

FURTHER STUDY OF *CONTRACAEUM PELAGICUM* (NEMATODA: ANISAKIDAE) IN *SPHENISCUS MAGELLANICUS* (AVES: SPHENISCIDAE) FROM ARGENTINEAN COASTS

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ABSTRACT: The anisakid species *Contracaecum pelagicum* Johnston and Mawson, 1942, is reported for first time at 2 different sites on the Argentine coast (Península Valdés, 42°04'S, 63°38'W and Mar del Plata, 38°05'S, 57°38'W), parasitizing the Magellanic penguin, *Spheniscus magellanicus* Foster. Morphometric analysis and further studies of adult specimens of *C. pelagicum* were done using light and scanning electron microscopy. The presence of bifurcated interlabia differentiates the present species from most others in the genus, except (1) from *Contracaecum travassosi*, which possesses higher interlabia and longer spicules, and a blunt, more constrained tail; (2) from *Contracaecum rudolphii*, which has longer spicules, blunter spicule tips, postpara-cloacal papillae with oblique disposition, and a blunter constrained tail; (3) from *Contracaecum eudypuluae*, which has a blunter tail and longer spicules; and (4) from *Contracaecum variegatum*, which possesses smaller-diameter, hooklike extensions on auricle lips, and a less robust interlabium with a more marked furrow. In this paper we present the first detailed description of *C. pelagicum* adults from *S. magellanicus*. Morphometric data between adult specimens of *C. pelagicum* from *S. magellanicus* and those from the black-browed albatross, *Diomedea melanophris* Temminck, from Argentinean coasts were compared. In addition, fourth-stage larvae that parasitized both hosts were assigned to a nondetermined *Contracaecum* species. Ecological parameters for adults and larvae nematodes were calculated.

Anisakid nematodes have a worldwide distribution and are associated with fishes, birds, and marine mammals. Transmission of species usually involves aquatic invertebrates and fish as intermediate or paratenic hosts (Anderson, 2000). Species of *Contracaecum* Railliet and Henry, 1912, belong to the Anisakinae. The definitive hosts are piscivorous birds and mammals, e.g., cormorants, pelicans, and seals, associated with freshwater, brackish, and marine systems (Anderson, 2000).

The Magellan penguin *Spheniscus magellanicus* Forster (Sphenisciformes: Spheniscidae) has a wide breeding distribution in South America (Yorio et al., 2001) and can be found occasionally, or accidentally, in Australia, New Zealand, and South Atlantic islands (Vanegas, 1999). It is one of the most abundant marine birds on the Argentine coast; more than 220,000 couples breed along the northern coast of the San Jorge Gulf (46°02'S, 67°03'W) (Scolaro and Badano, 1986; Scolaro, 1987; Yorio et al., 2001). Adults arrive at the nest sites to breed in September, and after a period of burrow excavation and nest repair, they begin to lay eggs around mid-October. The colony abruptly grows with the offspring, and the 1-yr-old chicks extend their marine life to molt on coasts (Scolaro, 1987).

Contracaecum pelagicum Johnston and Mawson, 1942, was described for first time from the black-browed albatross (*Diomedea melanophris* Temminck) (Procellariiformes: Diomedidae) in Australia (Johnston and Mawson, 1942). Later Lent and Freitas (1948) redescribed the species from the same host on the Uruguayan coast, and Portes-Santos (1984) and Fagerholm et al. (1996) reported the species parasitizing *S. magellanicus* from Brazilian and South African Atlantic coasts, respectively. Recently Silva et al. (2005) reported the occurrence of *C. pelagicum* in *Sula leucogaster* (Pelecaniformes: Sulidae).

There are a couple of records of *Contracaecum* spp. in Argentina: *Contracaecum microcephalum* (Rudolphi, 1809) was cited from the freshwater bird *Casmerodius albus egretta* (Linnaeus) (Ciconiiformes: Ardeidae) in Tucumán province (Schuurmans-Sterkhoven, 1951); and *Contracaecum longicae-*

cum Schuurmans-Sterkhoven, 1951, was found in the freshwater fish *Platystoma* sp. (Siluriformes: Pimelodidae) in the Paraná River, Santa Fe province (Schuurmans-Sterkhoven, 1951). This latter species was regarded as a species inquirenda by Navone et al. (2000) because its description was based entirely on larval specimens. Boero et al. (1972) found *C. microcephalum* parasitizing species of Ardeidae, i.e., *Ardea cocoi* Linnaeus, *Ncticorax ncticorax* (Gmelin), and *C. albus egretta*, from Buenos Aires province. *Contracaecum multipapillatum* (von Drasche, 1882) was reported in other ardeid birds also in Buenos Aires province (Labriola and Suriano, 1996; Navone et al., 2000). Malacalza et al. (1998) reported *Contracaecum* sp. in the same bird from Chubut province, Argentina. *Contracaecum spheniscus* Boero and Led, 1970, was described on the base of a single male specimen found in a Magellan penguin from La Plata's zoo, Buenos Aires province, Argentina (Boero and Led, 1970). In marine mammals, Timi et al. (2003) reported the occurrence of *Contracaecum ogmorhini* s. s. Johnston and Mawson, 1941, in *Arctocephalus australis* (Zimmermann, 1783) (Otariidae) from the Argentine Sea and discussed the taxonomic status between this species and *Contracaecum corderoi* Lent and Freitas, 1948, collected from the same host. Several authors demonstrated the existence of different sibling species within morphospecies belonging to *Contracaecum* using different genetic-molecular methodologies (Nascetti et al., 1993; Mattiucci et al., 1998). Mattiucci et al. (2003) demonstrated the existence of 2 distinct sibling species within the morphospecies *C. ogmorhini* (s.l.) from boreal and austral regions due to a remarkable genetic heterogeneity. Li et al. (2005) concluded that *Contracaecum rudolphii* (Hartwich, 1964) represents a complex of at least 2 sibling species and provided support for the validity of *Contracaecum septentrionale* Kreis, 1955, as a separate species.

