

Digenetic trematodes parasitic on *Engraulis anchoita* (Pisces: Engraulidae) from Argentina and Uruguay

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Key words: *Engraulis anchoita*, parasites, *Parahemiurus merus*, *Lecithochirium microstomum*, *Cardiocephaloides* sp., *Rhipidocotyle* sp., Argentina, Uruguay

Abstract. A total of 2,086 specimens of *Engraulis anchoita* Hubbs et Marini (Pisces: Engraulidae), from waters off Argentina and Uruguay were examined for parasitic digeneans. Four species of digeneans were found, *Parahemiurus merus* (Linton, 1910) (adult) in the stomach; *Lecithochirium microstomum* Chandler, 1935 (non-ovigerous and ovigerous juveniles) in the swimbladder; *Cardiocephaloides* sp. (metacercaria) in the eyes and *Rhipidocotyle* sp. (metacercaria) in the musculature. These four species are recorded for the first time as parasites of *E. anchoita*.

Engraulis anchoita Hubbs et Marini (Argentine anchovy) is one of the most abundant species in the Argentine Sea. This species constitutes the highest biomass among the potential fishery resources in the area (Sánchez 1989).

As well as being commercially important in themselves, anchovies represent an extremely important food base for other valuable fish species, as well as for marine birds and mammals, because of high availability and nutritive value (Angelescu 1982). *E. anchoita* is the most studied species in the South West Atlantic Ocean (Ciechomski and Sánchez 1986); nevertheless its parasite fauna is poorly known. At present, the records of parasites in anchovy are represented by one species of the genus *Hemiurus* and a tetraphyllidean (Cestoda) larva in the digestive tract (Angelescu 1982), *Hysterothylacium aduncum* (Nematoda) third-stage larvae in the body cavity (Navone et al. 1998) and a parasitic copepod, *Nothobomolochus cressei* in the gills (Timi and Sardella 1997).

The aim of this paper is to describe the composition of the digenean fauna harboured by *E. anchoita* in the Argentine and Uruguayan Seas.

MATERIALS AND METHODS

A total of 2,086 specimens of *Engraulis anchoita* were examined for parasitic digeneans.

The samples were collected during the research cruises of the Capitán Oca Balda (OB) and Dr. E. Holmberg (H) (Instituto Nacional de Investigación y Desarrollo Pesquero, INIDEP) OB 11/93 (October 1993), OB 13/93 (November-

December 1993), H 04/94 (May 1994), OB 08/94 (October 1994), H 07/95 (September 1995) and OB 14/95 (October 1995), covering the South West Atlantic continental shelf from 34°S to 46°S.

Fish were fixed in buffered 10% formalin and transported to the laboratory where they were dissected out and examined under a stereoscopic microscope. A sample of 100 fresh specimens of *E. anchoita* obtained from catches of commercial trawlers at the port of Mar del Plata (October 1995) was also examined for living digeneans. These anchovies were not included in the quantitative data.

Live parasites were fixed under slight pressure of the cover glass in 5% formalin, stored in 70% alcohol, stained with Semichon's acetocarmine and mounted in Canada balsam. Drawings were made with the aid of a drawing tube. Measurements are given in micrometers; means are followed by range in parentheses.

The material studied was deposited in the Invertebrate Collection (Helminths) of La Plata Natural Sciences Museum (LPNSM), La Plata, Argentina.

Prevalence and mean intensity of infection were calculated according Margolis et al. (1982) for each host population known in the area: Bonaerense population (Uruguayan Sea to 41°S) and Patagonian population (41-45°S) (Hansen et al. 1984).

RESULTS

Parahemiurus merus (Linton, 1910). Fig. 1 A, Tab. 1

Site of infection: stomach.

Voucher specimens: LPNSM collection number 4553.

Prevalence of infection: in Bonaerense anchovy

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population: 9.60 %; in Patagonian population: 0.73 %.

Mean intensity of infection: in Bonaerense anchovy population: 1.4 (1-12); in Patagonian population: 1.0 (1).

Measurements are given in Table 1.

Comments: The studied specimens agree well with the morphological features of the species given by Bray (1990) for this cosmopolitan digenean.

