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Metacestodes of the family Dilepididae (Cestoda: Cyclophyllidea) parasitising fishes in Mexico

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Abstract

A survey of metacestodes of dilepidid tapeworms (Cyclophyllidea) occurring in fish from Mexico is presented. They belong to the following species (those first reported from Mexico marked with an asterisk): *Cyclustera capito* (Rudolphi, 1819); **Cyclustera* cf. *ralli* (Underwood & Dronen, 1986); *Dendrouterina pilherodiae* Mahon, 1956; **Glossocercus auritus* (Rudolphi, 1819); **G. caribaensis* (Rysavy & Macko, 1973); **Paradilepis caballeroi* Rysavy & Macko, 1973; **Paradilepis* cf. *urceus* (Wedl, 1855); **Paradilepis* sp.; *Parvitaenia cochlearii* Coil, 1955; **Parvitaenia macropeos* (Wedl, 1855); **Valipora campylancristrota* (Wedl, 1855); **V. mutabilis* Linton, 1927; and **V. minuta* (Coil, 1950). Metacestodes of *Dendrouterina papillifera* (Fuhrmann, 1908), previously reported from the gall-bladder of the pimelodid catfish *Rhamdia guatemalensis* from Mexico by Scholz et al. (1996), belong actually to *V. minuta*. Data on the morphology of metacestodes, their fish hosts and rate of infection, site and distribution in Mexico are provided.

Introduction

A peculiar larval stage (metacestode) of dilepidid cestodes (Cyclophyllidea), named "plerocercus" by Jarecka (1975), occurs in freshwater fish serving as second intermediate or paratenic hosts (Jarecka, 1970a,b; Bona, 1994). Despite a common occurrence of adults in fish-eating birds (Bona, 1975, 1994; Ryzhikov et al., 1985), metacestodes from fish are reported infrequently, probably because of their small size and site of location, such as the gall-bladder, mesenteries or intestine. Whereas there are several reports of metacestodes of dilepidids from freshwater fish in Europe (see Chubb, 1982, for review), almost no data are available on their occurrence in other continents, including North and South America (Hoffman, 1999; Rego et al., 1999).

In Mexico, the only information about the occurrence of dilepidid metacestodes in fish represent records of *Valipora minuta* (Coil, 1950), formerly misidentified as *Dendrouterina papillifera* (Fuhrmann, 1908) by Scholz et al. (1996), and of *D. pilherodiae* Mahon, 1956, from the gall-bladder of the pimelodid catfish *Rhamdia guatemalensis* (Günther) from cenotes (sinkholes) of the Yucatan Peninsula (Scholz et al., 1996). During recent investigations in Mexico, metacestodes of several other species of the Dilepididae, not previously reported, have been found in fish.

Materials and methods

The material was collected mainly in central and southeastern parts of Mexico (see survey of species for

localities). Metacestodes found were fixed either with 4% formaldehyde solution or as for monogeneans, after flattening under a coverslip with GAP (1 part of glycerine: 3 parts of ammonium picrate or picric acid) in order to better observe the rostellar hooks, and then mounted into Canada balsam (Ergens, 1969). Measurements are in micrometres (μm) unless otherwise stated. If available, data on the number of fish infected and intensity of infection are provided.

The specimens are deposited in the National Helminthological Collection, Instituto de Biología, Universidad Nacional Autónoma de México, Mexico City (CNHE); US National Parasite Collection (USNPC), Beltsville, Maryland, USA; the Institute of Parasitology, Academy of Sciences of the Czech Republic, České Budějovice (IPCAS); the helminthological collection of CINVESTAV-IPN Mérida, Mexico (CHME); and the Natural History Museum, London, UK (BMNH).

The type-specimens (holotype and four paratypes) of *Glossocercus caribaensis* (Ryšavý & Macko, 1973) from the helminthological collection of the Parasitological Institute of the Slovak Academy of Sciences, Košice, Slovakia (Nos 9673a,b,c,e), one paratype and vouchers of *Glossocercus cyprinodontis* Chandler, 1935 from the USNPC (Nos 39528, 80403 and 80404), and one paratype of *Cyclustera ralli* (Underwood & Dronen, 1986) (USNPC 78464) were examined for comparison with the present material.

Synonymies of dilepidid cestodes proposed by Baer & Bona (1960) and Bona (1975, 1994) were followed; species first reported from Mexico are marked with an asterisk. The nomenclature of fish and birds follows those of Eschmeyer (1998) and del Hoyo et al. (1992), respectively.

