



Cestodes of the Antarctic fishes

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ABSTRACT: The paper comprises the review of all known species of cestodes parasitizing the Antarctic and Subantarctic fishes along with synonyms and keys based on morphological features. Also, the review of larval forms of cestodes occurring in bony fishes and provisional identification of them with adult forms is given. In total, 11 valid species (and 3 unnamed forms) of the order Tetracanthocephala and Diphyllidae occur in skates, whereas 3 species of the order Pseudophyllidae were reported from bony fishes. Six morphological forms of larvae, 5 belonging to the Tetracanthocephala and one to the family Tetracanthidae as well as undetermined plerocercoids of Diphyllidae were recognized.

Key words: Antarctica, fishes, cestodes.

Introduction

According to Fischer and Hureau (1985) and Gon and Heemstra (1990) the Antarctic fish fauna is represented by sharks, skates and bony fishes. Sharks are uncommon in Antarctic waters and only 3 species from 2 families, Squalidae and Lamnidae, were recorded off South Georgia and in the Subantarctic. They are: *Somniosus microcephalus* Bloch *et* Schneider, 1801, *Lamna nasus* (Bonnaterre, 1788) and *Etmopterus lucifer* Jordan *et* Snyder, 1902. All sharks in the Southern Ocean have been caught near the bottom around islands and no data exist about the presence of pelagic species or the extension of the distribution of sharks along the Antarctic coast. All Antarctic skates belong to the family Rajidae and they represent about 10 species from two genera: *Raja* Linnaeus, 1758 and *Bathyraja* Ishiyama, 1958. Also, about 274 species of bony fishes from 49 families occur in the Antarctic and Subantarctic waters and over 120 species belong to the superfamily or suborder Notothenioidei (Eastman and Clarke 1998).

According to Southwell (1925) the first report on the occurrence of adult cestodes in the Antarctic fishes was given by Linstow (1907) who described a new species, *Phyllobothrium dentatum*, from unidentified shark. Up to the beginning

of the author's studies, Antarctic skates were not examined for parasites. One cestode species, *Parabothriocephalus johnstoni* Prudhoe, 1969 has been reported from the Antarctic bony fish, *Macrourus whitsoni* Regan, 1913; two other species, *Bothriocephalus kerguelensis* Prudhoe, 1969 and *B. antarcticus* Wojciechowska *et al.*, 1995, were found in notothenioids in the Kerguelen subregion of the Subantarctic (Prudhoe 1969, Wojciechowska *et al.* 1995).

Larval cestodes occurring in the alimentary tract of bony fishes in the whole World Ocean as well as in the alimentary tract and various tissues of invertebrates, have been known from the beginning of the 18th century (Stunkard 1977). Various names have been used for these larvae; most often they have been reported as *Scolex pleuronectis* Müller, 1787 or *Scolex polymorphus* Rudolphi, 1819. Most of them were later identified as larval forms of Tetracystidae, parasites of sharks and skates. Larvae of Tetracystidae as well as plerocercoids of Diphyllididae are common in the Antarctic and Subantarctic bony fishes and marine mammals (Leiper and Atkinson 1914, 1915; Gusev 1958, 1960; Szidat 1965, Szidat and Graefe 1967, 1968; Prudhoe 1969, Skryabin 1970, 1972; Parukhin and Sysa 1975, Zdzitowiecki 1978, 2001a, b; Holloway and Spence 1980, Parukhin and Lyadov 1981, 1982; Lyadov 1985, Rodjuk 1985, Reimer 1987, O'Neill *et al.* 1988, Parukhin 1989, Gaevskaya *et al.* 1990, Moser and Cowen 1991, Palm 1992, Wojciechowska 1993a, b; Wojciechowska *et al.* 1994, 1995; Gaevskaya and Rodjuk 1997, Zdzitowiecki *et al.* 1997, 1998; Palm *et al.* 1998, Zdzitowiecki and Zadróźny 1999, Rocka 1999). Most of these papers do not contain any morphological data. The earliest reports of such larvae from the Antarctic accompanied by a description were published by Leiper and Atkinson (1914, 1915) who described them under the name *Anthobothrium wyatti* Leiper et Atkinson, 1914. Prudhoe (1969) identified this form as a tetracystid larva. Presently, *Anthobothrium wyatti* is considered a junior synonym of *Orymatobothrium versatile* Diesing, 1854 (Campbell and Overstreet 1994).

Most of parasitic material available for the present author was collected by Professor K. Zdzitowiecki during Antarctic scientific expeditions of the Polish Academy of Sciences in the years: 1977, 1978/79, 1986/87, and during Expedition ANT XIII/3 organised by the Alfred Wegener Institute for Polar and Marine Research at the Weddell Sea (1996). The part of material was from the Ross Sea (Terra Nova Bay), off the Heard Island, off Adelie Land, off the South Orkneys, the Davis Sea, South Georgia and Admiralty Bay.