In the South West Atlantic Ocean, this parasite has been reported in Brazilian waters parasitizing a large number of fish species: *Sardinella aurita* – Vaz and Pereira (1930a,b); *Harengula* sp. and *Lycengraulis grossidens* – Travassos et al. (1967); *Pomatomus saltator* – Gomes et al. (1972), Amato (1983) and Rego et al. (1983); *Sardinella* sp. – Feijó et al. (1979), Rodrigues et al. (1990); *Haemulon sciurus* – Kohn et al. (1982) and Bray (1990); *Caranx hippos*, *Cynoscion leiarchus*, *Isopisthus parvipinnis*, *Parona signata* – Amato (1983); *Harengula clupeiola* – Wallet and Kohn (1987); *Opisthonema aglinum* – Fabio (1988) and *Oligoplites palometa*, *O. saurus* and *O. saliens* – Takemoto et al. (1995, 1996).

Parahemiurus merus has also been reported in other members of the genus *Engraulis*, such as *E. australis* from Australia, *E. capensis* from South Africa, *E. encrasicolus* from Europe and Africa, *E. japonicus* from Japan, *E. mordax* from the United States and *E. ringens* from the Galapagos Islands (see Bray 1990).

The presence of *P. merus* in *E. anchoita* represents a new host record and the first report of this parasite in the Argentine and Uruguayan Seas. It is probable that the previous finding of specimens of *Hemiurus* sp. in the stomach of Argentine anchovies (Angelescu 1982) referred in fact to *P. merus*; this assumption is based on the high values of prevalence (18%) and intensity (12) for the digenean reported by Angelescu (1982) and because no representatives of the genus *Hemiurus* were found in the present study.

Lecithochirium microstomum Chandler, 1935

Fig. 1 B, Tab. 2

Site of infection: swim bladder.

Voucher specimens: LPNSM collection number 4554.

Prevalence of infection: in Bonaerense anchovy population: 53.37 %; in Patagonian population: 41.18 %.

Mean intensity of infection: in Bonaerense anchovy population: 5.4 (1-449); in Patagonian population: 7.8 (1-149).

Measurements are given in Table 2.

Comments: The studied specimens agree well with the morphological features of the detailed description of species given by León-Régagnon et al. (1997). *L. microstomum* is a cosmopolitan species (Amato 1983); in the South West Atlantic this digenean has been previously reported for *Trichiurus lepturus* (as

Glomerocirrus septemlobus) – Freitas and Kohn (1965); *Scombroides occidentalis* and *Thyrstlops lepdopoides* – Vicente and Santos (1973); *Micropogonias furnieri* – Fabio (1988); *Eucinostomus argenteus* and *Trichiurus lepturus* – Wallet and Kohn (1987); *Isopisthus parvipinnis* and *Parona signata* – Amato (1983) and *Oligoplites palometa*, *O. saurus* and *O. saliens* – Takemoto et al. (1995, 1996) from Brazilian waters. In the Argentine Sea this species was found parasitizing *P. signata* – Szidat (1969) and Ivanov (1996) and *Micropogonias furnieri* – Sardella et al. (1995). The presence of *L. microstomum* in *E. anchoita* constitutes a new host record and its presence in Patagonian waters represents the southernmost locality record for this species in the South West Atlantic.

Different developmental stages, juveniles and ovigerous specimens of *L. microstomum*, were found in the swimbladder of *E. anchoita*, some of them encapsulated by a thin membrane. A four-host-life-cycle is apparently a common feature of the genus *Lecithochirium*, with ovigerous forms encysted in the viscera of fish or encapsulated in the body cavity (Gibson and Bray 1986, Køie 1990, Bray 1991).

The smaller size of the specimens found in the present study, in relation with those described by Ivanov (1996) from Argentinean waters and by León-Régagnon et al. (1997) (Table 2), could be related to the developmental stage of the parasite, since the specimens reported by these authors are adult forms, which inhabit the digestive tract of their fish hosts. The original description of the species (Chandler 1935) as well as those given by Brazilian authors (Freitas and Kohn 1965, Vicente and Santos 1973, Amato 1983, Wallet and Kohn 1987, Takemoto et al. 1995) are also based on larger, adult specimens.

***Cardiocephaloides* sp. metacercaria**

Fig. 1 C

Site of infection: eyes.

Material deposited: LPNSM collection number 4555.

Prevalence of infection: in Bonaerense anchovy population: 5.88 %; in Patagonian population: 18.18 %.

