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A NEW SPECIES OF *PSEUDODELPHIS* (DRACUNCULOIDEA: GUYANEMIDAE) IN THE INTERTIDAL FISH *SCARTICHTHYS VIRIDIS* (BLENNIIDAE) FROM CENTRAL CHILE

Gabriela Muñoz

Facultad de Ciencias del Mar y de Recursos Naturales, Universidad de Valparaíso, Casilla 5080, Viña del Mar, Chile. *e-mail: gabriela.munoz@cienciasdelmar.cl*

ABSTRACT: A new species of nematode, *Pseudodelphis chilensis* n. sp., is described. This parasite was found in muscles of the pectoral fins of a blenniid fish, *Scartichthys viridis*, from central Chile. The new species differs from the other 2 described (*P. oligocotti* Adamson and Roth, 1990 and *P. limnicola* Brugni and Viozzi, 2006) for its longer glandular esophagus and a small caecum at the beginning of the glandular esophagus; both characteristics are in males and females. In addition, the male of *P. chilensis* n. sp. does not have an adanal caudal papillae, and it has longer spicules than the other 2 species. This is the first *Pseudodelphis* species described for Chile and the second for South America.

A few dracunculoid nematodes have been recorded in Chile, although none of them has been properly identified (Muñoz and Olmos, 2008). A few specimens, from gonads and muscles of 6 fish species, have been referred to as *Philometra* sp., whereas others from another 2 fish species have been identified to family.

During a study related to the parasite communities of intertidal fish species, some nematodes with morphological characteristics of Guyanemidae, specifically *Pseudodelphis* Adamson and Roth, 1990 were collected from a common blenniid fish that inhabits the rocky intertidal zone of central Chile. This nematode species exhibits several morphological and morphometric differences from the other 2 species described so far, i.e., *Pseudodelphis oligocotti* Adamson and Roth, 1990, and *P. limnicola* Brugni and Viozzi, 2006 (Adamson and Roth, 1990; Brugni and Viozzi, 2006); the new species is described here.

MATERIALS AND METHODS

The nematodes were found in the blenniid fish *Scartichthys viridis* (Valenciennes, 1836) collected from El Tabo, central Chile, between 2007 and 2008. The parasites were fixed in 10% formaldehyde solution in 0.9% physiological saline. Nematodes were sufficiently clear for direct observation using light microscopy. Measurements and drawings were made with a light microscope (model DM LS2, Leica, Wetzlar, Germany) and a camera lucida. The prevalence and mean intensity of nematodes were determined (Rózsa et al., 2000) and calculated according to Bush et al. (1997). All ranges of measurements, followed by the mean between parentheses, are expressed in micrometers (μm) unless otherwise stated.

The new nematodes were found in the host body at the muscular base of the pectoral fins. Because of this particular location, the nematodes were difficult to isolate by normal dissection, i.e., making a longitudinal ventral cut in the fish body. The best way to collect these parasites was by making an external cut at the base of the pectoral fin.

Morphological distinctions on the cephalic and caudal regions of the nematodes were observed via scanning electron microscopy (SEM). Two female and 2 male nematode individuals were used for this purpose. Specimens were dehydrated through an alcohol series and critical point-dried in CO_2, using a Balzers Union machine (Balzers Union, Balzers, Lichtenstein). Nematodes were sputter-coated with gold, making a layer of 500 Å using a sputter coater (model S150, Edwards, Marburg, Germany). Then, they were examined with an Etec-Autoscan SEM (PerkinElmer Life and Analytical Sciences, Boston, Massachusetts).

DESCRIPTION

Pseudodelphis chilensis n. sp.