In total, 63 specimens of skates (5 species) and 1446 specimens of bony fishes (about 48 species from 14 families and 5 orders) were examined. The term "cercoid" is used according to Jarecka (1970, 1975) and Pojmańska (1986); nomenclature of the morphology of the cercoids is according to Stunkard (1977). The term "acetabula" is used according to Cairns *et al.* (2001). Museum abbreviations used are as follows: BMNH (British Museum of Natural History, London); MZPW (Museum of Zoology, Warszawa).

Systematic review of cestodes

Cestodes of skates and sharks

Up to the beginning of the author's studies one species, *Phyllobothrium dentatum* (Linstow, 1907), were known from Antarctic elasmobranchs. The description was based on one immature specimen from an unidentified shark which was found on the coast of South Georgia and contains following data: strobila 5.37 mm long with maximum width 0.76 mm, four bothridia with free posterior ends. According to Southwell (1925) and Yamaguti (1959) this is *species inquirenda*. Sharks were not examined in present studies.

The following species of skates were examined by the present author: *Bathyraja eatonii* (Günther, 1876) (10 specimens), *Bathyraja murrayi* (Günther, 1880) (1), *Bathyraja maccaini* Springer, 1971 (26), *Bathyraja* sp. 2 Stehmann, 1985 (6), *Raja georgiana* Norman, 1938 (20).

Skates were infected with representatives of two orders: Tetracanthellida and Diphyllida. The present studies confirmed the occurrence of 10 valid cestode species of Tetracanthellida and one of Diphyllida. Additionally, three unnamed forms were recorded (two of Tetracanthellida and one of Diphyllida). All cestodes occurred in the spiral valve.

Checklist of the Antarctic Tetracanthellida

Order Tetracanthellida Carus, 1863

Family Phyllobothriidae Braun, 1900

Subfamily Phyllobothriinae de Beauchamp, 1905

Genus *Phyllobothrium* van Beneden, 1850

Phyllobothrium dentatum (Linstow, 1907)

Synonym: *Monorygma dentatum* Linstow, 1907 (see: description of Southwell 1925).

Host: Unidentified shark.

Locality: Environs of South Georgia (Southwell 1925).

Genus *Anthocephalum* Linton, 1890

Anthocephalum georgiense (Wojciechowska, 1991)

(see: description Wojciechowska 1991a, fig. 1)

Synonym: *Phyllobothrium georgiense* Wojciechowska, 1991.

Host: *Raja georgiana*.

Locality: Shelf around South Georgia (Wojciechowska 1991a).

Holotype: MZPW 1812; paratype: BMNH 1992.1.6.27.

Anthocephalum rakusai (Wojciechowska, 1991)

(see: description Wojciechowska 1991a, fig. 2 a–b)

Synonym: *Phyllobothrium rakusai* Wojciechowska, 1991.

Host: *Bathyraja maccaini*.

Locality: Environs of the South Shetlands – shelf around Elephant Island and Joinville Island in Bransfield's Strait (Wojciechowska 1991a).

Holotype: MZPW 1816; paratype: BMNH 1992.1.6.28.

Anthocephalum siedleckii (Wojciechowska, 1991)

(see: description Wojciechowska 1991a, fig. 2 c–e; Rocka and Zdzitowiecki 1998, fig. 2)

Synonym: *Phyllobothrium siedleckii* Wojciechowska, 1991.

Host: *Bathyraja eatonii*, *Bathyraja maccaini*.

Locality: Environs of the South Shetlands – shelf around Elephant Island and Joinville Island in Bransfield's Strait (Wojciechowska 1991a), and the eastern part of the Weddell Sea, 70–74°S, 8–22°W (Rocka and Zdzitowiecki 1998).

Holotype: MZPW 1815; paratype: BMNH 1992.1.6.29; voucher specimens from the Weddell Sea: MZPW 7/98, BMNH 1997.11.3.2

Anthocephalum arctowskii (Wojciechowska, 1991)

(see: description Wojciechowska 1991a, fig. 3; Rocka and Zdzitowiecki 1998, fig. 3)

Synonym: *Phyllobothrium arctowskii* Wojciechowska, 1991.

Host: *Bathyraja* sp. 2.

Locality: Environs of the South Shetlands – Admiralty Bay and shelf near Elephant Island (Wojciechowska 1991a), and the eastern part of the Weddell Sea, 70–74°S, 8–22°W (Rocka and Zdzitowiecki 1998).

Holotype: MZPW 1814; paratypes: BNMH 1992.1.6.30; voucher specimen from the Weddell Sea: MZPW 7/98.

Anthocephalum sp. (Wojciechowska *et al.*, 1995)

(see: description Wojciechowska *et al.* 1995, fig. 1)

Synonym: *Phyllobothrium* sp. Wojciechowska *et al.*, 1995.

Host: *Bathyraja eatonii*.

Locality: The Heard Island, Subantarctic (Wojciechowska *et al.* 1995). Specimens in author's collection in the Institute of Parasitology Polish Academy of Sciences, Warszawa.