Cyclustera capito (Rudolphi, 1819) Fuhrmann, 1901 (Figure 1K,L)

Description

(Based on 1 specimen from *Floridichthys polyommus* Hubbs). Metacestodes divided to 2 parts; anterior part with scolex, tapering posteriorly, 4.06 mm long; posterior part (bladder) 2.23 × 1.52 mm. Scolex almost spherical, 1.40 × 1.34 mm, with conical rostellum, 528 × 464, and 4 spherical suckers, 316-328 × 256-264. Rostellum bearing 2 circles of 28 massive hooks, 14 in each circle. Distal hooks (Figure 1L) 221-234; blade 112-122; handle 118-125; blade/handle ratio 0.94-0.97; proximal hooks (Figure 1K) 173-182; blade 90-93; handle 99-105; blade/handle ratio 0.85-0.93. Hooks with well-developed striation, in particular on guard and base of handle.

Host and locality: *Floridichthys polyommus* Hubbs (Cyprinodontidae) – State of Yucatán: Chelém Lagoon – Chuburná (15 fish infected of 20 examined; intensity 1-10 specimens [mean intensity 3]), Chelém Lagoon – Yucalpetén (11/19; 1-22 [6]).

Site: Mesenteries.

Specimens deposited: IPCAS C-279.

Comments

The metacestodes belong to *Cyclustera capito*, which was redescribed by Coil (1955a) and Bona (1975). The present finding represents the first record of metacestodes of this tapeworm from fish.

Cyclustera capito was originally described from Brazil and then found in fish-eating birds in Egypt (?), the former USSR, Cuba and southeastern USA (Florida) (Rysavy & Macko, 1973; Bona, 1975; Sepúlveda et al., 1994). It was first reported from Mexico by Coil (1955a), who found adult cestodes in the roseate spoonbill *Platalea ajaja* Linnaeus from Tututepec, Oaxaca, and reported the hooks to measure 213-250 (distal) and 147-169 (proximal).

**Cyclustera* cf. *ralli* (Underwood & Dronen, 1986) Bona, 1994 (Figure 1G-J)

Description

(Body measurements based on 4 specimens from *Alloophorus robustus*; hook measurements on 7 specimens from *Girardinichthys multiradiatus* (Meek)). Metacestodes oval, 740-995 × 576-914, with scolex invaginated; if scolex is everted, anterior part with scolex up to 1,400 long and 280 wide. Scolex with triangular rostellum, 176-234 × 173-176, and 4 spherical to oval suckers, 93-115 × 80-109. Rostellum armed with 20 massive hooks, rather similar in size and shape, with epiphyseal thickenings (see *Discussion*) on base of handle and distal end of guard, and striation on base of handle and guard (Figure 1G-J). Distal hooks 125-141, with guard directed slightly posteriorly; blade 75-83; handle 59-66; blade/handle ratio 1.20-1.35. Proximal hooks 111-123, with large, perpendicularly directed guard, wider (26-27) than high; blade 63-70; handle 57-66; blade/handle ratio 1.09-1.24.