(Figs. 1–13)

General: Large body length. Almost smooth cuticle with tiny striations. Circular oral opening (Fig. 1). Fourteen cephalic papillae arranged in 2 circlets; the inner circle with 3 pairs of small papillae (2 pairs located ventrolaterally and dorsoventrally, 1 pair anterior to amphids) and the outer circle with 4 duplets of larger papillae located dorsally and ventrally on each side (Figs. 1, 4). A pair of lateral amphids. Peribuccal ring absent. No buccal cavity present (Figs. 5, 6). Oral opening followed by esophagus, composed of a muscular and a glandular section, a straight tube (Fig. 6). Muscular esophagus shorter and thinner than glandular section (Figs. 5, 6). Small caecum at beginning of glandular esophagus, to excretory pore side, usually 109–327 in males and females (Figs. 5, 6). No posterior extension of glandular esophagus (Fig. 9). Nerve ring encircling muscular esophagus, located approximately at middle. Deirids simple and small papillae, 3 long. Deirids (Fig. 5) and excretory pore (Fig. 6) posterior to nerve ring. Intestine long and straight. Long pointed tail in males and females (Figs. 7, 8, 12, 13). Males smaller than females.

Male (7 specimens): Body length 16.92–26.78 (23.07) mm. Body width at nerve ring level 95–125 (106), maximum width 130–192 (150), and tail width 85–161 (130). Length of muscular esophagus 500–725 (620). Length of glandular esophagus 2,230–3,270 (2,674). Glandular esophagus 4–6 (4.52) times longer than muscular portion. Nerve ring 262–318 (290) from anterior end of body. Deirids observed in 1 specimen, 1 slightly anterior to other 375 and 400 from anterior end (Fig. 5). Excretory pore at 377–462 (427) from anterior end. Spicules slight arched shape, well sclerotized. Both spicules with similar lengths 71–91 (85) (Fig. 12). Gubernaculum not observed. Testis situated from anterior quarter portion of body up to cloaca. At posterior end of testis, a constriction forms a chamber 109–136 (119) long and 33–51 (43) wide (Fig. 13). Four pairs of preanal and 4 pairs of postanal papillae (Figs. 3, 12, 13). One pair of preanal papillae close to cloaca. The post-anal papillae pairs not side by side, but in zigzag pattern (Fig. 12). Phasmids not distinguished. Area rugosa and caudal alae not present (Fig. 1, 12). Posterior portion of body coiled (Figs. 2). Cloacal opening bulky (Figs. 3, 13). Tail 236–313 (271).

Female (1 ovigerous and 5 larvigerous specimens): Body length 34.0–96.0 (67.6) mm. Two or 3 times as long as males. Body width at nerve ring level 125–175 (161), width at vulva level 167–350 (287), and width at anus level 75–295 (144). Length of muscular esophagus 650–840 (765). Length of glandular esophagus 2,760–3,950 (3,468). Glandular esophagus 4–5 (4.52) times as long as muscular portion. Nerve ring at 337–375 (360) from anterior end (Fig. 6). Deirids at 450 from anterior end seen in 1 specimen. Excretory pore 500–575 (529) from anterior end. Anterior uterus ending in blind sac, 1.52–2.65 from anterior end of body (Fig. 6). Ovary some distance from anus (Fig. 7), 1,250–2,100 from posterior extremity. Vulva non-elevated near end of glandular esophagus (Fig. 9) at 3,390–4,937 (3,813) from anterior body end (Fig. 6), corresponding to 5.3–10.7% (7.74%) of body length. Muscular vagina 200–272 long, directed posteriorly (Figs. 9, 10). Tail 413–720 (549) (Figs. 7, 8). Larvigerous eggs with smooth thin shell; size 88–113 × 63–73 (Fig. 11). Nematodes with eggs and larvae at different developmental stages (Fig. 11). Largest females full of larvae. Larvae 400–537 long and 29–44 wide.

Taxonomic summary

Type host: Scartichthys viridis (Valenciennes, 1836) (Blenniidae).

Site of infection: Muscles at the base of pectoral fins. The muscular fibers of fins and the lateral body area are in different directions; between them there is a space in which the parasite is found.

Type locality: El Tabo (33°27′S, 71°37′W), Chile.

Other locality: Las Cruces (33°30′S, 71°38′W), Chile.