Contracaecum spp. larval stages were reported by Torres et al. (1993), Kreiter and Semenas (1997) from Patagonian lakes, and Diaz (pers. comm.) in *Larus dominicanus* Lichtenstein (Laridae) from the Atlantic coast. Moreover, Timi et al. (2001) found third-stage larvae of *Contracaecum* sp. parasitizing the marine fish *Engraulis anchoita* Hubbs and Marini (Engraulidae). Moravec (1998) described *Contracaecum* sp. third-stage

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TABLE 1. Morphometrical data of *Contracaecum pelagicum* from host species *D. melanophris* and *S. magellanicus* from Argentina.

Morphological feature	Johnston and Mawson (1942) <i>D. melanophris</i> New South Wales, Australia	Lent and Freitas (1948) <i>D. melanophris</i> Maldonado coast, Uruguay	Portes-Santos (1984) <i>S. magellanicus</i> Guanavara Bay, Rio de Janeiro, Brazil	Fagerholm et al. (1996) <i>S. magellanicus</i> South Atlantic African coast	Present study <i>D. melanophris</i> Fracasso Beach Peninsula Valdés	Present study <i>S. magellanicus</i> Ea. San Lorenzo, Punta Norte Peninsula Valdés
<i>Male</i> (n)	—	7	3	2	4	10
Body length	30–33	25.12–28.81	31.03–31.77	20.10–23.0	22.18 (20.44–25.52)	17.56 (11.00–25.08)
Maximum body width	—	0.80–0.90	0.53–0.55	0.40–0.41	0.75 (0.55–0.90)	0.67 (0.56–0.96)
Anterior end to nerve ring	—	0.50–0.53	0.55–0.75	0.86–0.88	0.48 (0.38–0.61)	0.46 (0.36–0.51)
Anterior end to deirids	—	0.61–0.70	0.60–0.86	0.66–0.65	0.61 (0.53–0.69)	0.65 (0.57–0.73)
Esophagus length	2.61–3.40	2.88–3.55	3.47–3.95	2.28–2.94	2.88 (2.36–3.88)	2.78 (1.90–3.97)
Intestinal caecum length	1.74–2.26	2.10–2.68	2.11–3.08	1.80–2.30	2.23 (1.88–2.98)	1.97 (1.56–2.68)
Ventriculus length	—	0.23–0.25	—	0.16–0.17	0.21 (0.18–0.23)	0.22 (0.16–0.26)
Ventricular appendix length	0.53–0.69	0.67–0.91	0.64–0.95	0.63–0.66	0.64 (0.59–0.80)	0.74 (0.63–0.83)
Spicule length	5.23	4.32–4.48	4.10–4.75	4.25–4.45	4.87 (4.81–4.90)	4.10 (3.07–5.07)
Tail length	0.18	0.20–0.23	0.09–0.22	0.14	0.16 (0.12–0.20)	0.18 (0.11–0.29)
Precloacal papillae pairs	Numerous	25	28–31	—	30–31	25–31
Postcloacal papillae pairs	6	7	7	—	7	7
Paracloacal papillae pairs	2	2	2	2	2	2
Subventral distal papillae pairs	2	2	2	2	2	2
Lateral distal papillae pairs	2	2	2	2	2	2
Median papillae	—	—	—	1	—	—
<i>Female</i> (n)	—	4	11	1	4	10
Body length	35–38	31.15–36.01	40.96–52.53	26.10	35.33 (32.60–39.20)	24.17 (17.56–33.05)
Maximum body width	—	1.07–1.14	0.69–0.75	0.85	0.82 (0.79–0.85)	0.94 (0.52–1.48)
Anterior end to nerve ring	—	0.55–0.61	0.47–0.56	0.54	0.57 (0.51–0.61)	0.55 (0.48–0.65)
Anterior end to deirids	—	0.66–0.83	0.58–0.95	0.60	0.64 (0.58–0.71)	0.72 (0.62–0.90)
Esophagus length	—	2.98–3.52	2.99–3.77	2.96	3.74 (3.22–4.60)	3.03 (2.81–3.32)
Intestinal caecum length	—	2.18–2.85	2.34–3.90	2.23	2.73 (2.28–3.20)	2.38 (2.10–2.74)
Ventriculus length	—	0.25–0.31	—	0.21	0.21 (0.16–0.26)	0.22 (0.17–0.26)
Ventricular appendix length	—	0.63–0.76	0.39–0.76	0.68	0.86 (0.79–0.91)	0.72 (0.65–0.82)
Anterior end to vulva	11.66–12.66	6.70–12	7.91–15.12	8.41	9.75 (8.20–11.90)	6.94 (5.28–9.23)
Tail length	0.32	0.33–0.43	0.27–0.61	0.41	0.36 (0.31–0.43)	0.41 (0.30–0.63)
Embrionated egg	0.040–0.050/ 0.070–0.080	0.050/0.067	0.05–0.06	0.06–0.068	0.064 (0.062–0.066)	0.060