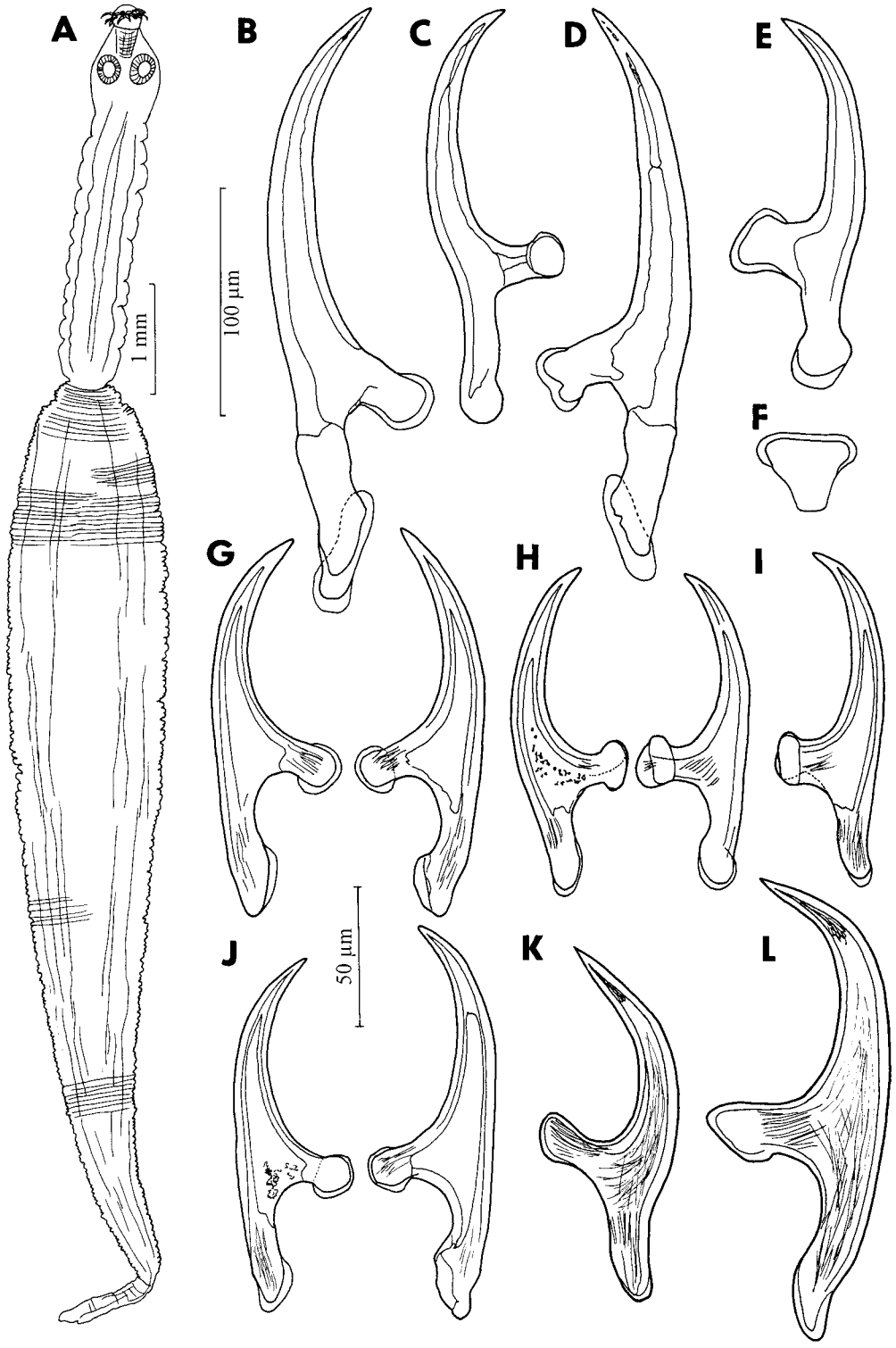

Figure 1. *Glossocercus auritus* (Rudolphi, 1819) – metacestodes from the mesenteries of *Poeciliopsis gracilis* (A,E) and *Poecilia catemaconis* (B–D,F); *Cyclustera* cf. *ralli* (Underwood & Dronen, 1986) – metacestodes from the mesenteries of *Cyprinus carpio* (G,H) and *Girardinichthys multiradiatus* (I,J); *Cyclustera capito* (Rudolphi, 1819) – metacestodes from the mesenteries of *Floridichthys polyommus* (K,L). A, total view; B,D,G,J,L, distal hooks; C,E,H,I,K, proximal hooks; F, guard of proximal hook, upper view.

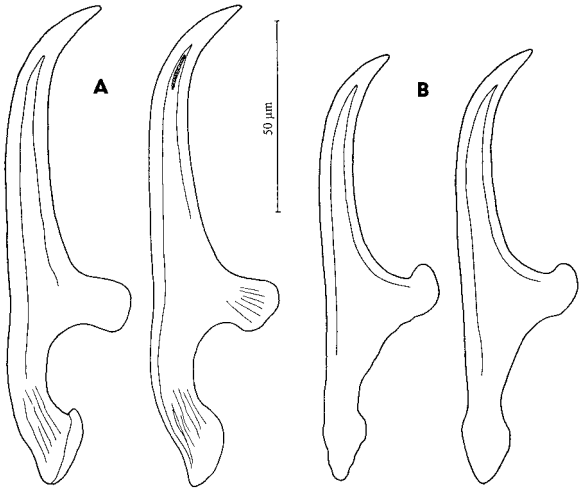

Figure 2. Cyclustera ralli (Underwood & Dronen, 1986) – hooks of the paratype (USNPC 78464) from *Rallus longirostris*, Galveston Bay, Texas. A, distal hooks; B, proximal hooks.