Genus *Marsupiobothrium* Yamaguti, 1952

Marsupiobothrium antarcticum Wojciechowska, 1991

(see: description Wojciechowska 1991b, fig. 1)

Host: *Bathyraja eatonii*, *Bathyraja maccaini*.

Locality: Environs of the South Shetlands – shelf around Joinville Island in Bransfield's Strait (Wojciechowska 1991b).

Holotype: MZPW 1817; paratype: BMNH 1992.1.6.31.

Marsupiobothrium awii Rocka *et* Zdzitowiecki, 1998

(see: description Rocka and Zdzitowiecki 1998, fig. 1)

Host: *Bathyraja maccaini*.

Locality: The eastern part of the Weddell Sea, 70–74°S, 8–22°W (Rocka and Zdzitowiecki 1998).

Holotype: MZPW 1818; paratype: BMNH 1997.11.3.1

Genus *Anthobothrium* van Beneden, 1850

Anthobothrium sp. Wojciechowska, 1991

(see: description Wojciechowska 1991b, fig. 3)

Host: *Bathyraja* sp. 2.

Locality: Environs of the South Shetlands – Drake’s Strait near King George Island and environs of Elephant Island (Wojciechowska 1991b). Specimens in author’s collection in the Institute of Parasitology Polish Academy of Sciences, Warszawa.

Subfamily Echeneibothriinae de Beauchamp, 1905

Genus *Pseudanthobothrium* Baer, 1956

Pseudanthobothrium notogeorgianum Wojciechowska, 1990

(see: description Wojciechowska 1990b, fig. 2)

Host: *Raja georgiana*.

Locality: Shelf around South Georgia (Wojciechowska 1990b).

Holotype: MZPW 1807; paratypes: MZPW 1808–1809, BMNH 1989.4.9.2.

Pseudanthobothrium minutum Wojciechowska, 1991

(see: description Wojciechowska 1991b, fig. 2)

Host: *Bathyraja eatonii*.

Locality: Environs of the South Shetlands – shelf around Elephant Island (Wojciechowska 1991b).

Syntypes: In the author’s collection in the Institute of Parasitology Polish Academy of Sciences, Warszawa.

Genus *Notomegarhynchus* Ivanov and Campbell, 2002

Notomegarhynchus shetlandicum (Wojciechowska, 1990)

(see: description Wojciechowska 1990b, fig. 1; Ivanov and Campbell 2002, figs 20–33)

Synonym: *Pseudanthobothrium shetlandicum* Wojciechowska, 1990.

Host: *Bathyraja eatonii*, *Bathyraja maccaini*.

Locality: Environs of the South Shetlands – Admiralty Bay and shelf around Joinville and Elephant Islands (Wojciechowska 1990b).

Holotype: MZPW 1810; paratypes: MZPW 1811, BMNH 1989.4.9.3.

Family Oncobothriidae Braun, 1900

Genus *Oncobothrium* de Blainville, 1828

Oncobothrium antarcticum Wojciechowska, 1990

(see: description Wojciechowska 1990a, figs 1 and 2a–c; Rocka and Zdzitowiecki 1998, fig. 4)

Host: *Bathyraja eatonii*, *Bathyraja maccaini*.

Locality: Environs of the South Shetlands – shelf around Joinville Island in Bransfield’s Strait (Wojciechowska 1990a), and the eastern part of the Weddell Sea, 70–74°S, 8–22°W (Rocka and Zdzitowiecki 1998).

Holotype: MZPW 1805; paratypes: MZPW 1806, BMNH 1989.4.19.1.

Checklist of the Antarctic Diphyllidea

Order Diphyllidea Carus, 1863

Family Echinobothriidae Perrier, 1897

Genus *Echinobothrium* Beneden, 1849

Echinobothrium acanthocolle Wojciechowska, 1991

(see: description Wojciechowska 1991b, fig. 4)

Host: *Raja georgiana*.

Locality: Shelf near South Georgia. Holotype and paratype in the author's collection in the Institute of Parasitology Polish Academy of Sciences, Warszawa.

Family Macrobothriidiidae Khalil et Abdul-Salam, 1989

Genus *Macrobothridium* Khalil et Abdul-Salam, 1989

Macrobothridium sp. Wojciechowska *et al.*, 1995

(see: description Wojciechowska *et al.* 1995, fig. 2)

Host: *Bathyraja eatonii*.

Locality: The Heard Island, Subantarctic (Wojciechowska *et al.* 1995). One specimen in author's collection in the Institute of Parasitology Polish Academy of Sciences, Warszawa.