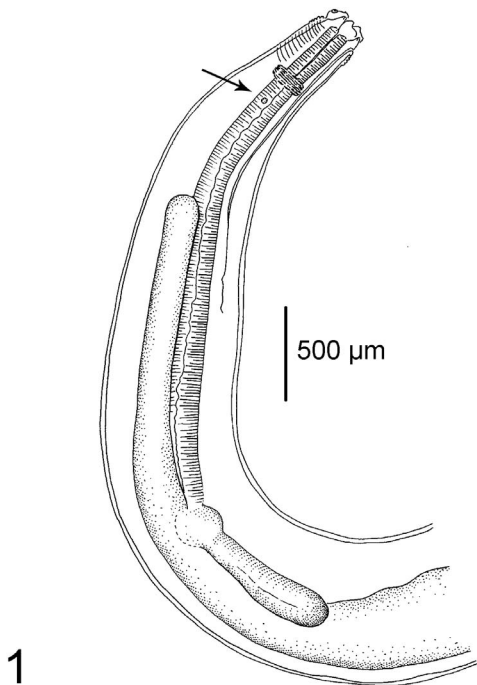


FIGURE 1. *Contracaecum pelagicum* Johnston and Mawson, 1942, from *S. magellanicus* from Península Valdés. Adult: anterior end, nerve ring, excretory duct, esophagus, intestinal caecum, ventriculus, ventricular appendix, and deirids (arrow).

larvae, named as Type 2, that parasitized several freshwater fish species from the Paraná River basin, Argentina.

The aim of the present paper is to describe adults of *C. pelagicum* and fourth-stage larvae of *Contracaecum* sp. parasitizing *S. magellanicus* from Península Valdés. Measurements belonging to adult specimens are compared with those of *C. pelagicum* adults that parasitize *D. melanophris* in Península Valdés. Measurements of the specimens in the present study are compared to those given by previous authors. Fourth-stage larvae parasitizing Península Valdés penguins are also compared with those found in Mar del Plata penguins. Morphological details seen in the scanning electron microscope (SEM) and data of prevalence, mean intensity, and abundance are provided.

MATERIAL AND METHODS

At irregular intervals from September 1996 to May 2002, 20 morbid or dead Magellan penguins were collected along the coast of Península Valdés, Chubut province (42°04'–42°53'S, 63°38'–64°30'W), and 4 additional specimens were collected from Mar del Plata coast, Buenos Aires province (38°05'S, 57°38'W), Argentina. In addition, from May 2000 to April 2002, 3 dead black-browed albatrosses were collected in Península Valdés. Only the esophagus and stomach were examined on Mar del Plata penguins and Península Valdés albatrosses. All dead birds were in good condition. Birds were dissected and the digestive tract fixed in 10% formalin. In the laboratory the viscera were examined under a stereomicroscope, and nematodes were removed and stored in 70% alcohol. Twenty adult and 20 larval nematodes from *S. magellanicus* and 20 adult nematodes from *D. melanophris* were cleared in lactophenol and studied using light microscopy. Drawings were made with the aid of a drawing tube. Some specimens were dried by the critical point method and observed using scanning electron microscopy (JEOL/JSMT 6360 LV® from the Museo de La Plata, La Plata, Buenos Aires, Argentina) and photographed. Average measurements are expressed in millimeters with the range in parentheses. Spatial location of papillae

was named according to Fagerholm (1990). Morphometric means for *C. pelagicum* adults from *S. magellanicus* and *D. melanophris* from Península Valdés and fourth-stage larvae from both sampling sites were analyzed with a 1-way ANOVA, with significant difference values $P < 0.05$. Those fourth-stage larvae from Mar del Plata were compared with the third-stage larvae of *Contracaecum* sp. studied by Timi et al. (2001). Prevalence was calculated for nematodes of *S. magellanicus* from both sampling sites and *D. melanophris* from Península Valdés. Mean intensity and abundance only for *S. magellanicus* are given according to Bush et al. (1997).

REDESCRIPTION

Contracaecum pelagicum Johnston and Mawson, 1942

Adult (20 specimens from *S. magellanicus* from Península Valdés, Table 1, Figs. 1–8): Body entirely transversally striated (Figs. 1, 3, 6). Conspicuous cephalic collar with concentric anteriorly directed free edges and V-shaped lateral region without striations (Figs. 2, 4). Three bifurcated interlabia (Figs. 2, 4, 5). Lips longer than interlabia with 3 apical notches, central one deeper and larger than lateral ones (Figs. 2, 4). Lips with 2 auricles, each with lateral directed pointed processes on anterior corners, both with 2 sensory pits at external end (Figs. 2, 4, 5). Large double-lip papillae, 2 on the dorsal lip and 1 on each ventrolateral lip (Figs. 2, 4). Rounded amphids located on ventrolateral lips (Fig. 2). Deirids nonconspicuous and rounded shape (Figs. 1, 3, see arrows). Ventriculus with solid posterior appendix, intestinal caecum well developed, longer than ventricular appendix (Fig. 1).