Hosts and localities: *Cyprinus carpio* Linnaeus – State of México: Presa Ignacio Ramírez (1/42; 1); *Notropis sallei* (Günther) (both Cyprinidae) – Guanajuato: Presa Ignacio Allende (1/15; 1); *Alloophorus robustus* (Bean) – Michoacán: Lago de Pátzcuaro (2/15; 2-3); *Girardinichthys multiradiatus* – México: Lago de Chicnahuapan (Almoloya del Río) (20/211; 1-3); *Xenotoca variata* (Bean) (all Goodeidae) - Guanajuato: Presa Ignacio Allende (2/24; 1).
Site: Mesenteries.
Specimens deposited: BMNH 2000.11.8.1, CNHE 4119, IPCAS C-312; USNPC 90804-6.

Comments

The metacestodes resemble in the hook morphology the species *Cyclustera ralli*, originally described by Underwood & Dronen (1986) as *Neocyclustera ralli* from the clapper rail *Rallus longirostris* Boddaert from marshes in Texas, USA. This species, recently placed to the genus *Cyclustera* Fuhrmann, 1901 by Bona (1994), is typified by the size of the rostellar hooks (120-133 distal hooks; 101-113 proximal hooks) that differ mainly in the direction of the guard (directed posteriorly in distal hooks versus perpendicularly in proximal ones).

The examination of the paratype of *C. ralli* (USNPC 78464) has revealed some fine differences in the size and shape of the hooks from metacestodes from Mexico, which have slightly larger hooks, with a more curved blade, especially in the case of the proximal hooks, than the hooks of the paratype (Figure 2). The distal hooks of the paratype are 125-126 long (blade 74-75; handle 56; blade/handle ratio 1.32-1.33); the proximal ones are 112-113 long (blade 55-57; handle 60-61; blade/handle ratio 0.90-0.94). However, the hooks of the paratype (and also of the holotype – P. Pilitt and E.P. Hoberg, personal communication) are very difficult to observe and measure, and the above-mentioned differences might be related at least partly to the unsuitable condition of the type-material of *C. ralli*. The species identification of the metacestodes from Mexico is, therefore, only tentative until adults are available for comparison with adults of *C. ralli.*

The present finding is the first record of metacestodes of *C.* cf. *ralli* reported from Mexico. The clapper rail, the definitive host of *C. ralli*, is a member of the order Charadriiformes, but it also feeds upon small fish that serve as second intermediate hosts of this cestode. In Mexico, the metacestodes were found in five species of small cyprinid and goodeid fish, some of them being endemic to central Mexico (Espinosa-Pérez et al., 1993).

***Dendrouterina pilherodiae* Mahon, 1956**
(Figure 3A,D)

Description

Scholz et al. (1996, p. 145, figure 4B,C) provided a description and illustrations of the metacestode that is typified mainly by the morphology of the hooks and the fact that there are only a few differences in the shape and size between the proximal and distal hooks, unlike the situation in other *Dendrouterina* species (see Bona, 1975, plate 1). According to Scholz et al. (1996), the larval hooks measure 48-49 (distal) and 40-45 (proximal).
Host and locality: *Rhamdia guatemalensis* (Pimelodidae) – Yucatán: Ixin-há cenote (1/131; 1).
Site: Gall-bladder.
Reference: Scholz et al. (1996).
Specimens deposited: IPCAS C-241.

Comments

The adult of *D. pilherodiae* was described from *Nycticorax pileatus* [= *Pilherodius pileatus* (Boddaert)] from Brazil (Mahon, 1956) and its type was redescribed by Bona (1975). Bona (1983) found, in northern Argentina, specimens anatomically very similar to the type of Mahon (1956), with the hooks of identical shape but much larger. Given the difficulty

of stating whether they belong to a different species or represent a case of very wide intraspecific variation, a subspecies, *D. pilherodiae meridionalis*, was proposed for the Argentinian material (Bona, 1983). The hook size of *D. pilherodiae* can be summarised as follows (see Bona, 1983, p. 445): the holotype 43.5 and 38; *D. pilherodiae meridionalis* 52-56 and 45-49; metacestodes from Mexico 48-49 and 40-45. The hooks of metacestodes lie in between and enable us to assume that all this material belongs to the same species, notwithstanding its great variability.