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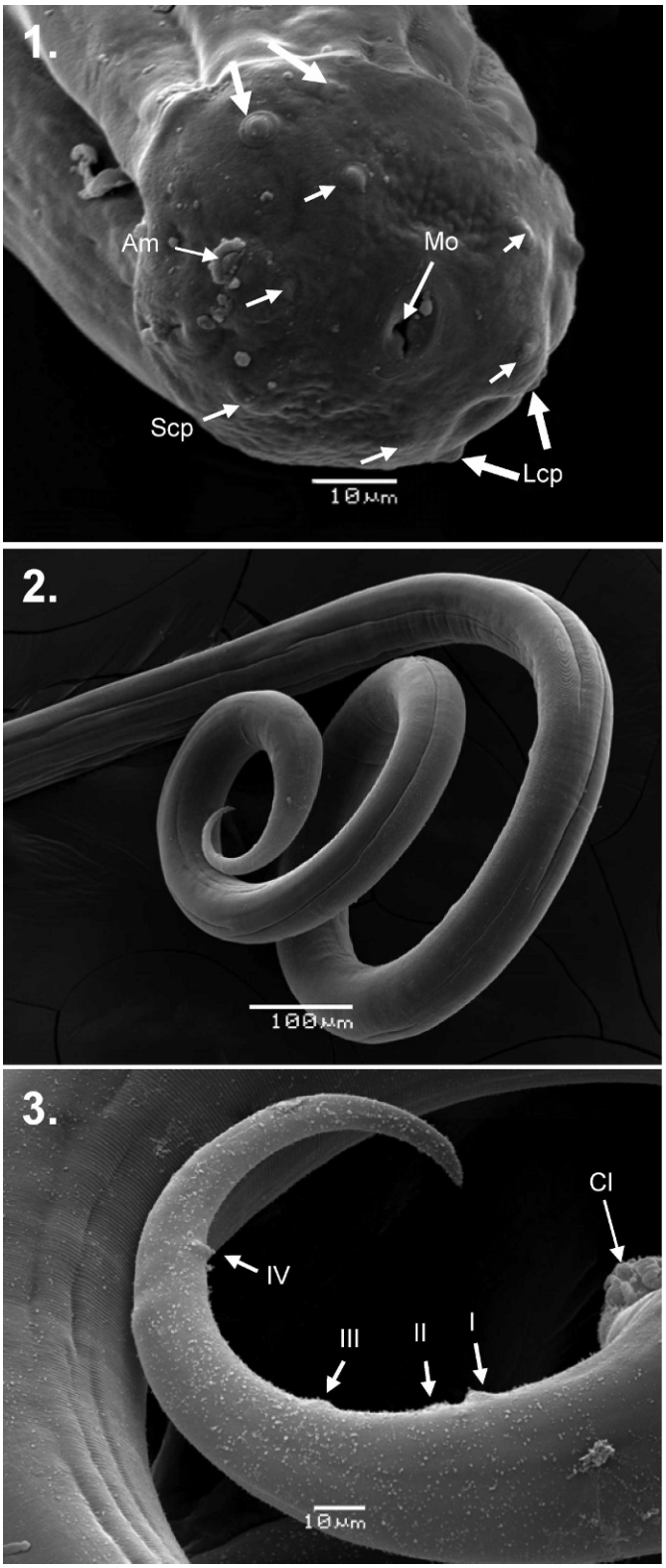


FIGURES 1–3. SEM of *Pseudodelphis chilensis* n. sp. (**1**) Cephalic characteristics. Mo, mouth; Am, amphid; Lcp, large cephalic papillae (indicated with large arrows); Scp, small cephalic papillae (indicated with small arrows). (**2**) Posterior part of the body of male. (**3**) Tail of male, I–IV, postanal papillae; Cl, cloaca.

Prevalence and intensity of infection: El Tabo: 13 fish parasitized from 1,067 (1.22% prevalence); 1.31 mean intensity (range: 1–3). Las Cruces: 3 fish parasitized from 247 (1.18% prevalence); 1.67 mean intensity (range: 1–3).