Mean intensity of infection: in Bonaerense anchovy population: 2.0 (1-12); in Patagonian population: 2.6 (1-23).

Description: Based upon 10 whole mounts and 15 fixed cysts. Each metacercaria included in spherical and thin-walled cyst, 600 (450-780) in diameter, whitish due to presence of numerous refractile excretory granules. In some cysts, variable number (2-6) of metacercariae was observed.

Excysted metacercaria: body oval, with ventral cavity, length: 656 (550-860), maximum width: 468 (360-620), with short anterior part of body separated by transverse fold (free border of ventral cavity) from the posterior part. Oral sucker at anterior end, subterminal

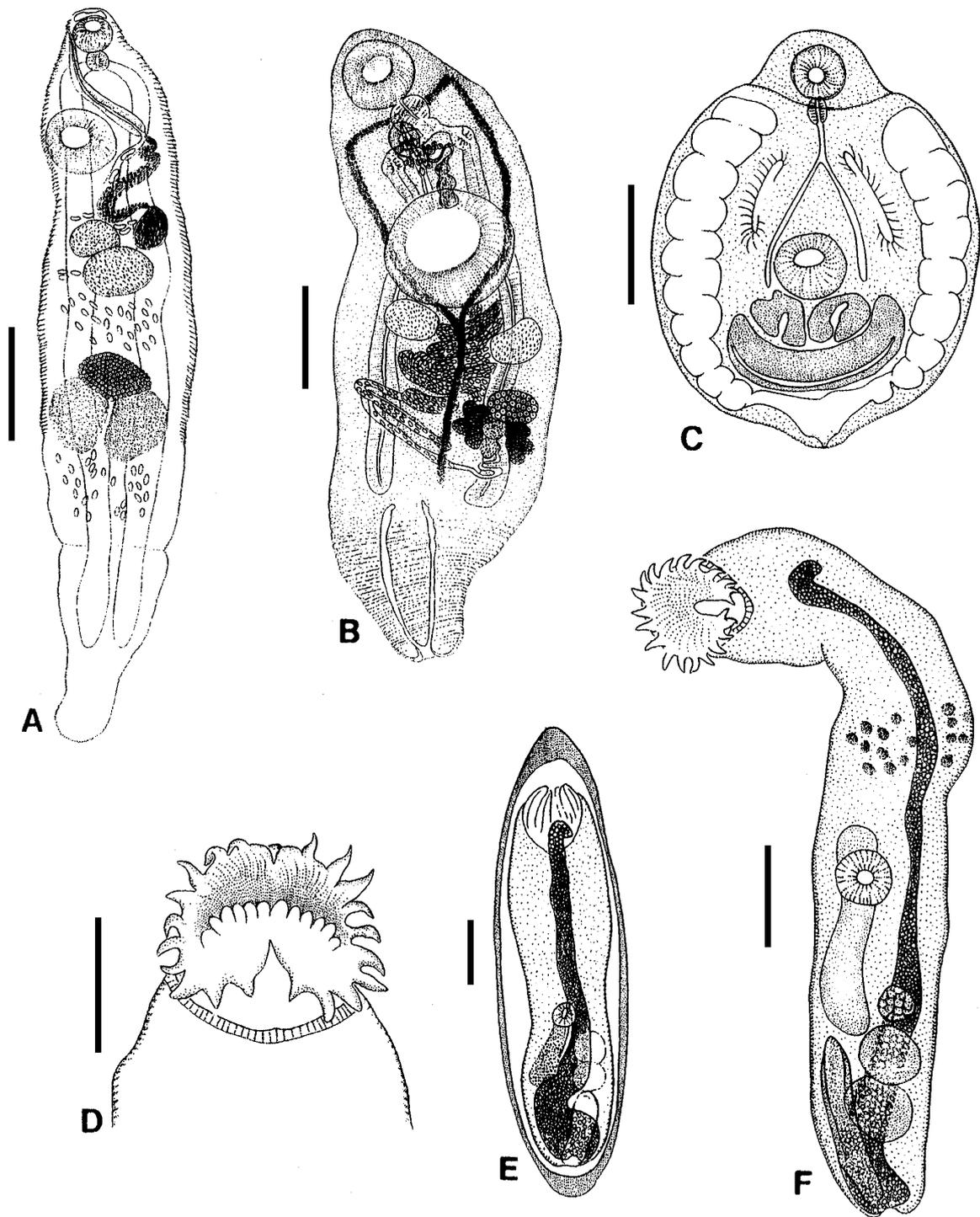


Fig. 1. Digeneans of *Engraulis anchoita*. **A** – *Parahemiurus merus*, ventral view; **B** – *Lecithochirium microstomum*, ventral view; **C** – *Cardiocephaloides* sp., excysted metacercaria, ventral view; **D** – *Rhipidocotyle* sp., excysted metacercaria, detail of anterior end; **E** – encysted *Rhipidocotyle* sp. metacercaria; **F** – *Rhipidocotyle* sp., excysted metacercaria, ventral view. Scale bars: A, B = 400 μ m; C-F = 100 μ m.

and ventral, length: 93 (70-110), width: 97 (80-120). Pharynx, length: 50 (40-60), width: 36 (30-40) situated immediately behind oral sucker. Oesophagus short,

bifurcated at level of anterior end of pseudosuckers, caeca reaching medial region of body. Two well-developed pseudosuckers, length: 142 (109-160),

present at each side of digestive caeca, anteriorly to acetabulum. Acetabulum, length: 132 (100-150), width: 133 (110-148), situated at middle of body, pre-acetabular space: 194 (210-420), post-acetabular space: 244 (185-310). Holdfast lobulate, length: 140 (100-200), width: 276 (240-310), filling bottom of ventral cavity. Excretory ducts running all along posterior part of body and join at posterior end to form an excretory vesicle, opening to terminal pore. Excretory system filled by numerous spherical refractile granules (omitted from Fig. 2C).

In some metacercariae the morphology and relative position of different organs varied (e.g., pseudosuckers extruded from the ventral cavity) depending on the movements of worms prior to fixation and/or on the cover-glass pressure.