**Glossocercus auritus* (Rudolphi, 1819) Bona, 1994 (Figure 1A-F)

Description

(Based on 15 specimens from *Poecilia sphenops* Valenciennes in Cuvier & Valenciennes and *Poeciliopsis gracilis* (Heckel)). Metacestodes very large, with body divided into 2 parts; anterior part with elongate and slender scolex, 3.37-4.47 × 0.56-0.73 mm; posterior part (bladder) larger and wider, tapering posteriorly, 8.02-11.30 × 0.85-1.48 mm. Scolex usually invaginated, 592-1,060 × 560-731, with 4 spherical sucker, 179-234 × 160-192, and muscular, spherical to oval rostellum, 234-250 × 224-253. Rostellum bearing 2 circles of 20 massive hooks, 10 in each circle, with well-developed amorphous part (epiphyseal thickenings) on handle and guard (Figure 1B-F). Distal hooks 242-267; blade 141-165; handle 102-114; blade/handle ratio 1.56-1.89; proximal hooks 189-202; blade 93-115; handle 83-96; blade/handle ratio 1.10-1.39.
Hosts and localities: *Poecilia catemaconis* Miller – Veracruz: Lago de Catemaco (1/23; 1); *P. mexicana* Steindachner – Hidalgo: Calabozo (1/9; 1); *P. sphenops* Val. in Cuv. & Val. – Guerrero: Presa Tepecoacuilco (1/6; 1), Santiago Xochihuehuetlán (3/16; 2); Oaxaca: Río Huajuapan (2/15; 1); *Poecilia* sp. – Veracruz: Laguna Escondida (Los Tuxtlas) (2/2; 1); *Poeciliopsis gracilis* Heckel (all Poeciliidae) – Guerrero: Presa Tepecoacuilco (9/16; 1-3).
Site: Liver, mesenteries, intestinal wall.
Specimens deposited: CNHE 4120, 4121, IPCAS C-281; USNPC 88229, 90350.

Comments

In the shape and size of the rostellar hooks these metacestodes correspond to *Parvitaenia aurita* (Rudolphi, 1819) redescribed by Bona (1975) and transferred recently (Bona, 1994) to the genus *Glossocercus* Chandler, 1935. Bona (1975), who reviewed all known material, found a great variation in the size and shape of the hooks and reported the length of the distal ones to be 242-264 and that of the proximal hooks 180-215. Rysavy & Macko (1973) reported slightly shorter hooks: 232 and 176, respectively (see remarks in Bona, 1975, p. 251).

Adults of *G. auritus* have been found in *Egretta caerulea* (Linnaeus) from Brazil and Nicaragua and in *E. tricolor* (P.L.S. Müller) from Cuba (Schmidt & Neiland, 1971; Rysavy & Macko, 1973; Bona, 1975). The described metacestode represents the first record of the larval stage of *G. auritus*.

**Glossocercus caribaensis* (Rysavy & Macko, 1973) Bona, 1994 (Figure 4)

Description

(Based on 22 specimens from *Fundulus persimilis* Miller and 2 specimens from *Cichlasoma urophthalmus* (Günther); measurements of the latter in parentheses). Metacestodes with invaginated scolex, variable in shape from widely oval, 0.91-1.14 × 0.77-0.94 mm, to elongate, 1.87-3.82 (4.00) × 0.57-0.73 (0.22) mm. Scolex subspherical, 480-610 (560-720) × 408-480 (680-744); suckers 131-176 (163-170) × 106-138 (134-144); rostellum strongly muscular, 264-294 (189) × 163-262 (166-198). Rostellum armed with 20 massive hooks, forming 2 circles of 10 hooks each. Hooks with well-developed epiphyseal thickenings of handle and guard (Figure 4). Distal hooks 189-211 (190-206); blade 106-125 (118-128), slightly curved in distal part; handle almost straight, 77-88 (74-86); blade/handle ratio 1.20-1.56 (1.43-1.61); proximal hooks 134-146 (138-146); blade more curved than in distal hooks, 66-74 (76-82); handle almost straight, 62-75 (64-68); blade/handle ratio 0.97-1.22 (1.15-1.23).
Hosts and localities: *Cichlasoma urophthalmus* (Cichlidae) – Yucatán: Mitza near Progreso; *Fundulus grandissimus* Hubbs – Yucatán: Chelém Lagoon – Chuburná (13/16; 1-279 [44]), Chelém Lagoon – Yucalpetén (20/20; 1-60 [24]); *F. persimilis* (both Cyprinodontidae) – Yucatán: Chelém Lagoon – Chuburná (22/23; 2-170 [46]), Chelém Lagoon – Yucalpetén (19/20; 1-142 [35]).
Site: Mesenteries and liver.