Deposition of types: Museo Nacional de Historia Natural de Chile, MNHNCL: Nem-N° 11850 (Monotype), Nem-N° 1851 (Allotype), Nem-N° 11852 (Paratypes); U.S. National Parasite Collection, USNPC 102234 and 102235 (paratypes), USNPC 102236 (vouchers).

Etymology: The specific name refers to the country in which this species was found, Chile.

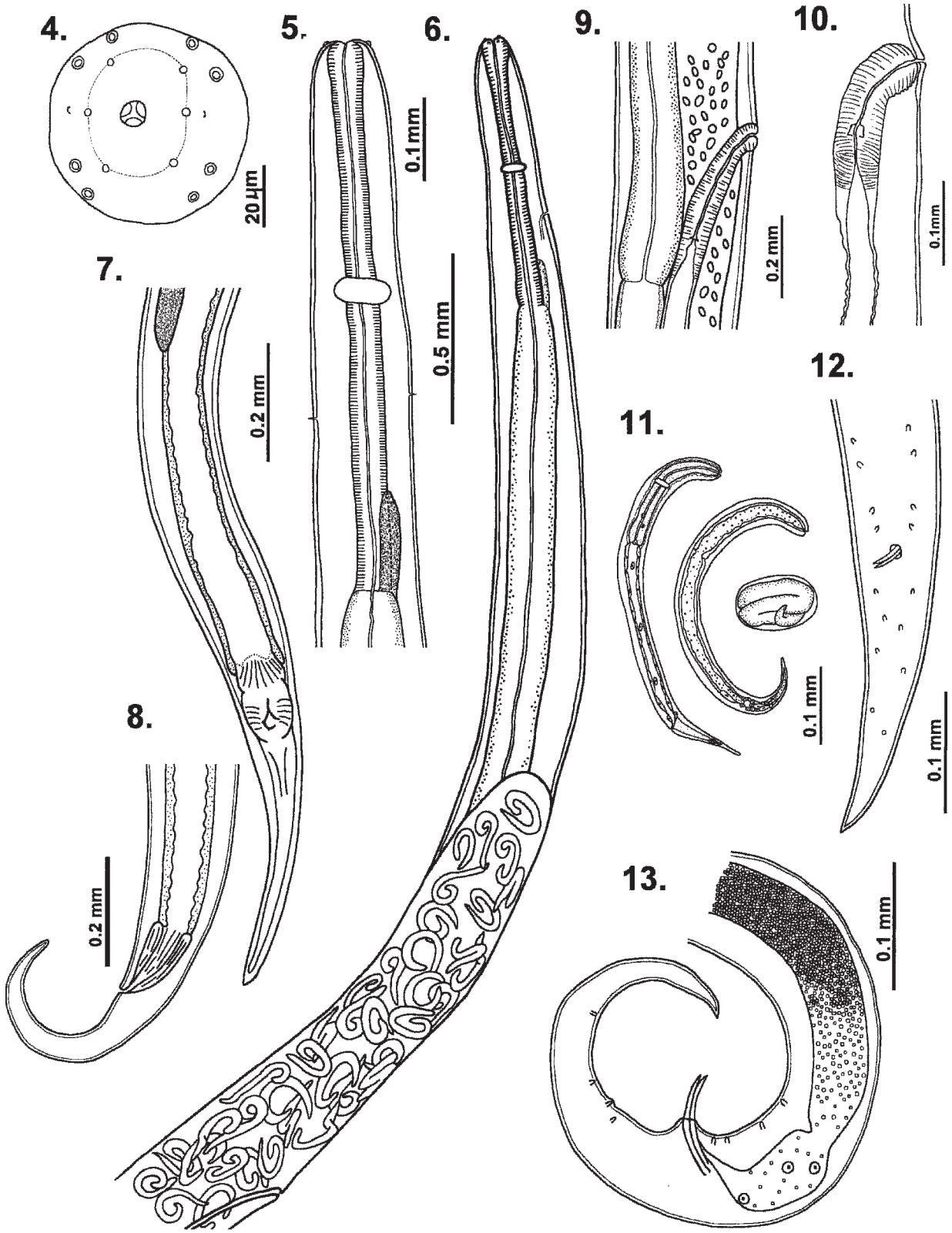
Remarks

Six genera, with 17 species in total, comprise the Guyanemidae. There are clear morphological distinctions among genera within this family; a taxonomic key of this group was provided by Ribu and Lester (2004). The main morphological characteristics of 6 genera that differed from *Pseudodelphis* are as follows. *Travassosnema* Costa, Moreira and Oliveira, 1991 has a long caecum from the posterior part of the glandular esophagus (Costa et al., 1991; Moravec et al., 1993a); *Guyanema* Petter, 1974 has a vulva position at the level of the end of muscular esophagus; the caudal alae, and small body lengths, males <10 mm and females <31 mm (Petter, 1974, 1987; Petter and Dlouhy, 1985; Moravec et al., 1993b, 1996); *Moravecia* Riby and Lester, 2004 has a transversely striated cuticule (Ribu and Lester, 2004; Braicovich et al., 2007). *Histodytes* Aragort, Alvarez, Iglesias, Leiro and Sanmartin, 2002 was mainly characterized in having a vulva positioned in the anterior part of the body (see Ribu and Lester, 2004) but a long distance posterior to the esophageal-intestine union (Aragort et al., 2002). However, the latter characteristic is similar to *Pseudodelphis*. Instead, *Histodytes* is better characterized for its cephalic papilla arrangement, with 7 pairs present; 2 of them are prominent and situated dorsally and ventrally around the mouth; the other pairs distributed in 2 circles (see Aragort et al., 2002). In addition, males exhibit an area rugosa (=ventral ornamentation of the tail) that has not been described in other genera of Guyanemidae. *Ichthyofilaria* Yamaguti, 1935 had been included in the Philometridae (see Moravec, 2004); however, recently, this genus was moved to Guyanemidae (see Moravec and Justine, 2009). *Ichthyofilaria* is mainly characterized by a short glandular esophagus with an appendix directed posteriorly (Timi et al., 2001; Moravec, 2004; Moravec and Justine, 2009).