Male (10 specimens from *S. magellanicus* from Península Valdés): Body length 17.56 (11.00–25.08). Maximum body width 0.67 (0.56–0.96). Distance from anterior end to nerve ring 0.46 (0.36–0.51) and to deirids 0.65 (0.57–0.73). Esophagus length 2.78 (1.90–3.97); intestinal caecum length 1.97 (1.56–2.68); ventriculus length 0.22 (0.16–0.26); ventricular appendix length 0.74 (0.63–0.83). Spicules of equal length 4.10 (3.07–5.07). Tail length 0.18 (0.11–0.29). Caudal extremity conical, bearing 25–31 pairs of subventral precloacal papillae, first 18 proximal pairs conspicuous. Pts zone including 3 pairs of precloacal papillae (Fig. 6). Seven pairs of postcloacal papillae: 2 large subventral post-paracloacal pairs situated side by side, 2 subventral pairs, 2 sublateral pairs, and 1 pair of phasmids placed closer to the more distal sublateral papilla (Fig. 6). Spicule distal tip extended and pointed; length of free distal end longer than spicule width (0.063 vs. 0.020) (Figs. 7, 8). Spicule wings slope distally toward shaft and insert at different points (Fig. 7, arrow).

Female (10 specimens from *S. magellanicus* from Península Valdés): Body length 24.17 (17.56–33.05). Maximum body width 0.94 (0.52–1.48). Distance from anterior end to nerve ring 0.55 (0.48–0.65) and to deirids 0.72 (0.62–0.90). Esophagus length 3.03 (2.81–3.32); intestinal caecum length 2.38 (2.10–2.74); ventriculus length 0.22 (0.17–0.26); ventricular appendix length 0.72 (0.65–0.82). Vulva in anterior half of body, distanced 6.94 (5.28–9.23) from anterior end. Embryonated egg 0.06 (0.057–0.064) in diameter. Tail length 0.41 (0.30–0.63).

Taxonomic summary

Hosts: *Diomedea melanophris* Temminck (Diomedidae), *Spheniscus magellanicus* Foster (Spheniscidae).

Localities: Península Valdés (42°04'–42°53'S, 63°38'–64°30'W), Chubut province and Mar del Plata (38°05'S, 57°38'W), Buenos Aires province, Argentina.

Infection sites: Stomach.

Prevalence: 40% from *S. magellanicus* from Península Valdés (n = 20), 100% from *S. magellanicus* from Mar del Plata (n = 4), and 100% from *D. melanophris* from Península Valdés (n = 3).

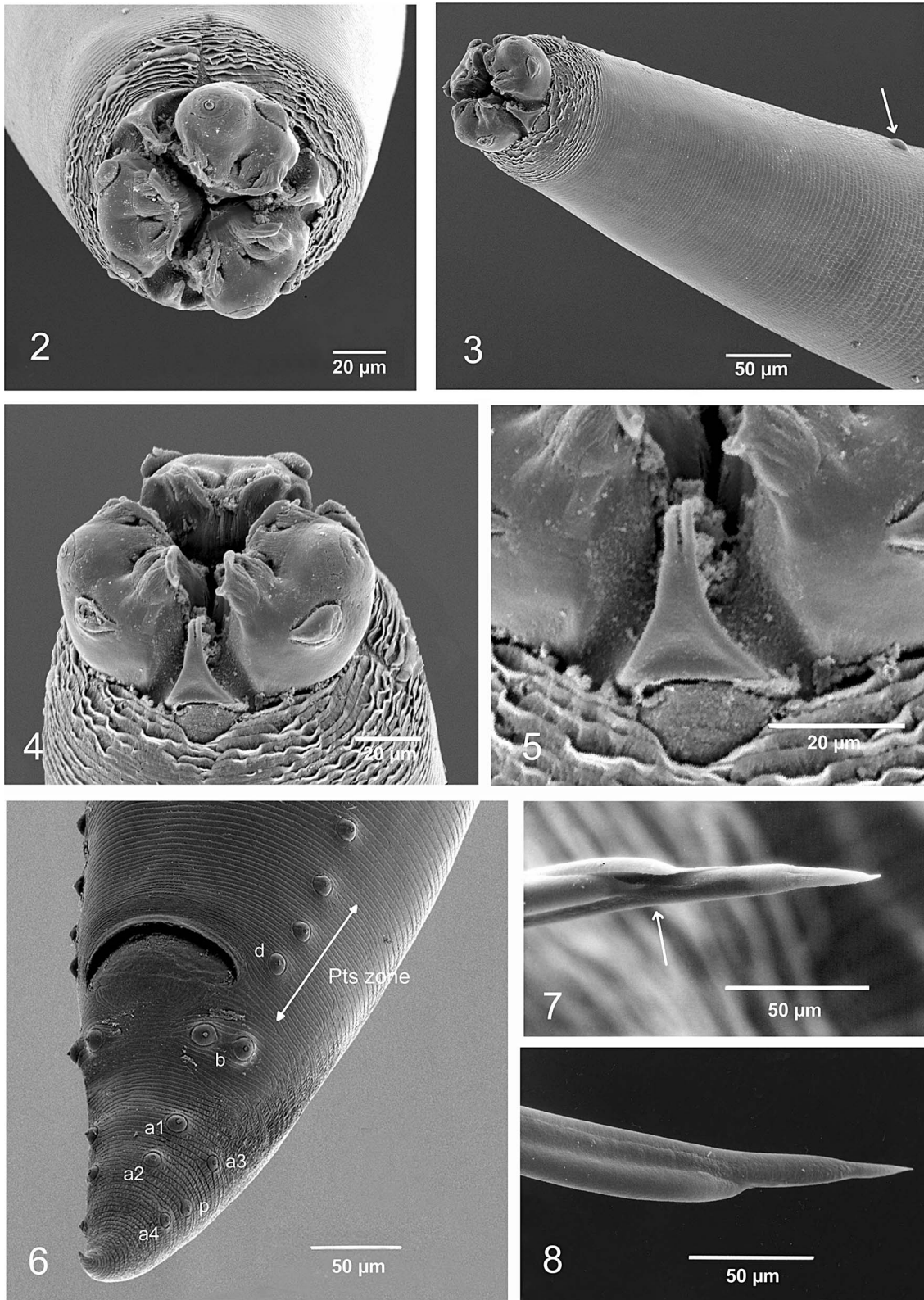
Mean intensity: 149 from *S. magellanicus* from Península Valdés.