Key to the Orders, Families, Subfamilies, Genera and Species of cestodes parasitizing Antarctic skates

- 1a.** Scolex with two bothria and cephalic peduncle Order Diphyllidea **2**
- 1b.** Scolex with four acetabula Order Tetrephyllidea **3**
- 2a.** Cephalic peduncle armed Family Echinobothriidae
- Total length 5 mm. Scolex proper, 0.80×0.59 mm, consists of armed rostellum, 0.16×0.19 mm and two bothria, 0.74×0.60 mm. Hook formula 3(16/15)3. Hook increasing in length toward center of group. Lateral hooklets arranged in two groups. Cephalic peduncle 0.12×0.26 mm, armed with 8 longitudinal columns of 2–5 spines. Spines with triradiate bases, 0.028–0.035 mm long. Testes 19–25, in 4–5 irregular columns *Echinobothrium acanthocolle*
- 2b.** Cephalic peduncle unarmed Family Macrobothriidiidae
- Scolex proper, 0.71×0.74 mm. Rostellum armed with two groups of hooks, each group consists of 10–12 large hooks in two rows, 0.078–0.13 mm and 9 smaller hooks on either side, 0.02–0.06 mm. Cephalic peduncle 0.28×0.16 mm *Macrobothridium* sp.
- 3a.** Acetabula armed Family Oncobothriidae
- Strobila 100–150 mm. Acetabula, 0.75–1.03×0.60–0.63 mm. Each acetabulum divided into 3 loculi which varied in size, with a cushion-like lobe in front of anterior loculus. A pair of hooks, separate from each other, not branched is situated on anterior margin of anterior loculus. Hooks of equal length, 0.10–0.11 mm, with handle 0.058–0.062 mm and prong 0.043–0.062 mm. Testes 125–135 in number, 0.13–0.15 mm in diameter. Cirrus pouch 0.34–0.55×0.19–0.26 mm, cirrus armed. Ovary 0.25–0.30×0.50–0.65 mm. Vagina with a sphincter in distal part. Vitellarium forms a compact lateral bands. Eggs 0.11–0.16 mm in diameter *Oncobothrium antarcticum*
- 3b.** Acetabula unarmed Family Phyllobothriidae **4**
- 4a.** Scolex with apical myzorhynchus. Acetabula smooth or divided by septa Subfamily Echeneibothriinae **5**

- 4b.** Scolex without myzorhynchus. Acetabula without loculi, with simple, crumpled or loculated margin Subfamily Phyllobothriinae **7**
- 5a.** Acetabula stalked, funnel-shaped or cylindrical with depression on apex ending with sucker-like structure. Myzorhynchus cylindrical, having apical disc that can be invaginated. Genus *Pseudanthobothrium* **6**
- 5b.** Acetabula stalked, highly muscular, sucker-like. Myzorhynchus massive, always everted Genus *Notomegarhynchus*
- Strobila 85–125 mm. Acetabula cylindrical 0.6–0.9 mm long ending in thickwalled sucker-like structure, 0.4–0.9 mm in diameter. Myzorhynchus mushroom-shaped, 0.63–1.00×0.96–1.45 mm. Testes 40–60 in number, 0.11–0.16 mm in diameter. Cirrus pouch 0.29–0.41×0.14–0.23 mm. Cirrus armed. Ovary 0.085–0.32×0.12–0.41 mm. Vitellarium gathered into two lateral bands. Eggs 0.043–0.055×0.040–0.047 mm, changing at one pole into filament 0.3 mm in maximum length *Notomegarhynchus shetlandicum*
- 6a.** Strobila 22–36 mm long. Acetabula funnel-shaped, 0.5–0.75 mm long ended with sucker-like structure. Myzorhynchus cylindrical, 0.38–0.58 mm long with apical disc, 0.28–0.30 mm in diameter. Testes 20–26 in number, 0.092–0.142 mm in diameter. Cirrus pouch 0.24–0.27×0.12–0.15 mm. Ovary 0.080–0.450×0.117–0.550 mm. Vitellarium gathered into two lateral bands *Pseudanthobothrium minutum*
- 6b.** Strobila 18–60 mm long. Acetabula funnel-shaped, 0.63–0.88 mm long with depression on apex surrounded by thinwalled sucker-like structure. Myzorhynchus cylindrical, 0.16–0.75 mm long with apical disc, 0.13–0.22 mm in diameter. Testes 25–36 in number, 0.12–0.14 mm in diameter. Cirrus pouch 0.20–0.28×0.12–0.16 mm. Cirrus armed. Ovary 0.08–0.33×0.12–0.30 mm. Vitellarium forms two narrow lateral bands. Eggs 0.043–0.046×0.038–0.041 mm, passing at one pole into filament 0.23 mm in maximum length *Pseudanthobothrium notogeorgianum*
- 7a.** Acetabula pedunculate, funnel-shaped, ending with sucker-like structure. Accessory sucker absent Genus *Anthobothrium*
- Strobila 5 mm long. Acetabula funnelled, 0.25 mm long, ending with sucker-like structure, 0.23–0.24 mm in diameter. Testes 11–12, elongate, 0.040–0.116×0.013–0.030 mm. Vitellarium forms large elongate follicles gathered into two lateral bands. *Anthobothrium* sp.
- 7b.** Acetabula sessile. **8**
- 8a.** Acetabula cup-shaped, hollow, opening is provided with sphincter-like muscle. Accessory sucker present at anterior end of each acetabulum Genus *Marsupiobothrium* **9**
- 8b.** Acetabula leaf-shaped with loculated margin, Acetabula not bifid in posterior end. Accessory sucker present. Genus *Anthocephalum* **10**
- 9a.** Strobila 140 mm long. Acetabula 1.34–1.44×0.83–0.91 mm. Accessory sucker 0.17 mm in diameter. Testes 200–220, 0.110–0.135 mm in diameter. Cirrus pouch 0.85–0.94×0.29–0.44 mm. Ovary multi-lobed, 0.70–0.75×1.13–1.25 mm. Vitellarium gathered into two lateral, wide compact bands. Vagina provided with sphincter in distal part *Marsupiobothrium antarcticum*
- 9b.** Strobila 30–90 mm long. Acetabula 0.95–1.38×0.34–0.63 mm. Accessory sucker 0.086–0.117 mm in diameter. Testes 120–150, 0.09–0.12×0.072–0.113 mm. Cirrus pouch 0.47–0.76×0.20–0.55 mm. Ovary multi-lobed, 0.28–0.65×0.62–0.95 mm. Vitellarium gathered into two wide, lateral bands. Vagina with sphincter in distal part. Eggs 0.016–0.017 mm in diameter *Marsupiobothrium awii*
- 10a.** Acetabula with strongly folded surface and numerous marginal loculi. **11**
- 10b.** Acetabula with only folded margin and marginal loculi **12**
- 11a.** Strobila 60–170 mm long. Acetabula, 1.13–1.50×0.60–0.90 mm. Acetabular sucker 0.18–0.23 mm in diameter. Testes 140–190, 0.086–0.126 mm in diameter. Cirrus pouch 0.66–0.88×

