossing connective tissue, especially numerous in sheet underlying skin at distance from surface. No segmentally arranged muscle bundles. Numerous scattered cylindrical to pyriform unicellular glands opening on surface as minute rounded pores easily recognized in SEM-pictures (Fig. 5B). Glands large reaching up to more than 150 μm into interior. Near bottom of genital depression, conspicuous complex of multicellular glands, staining intensively

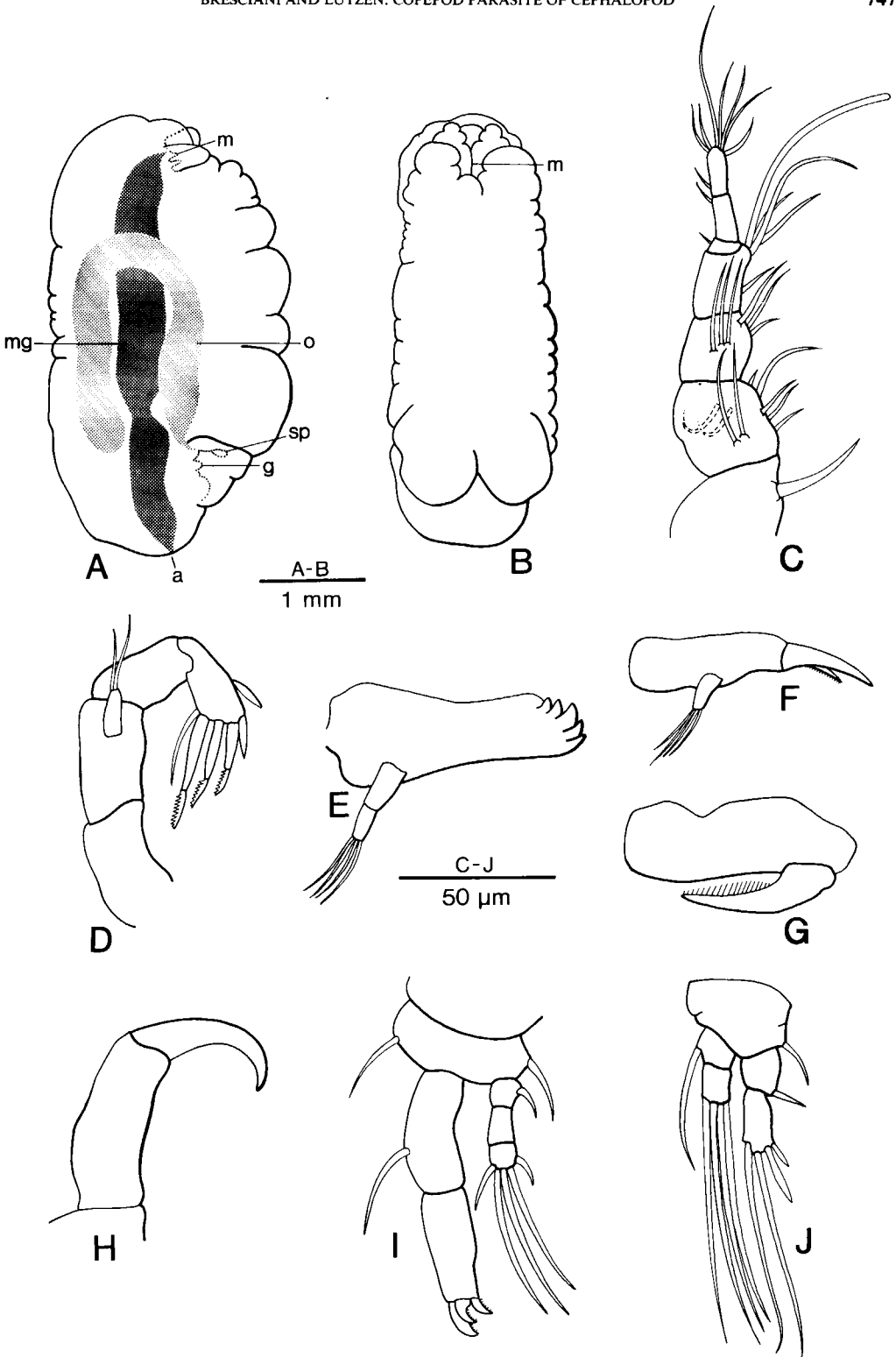
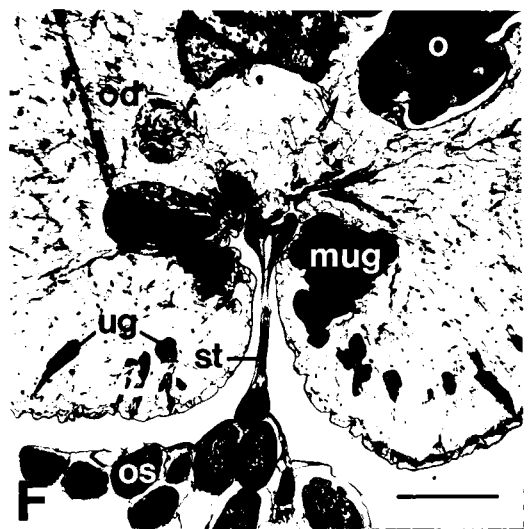