Abundance: 60 from *S. magellanicus* from Península Valdés.

Voucher specimens deposited: Helminthological Collection of Museo de La Plata (5591 CHMLP), La Plata, Buenos Aires, Argentina.

Remarks

From *Contracaecum* species found in sea mammals, i.e., *C. ogmorhini* and *Contracaecum margolisi* Mattiucci et al., 2003, are very similar to *C. pelagicum* with respect to the spatial distribution of tail papillae, even though they do not show bifid interlabia and their spicules



FIGURES 2–8. *Contracaecum pelagicum* Johnston and Mawson, 1942, from *Spheniscus magellanicus* from Península Valdés. Adult: (2) detail of the anterior end, apical view; (3) anterior end, lateroventral view, cephalic collar, and deirids (arrow); (4) anterior end, cephalic collar with V-shaped striations, excretory pore, lips, interlabia, cephalic lip papillae, auricles, and notches; (5) details of interlabium and excretory pore; (6) male caudal extremity, detail of the precloacal and postcloacal papillae: **a1–a2** subventral papillae, **a3–a4** sublateral papillae, **b** postparaocloacal papilla pair, **d** proximal precloacal papillae, **p** phasmid; (7) apical ventral view of spicule; (8) dorsal view of spicule.

TABLE II. Morphometrical and ANOVA test data of *Contracaecum* sp. fourth-stage larvae in *S. magellanicus* from both Península Valdés and Mar del Plata sampling sites.

Morphological feature	Península Valdés	Mar del Plata	Probability
Body length	6.40 (4.52–7.84)	5.23 (3.77–6.68)	0.014
Maximum body width	0.20 (0.16–0.24)	0.20 (0.12–0.27)	0.943
Anterior end to nerve ring	0.24 (0.08–0.33)	0.24 (0.17–0.28)	0.959
Anterior end to deirids	0.29 (0.21–0.38)	0.33 (0.22–0.43)	0.385
Tail length	0.14 (0.12–0.16)	0.13 (0.10–0.16)	0.418
Esophagus length	0.99 (0.74–1.26)	1.08 (0.76–1.38)	0.229
Intestinal caecum length	0.56 (0.41–0.70)	0.74 (0.50–0.94)	0.011
Ventricular appendix length	0.41 (0.30–0.67)	0.34 (0.22–0.43)	0.374
Ventriculus + ventricular appendix length	0.43 (0.36–0.64)	0.42 (0.28–0.51)	0.745
Posterior end to excretory gland	5.03 (4.01–5.47)	3.64 (2.80–4.60)	0.003

are longer (Mattiucci et al., 2003). *Contracaecum osculatum* (Rudolphi, 1802), *Contracaecum mirounga* Nikol'skii, 1974, and *Contracaecum radiatum* (Linstow, 1907), all have nonbifurcated interlabia, double paraocloacal papillae pairs, and 2 preocloacal papillae rows (Baylis, 1936; Fagerholm, 1988; Fagerholm et al., 1996).

From the *Contracaecum* species reported to date parasitizing seabirds, *C. magnipapillatum* (= *Contracaecum magnicollare*, Johnston and Mawson, 1941) from *Anous minutus* Chapin (Laridae) and *C. septentrionale* from *Phalacrocorax aristotelis*, share almost all morphological features, such as the spatial papillae distribution pattern, but lack bifurcated interlabia (Johnston and Mawson, 1941; Kreis, 1955; Hartwich, 1964; Fagerholm et al., 1996). In contrast, *C. multipapillatum* from *Egretta alba* (Gmelin) (Ardeidae), *Contracaecum heardi* Mawson, 1953, from *Pygoscelis papua* Forster (Spheniscidae), and *Contracaecum eudyptes* Johnston and Mawson, 1953, from *Eudyptes* sp. (Spheniscidae), can be distinguished from *C. pelagicum* in having nonbifurcated interlabia, a double paraocloacal papillae pair, and 2 proximal preocloacal papillae rows close to the cloaca region (Mawson, 1953; Portes-Santos, 1984; Navone et al., 2000). *Contracaecum spheniscus*, also with nonbifurcated interlabia, has smaller number of pre- and postocloacal papillae, and a shorter ventricular appendix than *C. pelagicum* (Boero and Led, 1970).