- 0.22–0.34 mm, situated diagonally. Ovary 0.20–0.80×0.62–1.13 mm. Vitellarium forms two lateral wide bands. Distal vaginal sphincter feeble *Anthocephalum georgiense*
- 11b.** Strobila 20 mm long. Acetabula, 0.55–0.68×0.64–0.87 mm. Acetabular sucker 0.11–0.14 mm in diameter. Testes 120–140 in number, 0.06–0.15×0.05–0.11 mm. Cirrus pouch 0.24–0.52×0.12–0.18 mm, situated diagonally. Ovary 0.25–0.84×0.39–0.74 mm. Vitellarium arranged in two lateral bands *Anthocephalum* sp.
- 12a.** Strobila 50–140 mm long. Acetabula, 0.88–1.62×0.62–0.85 mm, each with 36–40 marginal loculi. Acetabular sucker 0.25–0.31 mm in diameter. Testes 120–165, 0.07–0.13 mm in diameter. Cirrus pouch 0.55–0.76×0.18–0.23 mm, situated diagonally. Ovary 0.37–0.92×0.47–0.84 mm. Vitellarium forms compact layer. Distal vaginal sphincter feeble. *Anthocephalum rakusai*
- 12b.** Distal vaginal sphincter strong **13**
- 13a.** Strobila 36–150 mm long. Acetabula, 0.83–1.21×0.46–0.90 mm, each with 40–45 marginal loculi. Acetabular sucker 0.18–0.28 mm in diameter. Testes 85–105, 0.09–0.14 mm in diameter. Cirrus pouch 0.40–0.74×0.12–0.22 mm. Cirrus armed. Ovary 0.22–0.60×0.50–0.96 mm. Vitellarium forms compact layer. *Anthocephalum siedleckii*
- 13b.** Strobila 15–35 mm long. Acetabula, 0.75–1.06×0.45–0.80 mm, each with about 30 marginal loculi. Acetabular sucker 0.21–0.25 mm in diameter. Testes 60–80 in number, 0.08–0.12 mm in diameter. Cirrus pouch 0.37–0.55×0.15–0.26 mm. Ovary 0.12–0.67×0.43–0.70 mm. Vitellarium forms compact layer *Anthocephalum arctowskii*

Cestodes of bony fishes

Checklist of the Antarctic Pseudophyllidea parasitizing bony fishes

Order Pseudophyllidea Carus, 1863

Family Bothriocephalidae Blanchard, 1849

Genus *Bothriocephalus* Rudolphi, 1808

Bothriocephalus kerguelensis Prudhoe, 1969

(see: description Prudhoe 1969, figs 1–3)

Host: *Notothenia cyanobrancha* Richardson, 1844 and *Notothenia rossii* Richardson, 1844.

Habitat: The small intestine.

Locality: Royal Sound, Kerguelen subregion, Subantarctic (Prudhoe 1969).

Bothriocephalus antarcticus Wojciechowska *et al.*, 1995

(see: description Wojciechowska *et al.* 1995, fig. 3)

Host: *Champscephalus gunnari* Loennberg, 1905 and *Channichthys rhinoceratus* Richardson, 1844.

Habitat: Anterior half of the small intestine.