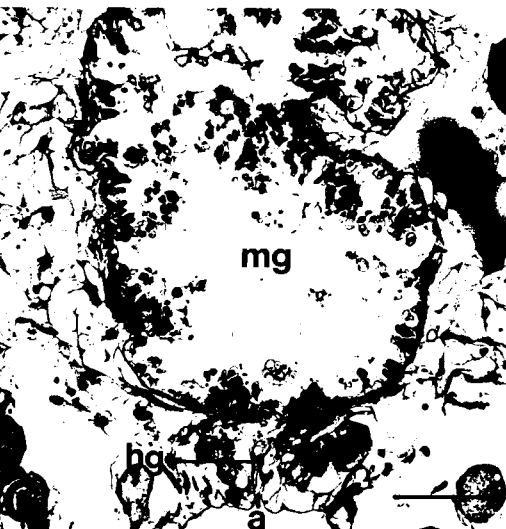
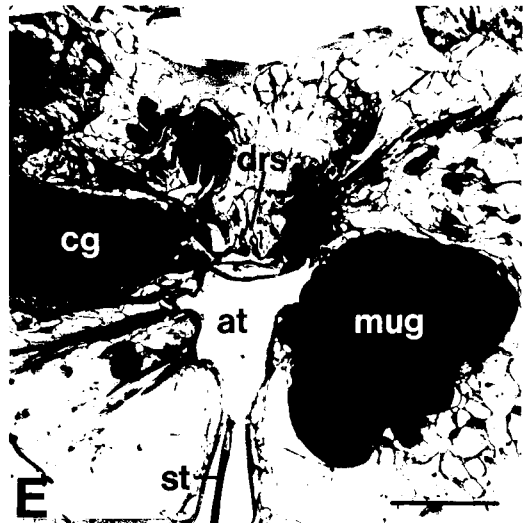
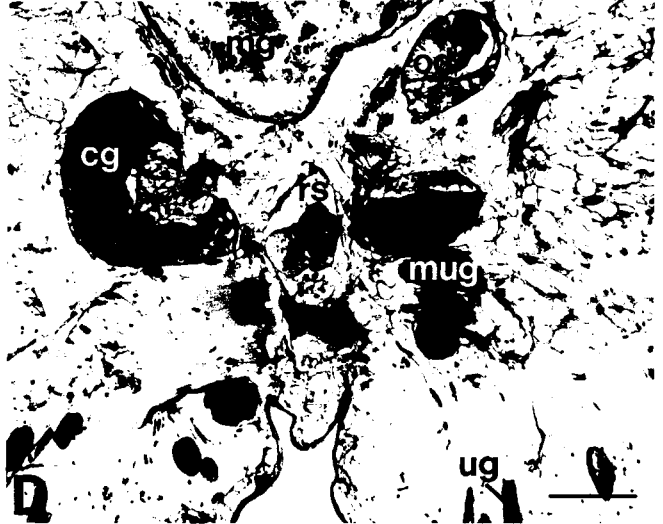
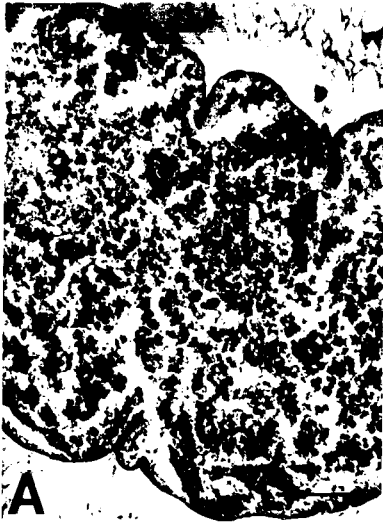


Fig. 3. *Avdeevia antarctica*, new genus, new species. A and B, female seen from right and ventral side. C, antennule; D, antenna; E, mandible; F, maxillule; G, maxilla; H, maxilliped; I, leg 1; J, leg 2 (g, genital area with spermatophore; a, anus; m, mouth area; mg, midgut; o, right ovary; sp, spermatophore). Drawn by B. Beyerholm.