Contracaecum travassosi Gutiérrez, 1943, from *Phalacrocorax albiventer* Lesson (Phalacrocoracidae), *C. rudolphii* from *Phalacrocorax carbo* Linnaeus, *Contracaecum eudyptulae* Johnston and Mawson, 1944, parasitizing *Eudyptula minor* (Forster) (Spheniscidae), and *Contracaecum variegatum* Rudolphi, 1809, from *Colymbus septentrionalis* (= *Gavia stellata*) (Pontoppidan) (Gaviidae), have bifurcated interlabia and are very similar to *C. pelagicum* (Gutiérrez, 1943; Johnston and Mawson, 1944; Hartwich, 1964; Fagerholm et al., 1996). However, the male of *C. travassosi* possesses interlabia as high as the lips, a wider-at-base with less noticeable furrow, and longer spicules (7.7–11.1 vs. 3.07–5.07 mm) and, therefore, a smaller body length–spicule length ratio (2.1–2.3 vs. 3.4–5.1). The tail of *C. travassosi* is more blunt and

constrained at the level of subventral and sublateral papillae (Gutiérrez, 1943). *Contracaecum rudolphii* has longer spicules (4.1–10.0 vs. 3.07–5.07 mm) and a smaller body–spicule length ratio (2.7–3.4 vs. 3.4–5.1), more blunt spicule tips, and smaller postparaocloacal papillae with oblique disposition. Moreover, the tail of *C. rudolphii* is also more blunt and with a distal constriction (Hartwich, 1964; Barus et al., 2000; Abollo et al., 2001). *Contracaecum eudyptulae* has a blunter tail, paraocloacal papillae with oblique disposition, fewer preocloacal papillae pairs, and a smaller body–spicule length ratio (1.70–2.80 vs. 3.41–5.10) (Johnston and Mawson, 1944). *Contracaecum variegatum* possesses hooklike extensions on auricle lips, less robust interlabium with a more marked furrow, and greater number of preocloacal papillae pairs (29–46 vs. 25–31). Moreover, *C. variegatum* has larger body length–width ratio (29.1–55.0 vs. 17.7–30.5 in males; 34.0–98.7 vs. 19.0–33.8 in females) (Hartwich, 1964; Fagerholm et al., 1996).

The ANOVA tests corroborated that there were no significant differences ($P < 0.05$) in morphologic features among those specimens from *S. magellanicus* and *D. melanophris* from Península Valdés studied here.

Contracaecum sp.

Fourth-stage larvae (L4) (20 specimens from *S. magellanicus* from Península Valdés, Table II, Figs. 9–13): Cuticle transversally striated especially marked at anterior extremity forming a developed cephalic collar with V-shaped lateral region without striations (Figs. 10, 11). Oral opening with 3 well-developed lips, with small winglike processes on their anterior corners (Figs. 10, 11). Dorsal lip bearing 2 internal papillae and 2 cephalic papillae. Each ventrolateral lip shows single internal papilla, double cephalic papilla, and an amphid (Figs. 10, 11). Excretory gland well developed, located posterior to ventricular appendix, close to nucleus (Fig. 9). Deirids nonconspicuous located just posterior to nerve ring (Figs. 9, 12, see arrows). Ventriculus small and subspherical. Intestinal caecum dorsal to esophagus, longer than ven-

TABLE III. Morphometrical data on *Contracaecum* sp. third-stage larvae from *E. anchoita* (Pisces: Engraulidae) compared to fourth-stage larvae from *S. magellanicus*, both from Mar del Plata, Argentina.

Morphological feature	Third-stage larvae (Timi et al., 2001)	Fourth-stage larvae (Present study)
Body length	5.01 (4.06–5.82)	5.23 (3.77–6.68)
Maximum body width	0.19 (0.16–0.24)	0.20 (0.12–0.27)
Anterior end to nerve ring	0.20 (0.16–0.24)	0.24 (0.17–0.28)
Anterior end to deirids	0.29 (0.24–0.34)	0.33 (0.22–0.43)
Tail length	0.10 (0.09–0.13)	0.13 (0.10–0.16)
Esophagus length	0.50 (0.40–0.63)	1.08 (0.76–1.38)
Intestinal caecum length	0.26 (0.21–0.34)	0.74 (0.50–0.94)
Ventricular appendix length	—	0.34 (0.22–0.43)
Ventriculus + ventricular appendix length	0.36 (0.30–0.43)	0.42 (0.28–0.51)
Posterior end to excretory gland	0.69 (0.39–0.96)	3.64 (2.80–4.60)

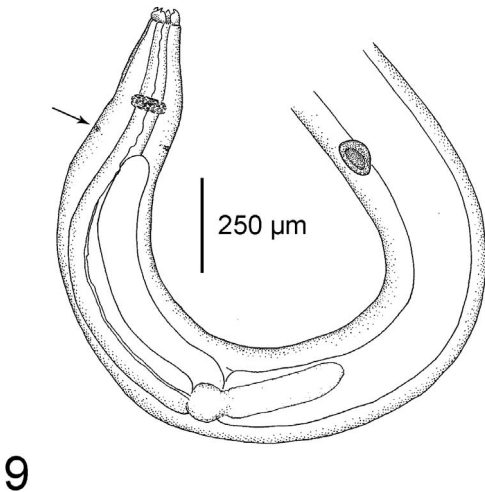


FIGURE 9. *Contracaecum* sp. Johnston and Mawson, 1942, from *S. magellanicus* from Península Valdés. Fourth-stage larvae (L4): anterior end, excretory gland, esophagus, intestinal caecum, ventriculus, ventricular appendix, and deirids (arrow).

tricular appendix (Fig. 9). Tail conical, without spike (Fig. 13). Phas-mids well developed (Fig. 13, see arrow).