Comments: So far, metacercariae of only four species of the family Strigeidae have been reported parasitizing the nervous system of marine fishes in the Northern Hemisphere: *Cardiocephalus mediconiger* Dubois et Vigueras, 1949 (as *C. brandesi* Szidat, 1928) from the brain and eyes of *Mugil cephalus* and *Menidia menidia* (Hunter and Vernberg 1960) and an unidentified strigeid metacercaria from the brain of *Fundulus heteroclitus* from the Atlantic coasts of the United States (Abbott 1968); *Cardiocephalus longicollis* Szidat, 1928 from the eyes of *Diplodus annularis*, *D. vulgaris*, *Boops salpa*, *Pagellus mormyrus* and *Belone belone* from France (Prevot and Bartoli 1980) and an unidentified species of *Cardiocephalus* from the brain of *Epinephelus morio* from Mexico (Moravec et al. 1997). The present report is the fifth record of strigeid metacercariae in marine fishes and the first in the Southern Hemisphere.

Comparisons with the metacercariae cited by Hunter and Vernberg (1960) and Abbott (1968) were not possible due to the brief descriptions given by these authors.

Metacercariae of both *C. longicollis* and *Cardiocephalus* sp. described by Prevot and Bartoli (1980) and Moravec et al. (1997) respectively, differ from the specimens described in the present study by having a larger body size, although in *C. longicollis* the oral sucker, the acetabulum and the pharynx are smaller. Furthermore, in both metacercariae, the caeca reach the posterior end of the body whereas in those from *E. anchoita* the ends of the caeca are situated at the middle of the body. In addition, in *Cardiocephalus* sp. from *E. morio*, anlagen of sexual glands are observed at the posterior end of the body.

The observed differences in the relative disposition of the organs could be due to the conditions of fixation (movements of the specimen, cover-glass pressure) and/or to different developmental stages of the specimens studied, such as it was observed by Prevot

and Bartoli (1980) for *C. longicollis*. These authors also observed, as in the present work, that the excysted metacercaria is larger than those inside cysts, which it is contracted.