Locality: The Heard Island, Kerguelen subregion, Subantarctic (Wojciechowska *et al.* 1995).

Holotype: MZPW 1621; paratypes: MZPW 1622–1623.

Family Echinophallidae Schumacher, 1914

Genus *Parabothriocephalus* Yamaguti, 1934

Parabothriocephalus johnstoni Prudhoe, 1969

(see: description Prudhoe 1969, figs 4–5; Rocka and Zdzitowiecki 1998, fig. 5)

Host: *Macrourus whitsoni* Regan, 1913.

Habitat: The small intestine.

Locality: Indian sector of the Antarctic Ocean (Prudhoe 1969) and the eastern part of the Weddell Sea, 70–74°S, 8–22°W (Rocka and Zdzitowiecki 1998). Voucher specimens from the Weddell Sea: BMNH 1997.11.13.3–4.

Key to the Families, Genera and Species of the Order Pseudophyllidea parasitizing Antarctic bony fishes

1a. Genital pore dorsal, median. Scolex elongate with apical disc; bothria shallow or deep, with non-crenulated margins, may be connected by apical groove. External segmentation present. Proglottids wider than long. Cirrus pouch thin-walled. Cirrus unarmed. Ovary median, posterior, transversely elongated, bialate or not. Uterine pore ventral, median or slightly submedian, anterior to genital pore Family Bothriocephalidae, Genus *Bothriocephalus* **2**

1b. Genital pore marginal or submarginal. Scolex with two surficial bothria but no apical disc. External segmentation almost complete. Proglottids longer than wide. Genital pores dorsosubmarginal. Cirrus pouch muscular. Cirrus armed. Ovary poral, lobed, bialate. Uterine pore midventral or slightly antiporal Family Echinophallidae, Genus *Parabothriocephalus*
Strobila 255 mm long. Scolex 1.75–2.06×0.54–1.00 mm. Testes 100–120, 0.053–0.088×0.045–0.075 mm. Cirrus pouch 0.65–1.0×0.18–0.32 mm. Cirrus up to 0.62 mm long, armed. Ovary 0.19–0.42×0.38–0.74 mm. Eggs operculate, 0.072–0.083×0.052–0.062 mm
. *Parabothriocephalus johnstoni*

2a. Strobila 110 mm long. Scolex 0.6–1.3 mm long. Testes, 0.07–0.10×0.06–0.09 mm form two lateral fields. Total, 80–100 testes in proglottid with single genital set; in proglottid with double set 100–120. There are 6–7 testes visible in transverse section, whereas 4–5 in sagittal section (and 6–7 in proglottid with double set). Cirrus pouch 0.11–0.13×0.05–0.06 mm in sagittal section; its length/width ratio is 2:1. Ovary 0.08–0.17×0.33–0.46 mm. Eggs, 0.06–0.07×0.04–0.05 mm, operculate *Bothriocephalus antarcticus*

2b. Strobila 10–82 mm long. Scolex 0.3–0.9 mm×0.4–0.6 mm. Testes 25–30, up to 0.12 mm in diameter; 4–5 testes visible in transverse section. Cirrus pouch 0.25×0.057 mm; its length/width ratio is 4:1. Ovary 0.4×0.3 mm. Eggs 0.057–0.065×0.037–0.042 mm
. *Bothriocephalus kerguelensis*

Tetraphyllidean cercoids

Chervy (2002) suggests for tetraphyllidean larvae two terms: “plerocercoid” and “merocercoid”. In present studies tetraphyllidean larvae occurred in the lumen of the small intestine and were attached to the mucosa by evaginated scolex. During the isolation and preservation, scolices of many cercoids (of all morphological forms), submitted the invagination. In such case, it is difficult to decide which term could be used. It seems, that most safety is using one of historical universal names “cercoid” or “metacestode”. The present author prefers the term “cercoid”.

Five morphological forms of cercoids were recognized. There were cercoids with: monolocular acetabula and accessory suckers, acetabula divided into two and three loculi lacking accessory suckers, acetabula undivided with accessory suckers and hook-like projections, acetabula subcylindrical. Cercoids were found in various parts of the small intestine, very were rare in the stomach.

Cercoid with monocular acetabula

(see: description Wojciechowska 1993, fig. 1)

Cercoid with apical sucker and four sessile acetabula, not attached to *pars bothridialis* along their entire lengths, but with free posterior ends. Acetabula are monocular, each with an accessory sucker at the anterior end. Acetabular surface of most larvae is folded.