Taxonomic summary

Infection sites: Esophagus, stomach, and intestine.

Prevalence: 100% from *S. magellanicus* from Península Valdés (n = 20); 100% from *S. magellanicus* Mar del Plata (n = 4), and 100% from *D. melanophris* Península Valdés (n = 3).

Mean intensity: 283 from *S. magellanicus* from Península Valdés.

Abundance: 283 from *S. magellanicus* from Península Valdés.

Voucher specimens deposited: Helminthological Collection of Museo de La Plata (5592 CHMLP), La Plata, Buenos Aires, Argentina.

Remarks

The presence of intestinal caecum and ventricular appendix allows for the inclusion of these specimens with other species of *Contracaecum*. The lips are well developed, but interlabia are lacking, which usually characterize fourth-stage larvae (Berland, 1989; Fagerholm, 1990; Fagerholm et al., 1996). To date, there are few descriptions of *Contracaecum* fourth-stage larvae. The present specimens of *Contracaecum* sp. seem to be very similar to those of *C. magnipapillatum* found by Fagerholm et al. (1996) in *A. minutus*. However, the winglike expanded auricles are larger in the former specimens. Fourth-stage larvae measurements of *C. rudolphii* are also very similar to those studied here, but they possess interlabium, which is a feature not usually present in fourth-stage larvae (Barus et al., 2000); perhaps these specimens might belong to a juvenile stage. *Contracaecum osculatum* fourth-stage larvae do not have auricle expansions, which differentiate them from the fourth-stage larvae specimens found in *S. magellanicus* (Fagerholm, 1988).

DISCUSSION

The present adult specimens of *C. pelagicum* fully agree with the morphology and measurements given by previous authors (Table I). However, the body length is almost half the length as reported by Johnson and Mawson (1942) in *D. melanophris* and Portes-Santos (1984) in *S. magellanicus*. Deirids are located posterior to the nerve ring level as mentioned by other authors; however, Johnson and Mawson (1942) did not observe this feature, while Fagerholm et al. (1996), observed it ahead of the nerve ring. Fagerholm et al. (1996) pointed out the presence of a single papilla on the anterior cloaca edge of *C. pelagicum*

male specimens. However, they did not study the specimens under SEM to corroborate its presence. Actually, the specimens examined here do not have a papilla, but do exhibit a lens-shaped plaque as described by Hugot et al. (1991) for *Contracaecum magnicollare*, a junior synonym of *C. magnipapillatum* (Fagerholm et al., 1996).

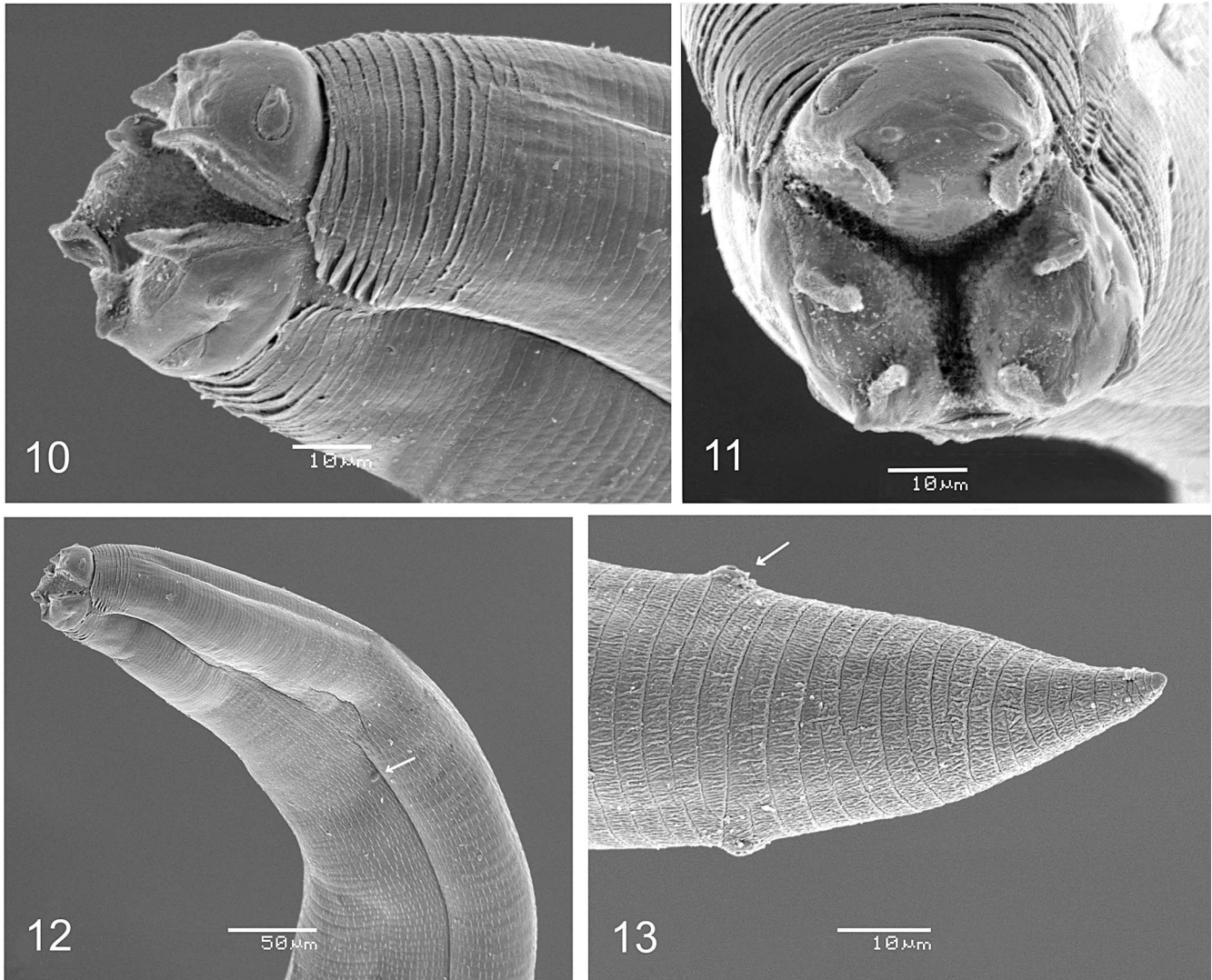
Contracaecum pelagicum from *S. magellanicus* from both sampling sites, i.e., Península Valdés and Mar del Plata, and those from *D. melanophris* from Península Valdés possess 25–31 pairs of precloacal papillae, a similar number to that reported by Portes-Santos (1984) (Table I). However, the caudal papillae number in a given species can vary both in a single population and from different regions of the world (Fagerholm, 1989).