Pseudodelphis has a vulva located close to the end of the glandular esophagus and without caudal alae (Adamson and Roth, 1990). *Pseudodelphis chilensis* n. sp. possesses these 2 characteristics. Furthermore, there are other morphological characters that are common among the species described in this genus, i.e., the arrangement of the cephalic papillae and the large body length (several centimeters) in comparison with other guyanemids, except for *Histodytes* that does include a large species.

Pseudodelphis chilensis has the same number of papillae and distribution as *P. oligocotti* (Adamson and Roth, 1990; Fig. 4), but it is slightly different from *P. limnicola* in that the latter species does not have a papilla located anterior to the amphids (Brugni and Viozzi, 2006). Moreover, the new species has a small caecum at the beginning of the glandular esophagus, which has not been described in other *Pseudodelphis* species or in other dracunculids (Moravec, 2004).

The body length of males was comparable among *Pseudodelphis* species (Table I), although the main differences occur in lengths of glandular esophagus and spicules, and number and distribution of caudal papillae. *Pseudodelphis chilensis* differs from other species in that it has a long glandular esophagus (Table I), especially in males; absolute measurements of the glandular esophagus and the ratio between glandular esophagus/body lengths are larger in *P. chilensis* n. sp. Spicule lengths are also larger in *P. chilensis* n. sp. than the other 2 species; however, these differences can be better appreciated between the new species and *P. limnicola* (Table I). The main difference in the caudal papillae arrangement among species is in the distribution of papillae and the presence of adanal pairs. *Pseudodelphis oligocotti* has 8 pairs (2 preanal, 2 adanal, and 4 postanal pars of papillae), whereas *P. limnicola* has 6–13 pairs (2–4 preanal, 1–2 adanal, and 3–7 postanal pairs of papillae), and *P. chilensis* n. sp. has 7–9, mostly 8 (3–4 preanal and 4–5 postanal pairs, but no adanal pairs) (Fig. 13). Some specimens occasionally had 1 of the preanal pairs of papillae close to the cloaca, so that it resembled an adanal pair; however, because most