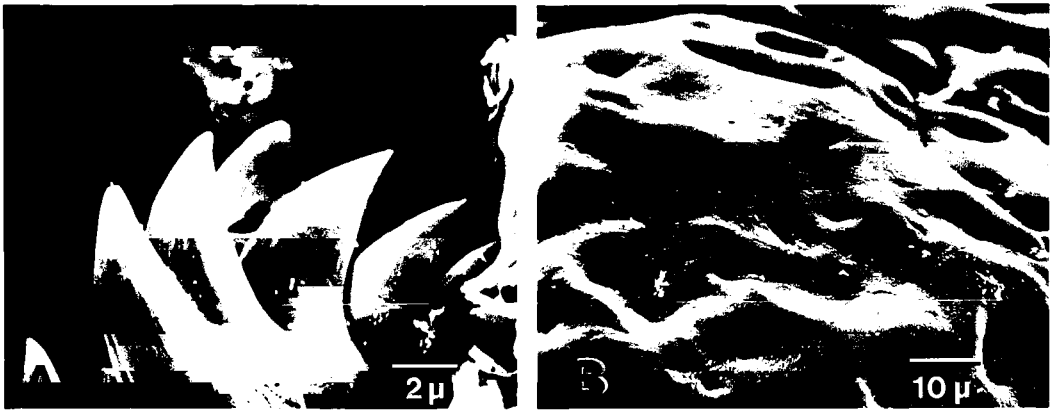


Fig. 5. *Avdeevia antarctica* new genus, new species. SEM micrographs of teeth of mandible (A) and skin surface with pores of unicellular glands (B).

(Fig. 4D–F). Other smaller unicellular glands encircling anus.

In sections, mouth opening appearing as simple pore probably opened by numerous muscle fibers attaching to its immediate surroundings. Foregut short (about 185 μm long) tube leading to midgut. Midgut voluminous elongate sac of almost uniform diameter (350–400 μm) throughout its length and without diverticula (Fig. 4A–C). From outside, midgut distinguished by its sepia brown color (Fig. 2A). Along two-thirds of its length divided by valve-like constriction into larger anterior and posterior parts. Anteriorly, and especially in hindmost part, epithelial cells cylindrical, often with inflated apical part, here and there protruding from internal ridges (Fig. 4B). Many of these cells extending far into lumen of gut. In middle section of midgut, epithelium high cubical. Almost entire midgut containing numerous spherical particles, by comparison with host's gill representing ingested blood corpuscles and their semidigested decomposition products (Fig. 4A).

Posteriorly, midgut succeeded by very short (about 100 μm), narrow, tubular hindgut with thin cuticular lining (Fig. 4C). Anus

opening within small ventral depression in front of posterior apex of body.

Very small single median ovary lying dorsally to gut behind middle of body. From it, 2 coiled oviducts emerging anterolaterally and passing on either side of gut to proceed backward ventral to gut (Figs. 2A, 3A). Except where they pass gut, 2 oviducts lying so close together and being so sinuous that distinguishing them difficult except in transverse sections.

Within ovary youngest oogenetic stages arranged in short rows proliferating into each of two oviducts. Oviducts lined by tenuous epithelial wall, 3–5 μm thick. While undergoing vitellogenesis in oviducts, oocytes lying closely compressed distending each duct to diameter of up to 300 μm .

Short posterior part of each oviduct (400–500 μm long) sinuous and lined by glandular cylindrical epithelium. Lumen of this region, or cement gland, empty of eggs, but filled with homogeneous secretion (Fig. 4D). Cement glands opening individually at each side of tiny cuticularized cavity (the antrum of Fahrenbach, 1962) together with very short, narrow, median duct from receptaculum seminis (Fig. 4E). Antrum partially

Fig. 4. *Avdeevia antarctica*, new genus, new species. A, longitudinal section through midgut with ingested host blood corpuscles; B, midgut epithelium; C, longitudinal section through hindgut and anus; D–F, successive longitudinal sections through genital area (a, anus; at, antrum; cg, cement gland; drs, duct of receptaculum seminis; hg, hindgut; m, muscle fiber; mg, midgut; mug, multicellular gland; o, ovary; od, oviduct; os, ovisac; st, stalk; rs, receptaculum seminis; ug, unicellular gland).