Contracaecum pelagicum can be distinguished from most *Contracaecum* species even though it has a great similarity with *C. variegatum*, which was described from *Colymbus septentrionalis* in the Northern Hemisphere (Hartwich, 1964). Later, *C. variegatum* was reported from *Spheniscus demersus* (Linnaeus, 1758) from South Africa, and *Pygoscelis papua* Forster, 1781 (Spheniscidae) from the Falkland Islands (Fagerholm et al., 1996). Although *C. pelagicum* and *C. variegatum* are differentiated by several morphological features, genetic-molecular analysis should be carried out to clarify the taxonomic status of these 2 species.

The fourth-stage larvae (L4) from Península Valdés and Mar del Plata showed significant differences in a few morphological features, i.e., the body length, intestinal caecum length, and distance from the excretory gland to the caudal end. These morphometric differences between larvae from both sampled sites could be explained by the different degree of development they reach after entering the definitive host, or by the influence of the intermediate or paratenic host on their development, or both (Anderson, 2000). It cannot be assured that these L4 found in *S. magellanicus* belong to *C. pelagicum*, since their morphologic diagnostic features are insufficient to recognize them at the species level. Moreover, they could belong to other *Contracaecum* species that infect other marine hosts in the study area not identified to date.

The reduction in the observed prevalence and intensity values in *C. pelagicum* adults of *S. magellanicus* from Península Valdés, compared with the same parameters in larval stages, may indicate that not all larvae found in penguins were able to develop in this host.

Timi et al. (2001) reported third-stage larvae (L3) of *Contracaecum* sp. in the anchovy *E. anchoita* from Mar del Plata. This fish is one of the major prey items of the Magellan penguin and is distributed over the continental shelf from about 23°S to 45°S (Gosztonyi, 1984; Scolaro et al., 1999; Putz et al., 2000). Comparing the relative development of L3 reported by Timi et al. (2001), and L4 from the present study from Mar del Plata, the body length did not exhibit differences. The specimens studied here showed an intestinal caecum longer than the ventricular appendix, whereas Timi et al. (2001) observed the opposite in the L3 of *Contracaecum* sp. from *E. anchoita*. In addition, the conspicuous development of the esophagus, which is twice the size in L4, has been observed. Perhaps there is a proportional development between the esophagus and intestinal caecum in this ontogenetic stage. A marked difference between these 2 larval stages is shown in the distance from the excretory gland to the caudal end that is larger in L4 (Table III). Considering



FIGURES 10–13. *Contracaecum pelagicum* Johnston and Mawson, 1942, from *S. magellanicus* from Península Valdés. Fourth-stage larvae (L4): (10) anterior end, lateral view, buccal opening, cephalic collar, well-developed lips with small winglike auricles; (11) anterior end, apical view; (12) anterior extremity, deirid location (arrow); (13) posterior extremity, phasmids (arrow), and striations.

the trophic relationship between the penguin and anchovy, it is possible that these L3 may belong to the same *Contracaecum* species. However, this question can not be answered yet since other *Contracaecum* species may occur in the anchovy, i.e., *C. ogmorhini*, *C. osculatum*, and *C. mirounga*, which also parasitize marine mammals inhabiting the studied area (Mattiucci et al., 2003). Studies of genetic-molecular analysis and experimental life cycle will eventually help to assign these larvae to a correct species.

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