Host: Nototheniidae: *Notothenia coriiceps*, *N. rossii*, *Nototheniops nudifrons*, *Trematomus newnesi*, *Lepidonotothen squamifrons*, *Dissostichus eleginoides*, *Pagothenia bernacchii*; Channichthyidae: *Champscephalus gunnari*, *Chionodraco rastrospinosus*, *Pseudochaenichthys georgianus*, *Chaenocephalus aceratus*, *Channichthys rhinoceratus*, *Patagonotothen brevicauda guntheri*; Myctophidae: *Electrona antarctica*, *E. carlsbergi*, *Gymnoscopelus nicholsi*, *Protomyctophum bolini*; Harpagiferidae: *Harpagifer antarcticus*; Gemphyliidae: *Paradiplospinus antarcticus*

Distribution: The South Shetland Islands area – Admiralty Bay, shelves and mesopelagic zone at the South Shetlands and Joinville Island; shelves around South Georgia and at Shag Rocks, the Antarctic convergence line northward of the South Shetlands and westward South Georgia (Wojciechowska 1993a, b; Zdzitowiecki and Zadróźny 1999), off the Heard Island (Wojciechowska *et al.* 1995), McMurdo Sound (Moser and Cowen 1991).

Cercoid with bilocular acetabula

(see: description Wojciechowska 1993, fig. 2; Wojciechowska *et al.* 1994, fig. 1a; Rocka 1999, fig. 1a)

Cercoid with apical sucker and four sessile acetabula which may be attached to *pars bothridialis* along their entire lengths or have free posterior ends. Acetabula bilocular, without accessory suckers. Posterior loculi larger than the anterior one.

Host: Many species from families: Nototheniidae, Artedidraconidae, Bathydraconidae, Macrouridae, Channichthyidae, Myctophidae and Muraenolepididae.

Distribution: The South Shetland Islands area – Admiralty Bay, shelves at the South Shetlands, King George Island and Joinville Island; shelves around South Georgia and at Shag Rocks, and Cumberland Bay (Szidat and Graefe 1968, Parukhin and Sysa 1975, Zdzitowiecki 1978, Rodjuk 1985, Reimer 1987, Wojciechowska 1993a, b; Palm *et al.* 1998), the Ross Sea (Leiper and Atkinson 1914, 1915; Wojciechowska *et al.* 1994), off Adelie Land (Prudhoe 1969, Zdzitowiecki *et al.* 1998, Zdzitowiecki 2001b), coastal waters at the South Orkneys (Zdzitowiecki *et al.* 1997), coastal waters at the Davis Sea (Rocka *unpubl.*), the eastern part of the Weddell Sea – off Kap Norvegia and north of Halley Bay (Rocka 1999), off the Heard Island (Wojciechowska *et al.* 1995) and off Kerguelen Islands (Prudhoe 1969).

Cercoid with trilocular acetabula

(see: description Wojciechowska 1993, fig. 3a; Wojciechowska *et al.* 1994, fig. 3b; Rocka 1999, fig. 1c)

Cercoid with apical sucker and four sessile acetabula, attached to *pars bothridialis* along their lengths. Acetabula are divided into three loculi (anterior is the smallest, middle – the largest) and lacking accessory suckers.

Host: Nototheniidae: *Notothenia coriiceps*, *N. rossii*, *Nototheniops nudifrons*, *N. nybelini*, *Gobionotothen gibberifrons*, *Trematomus newnesi*, *T. eulepidotus*, *T. lepidorhinus*, *T. loennbergi*, *T. scotti*, *Dissostichus eleginoides*, *D. mawsoni*, *Pagothenia bernacchii*, *P. hansonii*, *P. brachysoma*, *Pleurogramma antarcticum*, Channichthyidae: *Champscephalus gunnari*, *Chionodraco rastrospinosus*, *C. hamatus*, *C. myersi*, *Dacodraco hunteri*, *Pagetopsis maculatus*, *Pseudochaenichthys georgianus*, *Chaenocephalus aceratus*, *Cryodraco antarcticus*, *Neopagetopsis ionah*, *Chaenodraco wilsoni*; Bathydraconidae: *Bathydraco marri*, *Gerlachea australis*, *Prionodraco evansii*, *Racovitzia glacialis*, *Gymnodraco acuticeps*, *Parachaenichthys charcoti*, *Psilodraco* sp.; Myctophidae: *Gymnoscopelus nicholsi*; Artedidraconidae: *Pogonophryne scotti*, *P. permitini*; Harpagiferidae: *Harpagifer antarcticus*

Distribution: The South Shetland Islands area – Admiralty Bay, shelves at the South Shetlands, King George Island and Joinville Island (Rodjuk 1985, Reimer 1987, Wojciechowska 1993a, b; Palm *et al.* 1998, Zdzitowiecki and Zadróźny 1999, Zdzitowiecki 2001a), the Ross Sea – Terra Nova Bay (Wojciechowska *et al.* 1994), the eastern part of the Weddell Sea – off Kap Norwegia and north of Halley Bay (Rocka 1999), off Adelie Land (Zdzitowiecki *et al.* 1998, Zdzitowiecki 2001b), coastal waters at the South Orkneys (Zdzitowiecki *et al.* 1997).

Cercoid with undivided acetabula and hook-like projections

(see: description Wojciechowska 1993, fig. 3 b–c)

Cercoid with four leaf-like acetabula with anterior parts attached to *pars bothridialis*. Each acetabulum has an accessory sucker and a pair of hook-like projections.