In South American Atlantic coasts, two species of *Cardiocephalus* were reported from fish-eating marine birds: *C. brandesii* Szidat, 1928 in the gull *Larus maculipennis* and the skimmer *Rhynchops nigra*, and *C. physalis* (Lutz, 1926) in the Magellanic penguin *Spheniscus magellanicus* – Szidat (1964), Dubois (1968) and Yamaguti (1971). Randall and Bray (1983) and Clarke and Knowles (1993) cited the latter species in other penguin species as *Cardiocephaloides physalis*. The genus *Cardiocephaloides* Sudarikov, 1959 was considered a synonymous with *Cardiocephalus* by Dubois (1968) although Yamaguti (1971) consider both genera as valid, but he includes the species from *S. magellanicus* from South America in the genus *Cardiocephalus*. Nevertheless, as pointed out by Baer (1969), *Cardiocephaloides* Sudarikov, 1959 is the valid generic name, because *Cardiocephalus* Szidat, 1928 is preoccupied by *Cardiocephalus* Broili, 1904, a fossil amphibian.

Based on the geographical distribution and on the trophic relationships of the different hosts, the specimens found parasitizing *E. anchoita* probably belong to the species *C. physalis*.

Spheniscus magellanicus is one of the main predators of anchovy (Angelescu 1982) and the Argentine anchovy is the principal food item in the penguin diet (Scolaro and Badano 1986); furthermore, the higher values of prevalence and intensity in the southern zone (Patagonian), where the penguins are mainly distributed and have their breeding colonies (Scolaro et al. 1980), support this assumption. *C. physalis* was also reported (as *Cardiocephaloides physalis*) from jackass penguins *S. demersus* from South Africa (Randall and Bray 1983, Clarke and Knowles 1993). As pointed out by Randall and Bray (1983) *Engraulis capensis*, the most common species eaten by *S. demersus* may be the cause of the infection of penguins.

On the other hand, *L. maculipennis* is a generalist feeder and fish are not a frequent component of its diet (Lewington 1995) and the distribution of *Rhynchops nigra* does not reach the Patagonian coasts (Willis 1995), where the highest numbers of metacercariae were recorded.

***Rhipidocotyle* sp. metacercaria**

Fig. 1 D,F

Site of infection: musculature, mainly in head and operculum.

Material deposited: LPNSM collection number 4556.

Prevalence of infection: in Bonaerense anchovy population: 8.33 %; in Patagonian population: 4.21 %.

Table 1. Comparison of measurements of *Parahemiurus merus* (Linton, 1910) from Argentina and those reported by Bray (1990).

| | Present study (based on 20 whole mounts) | Bray (1990) |
|--------------------|---|-------------------|
| Body length | 986.9 (720-1,441) | 800-2,990 |
| Body width | 170.6 (120-247) | 210-570 |
| Pre-oral lobe | 15.2 (8.4-35.7) | 8-50 |
| Oral sucker | 63.1 (49.5-80) × 65.7 (52.8-80) | 36-83 × 51-82 |
| Ventral sucker | 132.7 (105.6-165) × 136.8 (99-200) | 101-170 × 124-170 |
| Sucker width ratio | 1: 1.58 (1: 1.71-1: 2.5) | 1: 1.76-1: 2.58 |
| Pharynx | 40.7 (33-49.5) × 40.2 (29.7-49.5) | 32-64 × 32-51 |
| Anterior testis | 64.2 (39.6-82.5) × 78.4 (49.5-132) | 40-152 × 68-145 |
| Posterior testis | 74.4 (36.3-90) × 88.4 (46.2-125.4) | 48-170 × 64-170 |
| Seminal vesicle | 73.36 (49.5-95.7) × 45.7 (36.3-62.7) | 48-278 × 41-130 |
| Ovary | 72.67 (39.6-102) × 104.44 (75.9-148.5) | 47-234 × 80-223 |
| Right vitellarium | 96.94 (56.1-132) × 79.82 (42.9-115.5) | - |
| Left vitellarium | 117.64 (59.4-178.2) × 99.05 (49.5-141.9) | - |
| Egg length | 28 (24-32) | 20-32 |
| Egg width | 9.9 (8.2-11.5) | - |

Table 2. Compared measurements of *Lecithochirium microstomum* Chandler, 1935.