Table 1. Species of the subfamily Cholidiynae.

Parasite species	Cephalopod host	Location on host	Distribution
<i>Cholidya polypi</i> Farran, 1914	<i>Benthoctopus ergasticus</i> (F. and H. Fisher)	Inner surface of arm web	Off coast of Iceland
<i>Cholidyella intermedia</i> (Bresciani, 1970)	unidentified cirroteuthid	Gills and mantle cavity	Faeroe-Shetland Channel, North Atlantic
<i>Cholidyella breviseta</i> (Avdeev, 1986)	<i>Opisthoteuthis californiana</i> Berry	Gills	Japan and Kuriles
<i>Cholidyella nesis</i> Avdeev, 1986	<i>Benthoctopus profundorum</i> Robson	Gills	Off Honshu, Japan
<i>Cholidyella incisa</i> Avdeev, 1982	<i>Benthoctopus fuscus</i> Taki	Gills	S. Kuriles
<i>Brescianiana rotundata</i> Avdeev, 1982	<i>Graneledone boreopacifica</i>	Gills	Honshu, Japan, and North and South Kuriles
<i>Tripartisoma trapezoidalis</i> Avdeev, 1983	<i>Pareledone harrisoni</i> (Berry)	Head	Ross Sea, Southern Ocean
<i>Tripartisoma ovalis</i> Avdeev, 1983	<i>Pareledone turqueti</i> (Joubin) <i>Pareledone charcoti</i> (Joubin) <i>Pareledone harrisoni</i>	Gills	Ross Sea, Southern Ocean
<i>Avdeevia antarctica</i> new genus, new species	<i>Megaleledone senoi</i> Taki	Gills	Prydz Bay, Southern Ocean

separated from genital depression by shelf-like protuberance. Receptaculum seminis an unpaired subspherical sac, approximately 100 μm broad and long, 120 μm high, and filled with spermatozoa (Fig. 4E).

DISCUSSION

With the inclusion of *Avdeevia antarctica*, nine species and five genera of harpacticoid copepods of the family Tisbidae, subfamily Cholidiynae Boxshall, 1979 (p. 227), are known to be associated with benthic octopods (Table 1). Females are known in all nine species, while males have been discovered in only two species of *Cholidyella* (Avdeev, 1986). The state of fixation of the present material enabled us to examine the anatomy of a representative of the subfamily.

The body in females of the Cholidiynae, including *Avdeevia*, is unsegmented and, except for *Tripartisoma*, there is no distinction between cephalothorax and metasome. The most conspicuous feature of the present genus is the extreme disproportion in the large size of the body compared to the appendages, and the reduction in number of the latter. The appendages are of the same dimension as in other species, but the body length and width are 3–4 times as large. Five pairs of legs and a strongly reduced sixth pair are present in all hitherto known genera

except *Cholidya*, in which only 1, 2, and 5 remain. In *Avdeevia* legs 3–6 are absent, and, as in *Cholidya*, the exopod of leg 1 is 2-segmented, but 3-segmented in the other genera. Patches of tiny spines occurring on some of the appendages in other Cholidiynae are absent in *Avdeevia*. The caudal rami, present in the other genera, are lost completely. The cephalic appendages and maxilliped, on the other hand, have undergone no or only slight modifications.

The parasite is immovably attached to the gill tissue by the hooked maxillae and maxillipeds, being wedged tightly between adjacent gill lamellae. The gill epithelium is probably perforated by means of the toothed part of the powerful mandibles and the maxillules. Host blood is sucked into the foregut and further through the midgut possibly by contractions of the criss-crossing muscle fibers. It is likely that the bulging apical part of the epithelial cells in the hindmost portion of the midgut void digested products by rupture of the cell, as has been described for the type 3 cell in another harpacticoid (Sullivan and Bisalputra, 1980).

Males were not present in the material, but the spermatophores attached to the females have the same shape as that illustrated in *Cholidyella* (Avdeev, 1986).

Etymology.—The genus is named after the Russian parasitologist, Dr. G. D. Avdeev,

Vladivostok; the species is named for the Southern Ocean of Antarctica, where this species was found.

ACKNOWLEDGEMENTS

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ANNOUNCEMENT

The following opinion was published on 30 June 1994 in Vol. 51, Part 2, of the *Bulletin of Zoological Nomenclature*.

Opinion 1769. *Styloptocuma* Băcescu & Muradian, 1974 (Crustacea, Cumacea): conserved with *S. antipai* Băcescu & Muradian, 1974 designated as the type species.