Host: *Champscephalus gunnari*.

Distribution: Shelf at Shag Rocks (Wojciechowska 1993a, b), off the Heard Island (Wojciechowska *et al.* 1995).

Cercoid with subcylindrical acetabula

(see: description Wojciechowska *et al.* 1994, fig. 1c; Rocka 1999, fig. 1b)

Cercoid with apical sucker and four sessile acetabula, subcylindrical in external shape with free posterior ends. Each acetabulum has a shallow cavity on its anterior end surrounded by a sucker-like structure.

Host: *Trematomus centronotus* Regan, 1914, *Cryodraco antarcticus* Dollo, 1900, *Pogonophryne scotti* Regan, 1914.

Distribution: The Ross Sea – Terra Nova Bay (Wojciechowska *et al.* 1994), the eastern part of the Weddell Sea – off Kap Norwegia and north of Halley Bay (Rocka 1999).

Identification of cercoids with adult cestodes

Comparison of morphology of scolices of cercoids and adult cestodes from the same areas is the basis of identifying larvae with adult forms. Frequency of each form of cercoid and adult parasites is also taken into consideration.

Cercoids with monolocular acetabula are regarded as representatives of the family Phyllobothriidae, mainly genus *Phyllobothrium* (Skryabin 1970, 1972; Reimer 1975, 1977; Stunkard 1977, Avdeeva and Avdeev 1980, Avdeeva 1989). Ruhnke (1994) resurrected *Anthocephalum* Linton, 1890 as a valid genus which is very similar to the genus *Phyllobothrium* and all Antarctic *Phyllobothrium* spp. occurring in skates were transferred to *Anthocephalum* and mentioned cercoids probably belong to *Anthocephalum* spp.

Cercoids with bilocular acetabula are recognized as the juvenile forms of the family Phyllobothriidae (Prudhoe 1969, Holloway and Spence 1980, Reimer 1987, Skryabin and Yurakhno 1987) or the Oncobothriidae (Avdeeva 1989). These forms are the most common and massively occurring cercoids found in Antarctic bony fishes. Apart from *Anthocephalum* spp., the only common parasites of Antarctic skates are representatives of the genus *Pseudanthobothrium* and *Noto-megarhynchus* (Wojciechowska 1990b, Ivanov and Campbell 2002). It seems possible that these cercoids are their juvenile forms. It may be that a part of them could belong to the genus *Anthobothrium*, very similar to the previous one.

Cercoids with trilocular acetabula are recognized as larvae of the family Oncobothriidae (Reimer 1975, 1977, 1987; Avdeeva 1989). Only one species of this family, *Oncobothrium antarcticum* Wojciechowska, 1990, has been described in the Antarctic and possibly cercoids mentioned belong to this species.

According to Stunkard (1977) cercoids with undivided acetabula and hook-like projections belong to the genus *Dinobothrium* (Phyllobothriidae) or *Thysanocephalum* (Oncobothriidae). The author is of the opinion that this cercoid could not be juvenile forms of *Thysanocephalum* because cestodes of this genus have bilocular acetabula and a pair of hooks instead of projections. It is possible that these cercoids belong to *Dinobothrium septaria* van Beneden, 1889, parasite of the shark, *Lamna nasus*, occurring near South Georgia and in the Kerguelen subregion.

According to Reimer (1975) cercoids with subcylindrical acetabula are determined as *Marsupiobothrium* sp. Two species of this genus have been described in the Antarctic.

Plerocercoids of Diphyllbothriidae and larvae of Tetrabothriidae

Plerocercoids of Diphyllbothriidae, in the adult stage parasites of seals and birds, are very common in the Antarctic bony fishes (Leiper and Atkinson 1914, 1915; Gusev 1958, 1960; Szidat 1965, Prudhoe 1969, Parukhin and Sysa 1975, Zdzitowiecki 1978, 2001a, b; Holloway and Spence 1980, Parukhin and Lyadov 1981, 1982; Lyadov 1985, Rodjuk 1985, O'Neill *et al.* 1988, Parukhin 1989, Gaevskaya *et al.* 1990, Moser and Cowen 1991, Palm 1992, Palm *et al.* 1998, Zdzitowiecki *et al.* 1998). In present studies undetermined plerocercoids were very numerous in obligatory or facultative predators; pelagic and benthopelagic

fishes feeding crill, were infected rarely. Plerocercoids were located mainly in the wall of stomach and the mesentery, rare in the liver and the lumen of stomach and small intestine of hosts.

Also, cestode larvae with apical sucker and lacking acetabula were found in the small intestine of adult specimens of *Champscephalus gunnari* and larvae of *Pagothenia hansonii*, *C. gunnari* and *Harpagifer georgianus* from Cumberland Bay, (Wojciechowska 1993a, fig. 3 c–d; Wojciechowska 1993b). Hoberg (1987) described similar larvae as belonging to cestodes from the family Tetrabothriidae, common parasites of the Antarctic marine birds and mammals.

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