| | Present study (based on 20 whole mounts) | León-Règagnon et al. (1997) | Ivanov (1996) |
|------------------------|---|--------------------------------|---------------------|
| Body length | 1,034 (744-1,592) | 2,940 (1,830-3,920) | 3,890 (1,140-4,270) |
| Body width | 323 (224-496) | 600 (450-810) | 970 (400-1,060) |
| Ecsoma length | 219.2 (112-384) | - | - |
| Pre-oral lobe | 21.2 (10.5-39.9) | - | - |
| Oral sucker length | 119.7 (88.2-144.9) | 130 (90-180) | 66-186 |
| Oral sucker width | 121.2 (96.6-159.6) | 150 (110-180) | 69-210 |
| Ventral sucker length | 207.6 (155.4-308.7) | 450 (280-540) | 210-264 |
| Ventral sucker width | 207.8 (153.3-296.1) | 440 (310-490) | 171-637 |
| Sucker width ratio | 1: 1.72 (1: 1.41-1: 2.09) | 1:3.5 (1:2.9-1:4.6) | - |
| Pharynx length | 62.2 (52.5-77.7) | - | - |
| Pharynx width | 64.9 (46.2-81.9) | - | - |
| Testicle length | 55.2 (23.1-117.6) | - | 105-320 |
| Testicle width | 61.8 (25.2-140.7) | - | 114-351 |
| Sinus sac length | 60.5 (37.8-81.9) | - | - |
| Sinus sac width | 39.6 (29.4-50.4) | - | - |
| Seminal vesicle length | 91.3 (65.1-153.3) | - | - |
| Seminal vesicle width | 43.2 (25.2-73.5) | - | - |
| Ovary length | 52.9 (31.5-98.7) | - | 114-325 |
| Ovary width | 70.6 (39.9-147) | - | 135-364 |
| Egg length | 16.4 (14.7-18.9) | 18 (15-21) | 14-23 |
| Egg width | 9.2 (8.4-10.5) | 11 (9-13) | 9-12 |

Mean intensity of infection: in Bonaerense anchovy population: 4.2 (1-143); in Patagonian population: 0.5 (3).

Description: Based upon 5 whole mounts and 10 fixed cysts. Cyst thin-walled, fusiform to oval, length 641 (410-800), width 208 (170-270), placed parallel to muscle fibres. Metacercaria extended or folded upon itself inside the cyst.

Excysted metacercariae: body elongate, length 1114 (900-1330), maximum width 172 (140-220), covered by fine spines. Rhynchus with cap-like expansion carrying 21 marginal tentacular appendages. Mouth median,

ventral, located at 647 (493-745) from anterior end. Pharynx spherical, length 66 (50-84), width 64 (50-77), intestine directed posteriorly, length 287 (200-380). Ovary spherical, posterior to mouth and pretesticular, length 45 (40-56), width 42 (40-43). Testes spherical to oval, in tandem, situated between ovary and posterior end of body, anterior testis length 102 (60-140), width 92 (70-120); posterior testis length 117 (70-150), width 99 (75-150). Cirrus sac long, from testicular level to near distal end of body, length 310 (220-460), width 47 (21-75). Several vitelline follicles at the anterior half of the body. Excretory vesicle extending from near

rhynchus, dorsal to genital organs, to posterior end, where excretory pore is located.

Comments: In the South West Atlantic, adult members of four species of the genus *Rhipidocotyle* have been reported parasitizing pelagic fishes from Brazil, *R. quadriculatum* Kohn, 1961 from *Scomberomorus maculatus* – Kohn (1961); *R. angusticollis* Chandler, 1941 from *Scomber japonicus* (as *S. colias*) – Fabio (1976), *R. fluminensis* Vicente et Santos, 1973 from *Euthynnus alletteratus* – Vicente and Santos (1973) and *R. gibsoni* Kohn et Fernandes, 1994 from the freshwater fish *Acestrorhynchus lacustris* – Kohn and Fernandes (1994). Adults of all Brazilian species differ from the metacercariae described herein mainly by the

absence of the 21 digitiform projections in the cap-like expansion anterior to the rhynchus.

In Argentinean waters, *S. japonicus*, whose main prey is *E. anchoita* Angelescu (1979, 1980) was not found parasitised by representatives of the genus *Rhipidocotyle* (Cremonte and Sardella 1997). The specimens described above probably belong to a new species whose adults are expected to be found in some other predator of *E. anchoita*.

Acknowledgements. The authors wish to thank Lic. Marcelo Pájaro, Dr. Jorge Hansen and Dr. Ricardo Perrota, Instituto Nacional de Investigación y Desarrollo Pesquero for providing and conditioning the anchovy samples and to Ms. M. C. Estivariz for the illustrations.

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Received 22 July 1998

Accepted 5 November 1998