FIGURES 4–13. Drawing of morphology of *Pseudodelphis chilensis* n. sp. (**4**) Apical view. (**5**) Anterior part of the body of a male and (**6**) a female. (**7**) Posterior part of a female body. (**8**) Tail of female in lateral view. (**9**) Vulva position. (**10**) Vagina. (**11**) Larvae and larvigerous egg. (**12**) Tail of male in ventral view and (**13**) lateral view.

TABLE I. Main morphometric measurements (μm) of *Pseudodelphis* species.

	P. oligocotti Adamson and Roth, 1990		*P. limnicola*, Brugni and Viozzi 2006		*P. chilensis* n. sp.	
Sex and no. of specimens	Male* (9)	Female* (8)	Male (20)	Female (20)	Male (7)	Female (6)
Body length (mm)	16.28	26.7	18.1–24.8	26.1–121.7	16.9–26.7	34.0–96.0
Maximum width	128	169	137–190	423–893	130–192	167–350
Length of muscular esophagus (ME)	561	618	545–682	727–1,091	500–725	650–840
Length of glandular esophagus (GE)	1,054	1,490	1,545–2,091	2,130–3,871	2,230–3,270	2,760–3,950
Ratio ME:GE*	1:1.88	1:2.41	1:2.87	1:4.04	1:4.52	1:4.52
% ME/body length	3.44	5.58	2.75–3.01	0.89–2.78	2.33–3.40	690–2.27
% GE/body length	6.4	5.54	8–43–8.53	3.18–8.16	9.28–16.65	2.96–9.37
Nerve ring†	294	274	269–384	291–509	262–318	337–387
Excretory pore†	416	362	423–518	509–778	377–462	500–575
Spicules	64	—	43–50	—	71–91	—
Vulva†	—	2,149	—	3,181–8,804	—	3,390–4,937
% Distance of vulva*	—	7.99	—	6.79	—	7.74
Tail	205	253	273–364	528–1,000	236–313	413–720

* Values based on means.
† Measurements from anterior extremity.

specimens had the last pair of preanal papillae at some distance from the anus, it was decided to describe them as preanal papillae.

Absolute measurements of females, such as body width, glandular esophagus, and the distance of excretory pore from anterior end, are smaller in *P. oligocotti* than *P. chilensis*. However, these differences may be the consequence of different body lengths among the specimens examined (Table I). Thus, the description of *P. oligocotti* was based on non-larvigerous females, so it is possible that this species reaches a larger body size and that some morphometric measurements change with body length. The length of the glandular esophagus of the new species is similar to *P. limnicola* (Table I). However, the glandular esophagus of *P. chilensis* n. sp. is 4.5 times larger than muscular esophagus, which is the largest ratio among *Pseudodelphis* spp. (Table I).

According to biological characteristics, *P. chilensis* n. sp. differs from other species of *Pseudodelphis* in habitat, locality, host species, and site of infection. *Pseudodelphis limnicola* is a nematode from a freshwater fish of the Perchichthydae, whereas *P. oligocotti* is from a marine fish of the Cottidae. These 2 species infect the body cavity of the host, as well as the intestine, sinus venosus, and atrium. *Pseudodelphis chilensis* n. sp. is unique in comparison with other species because it occurs in the muscles of pectoral fins of a marine blenniid fish.

DISCUSSION

Pseudodelphis limnicola and *P. chilensis* n. sp. are species recorded in South America, although the latter species is the first guyanemid nematode from the South Pacific coast. The host, *Scartichthys viridis*, is a littoral species distributed between central and northern Chile. It is herbivorous, feeding mainly on green algae. However, it is possible to that several invertebrates, such as crustaceans and molluscs (Muñoz and Ojeda, 1997), may have a role in the life cycle of *P. chilensis*.

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