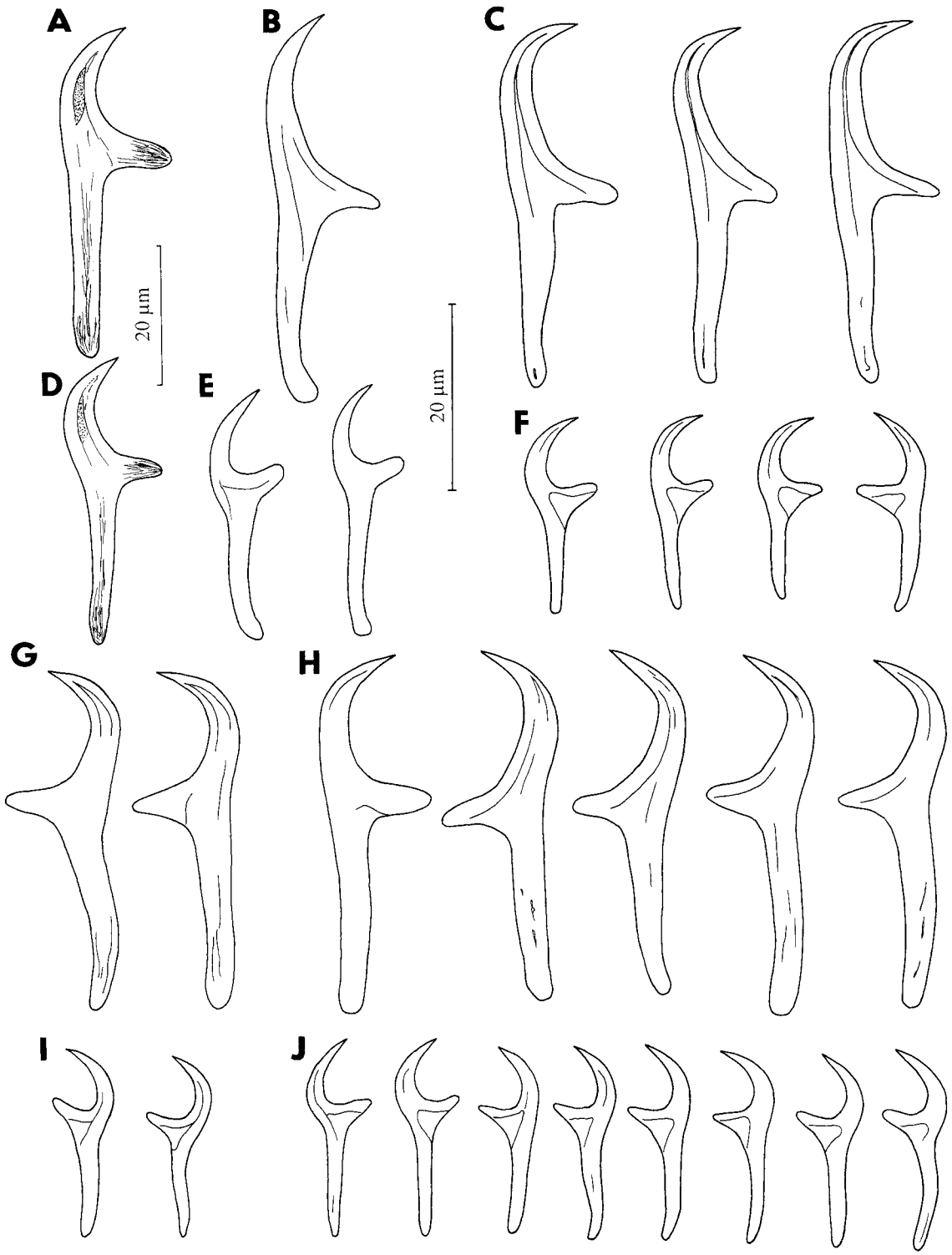

Figure 3. Dendrouterina pilherodiae Mahon, 1956 – metacestodes from the gall-bladder of *Rhamdia guatemalensis* (A,D); *D. papillifera* (Fuhrmann, 1908) – adults from the intestine of *Egretta thula* from Lago de Pátzcuaro, Michoacán, identified as *D. botauri* Rausch, 1948 – see Lamothe-Argumedo et al. (1997) (CNHE 1314) (B,E); *Valipora minuta* (Coil, 1950) – metacestodes from the gall-bladder of *R. guatemalensis*, previously misidentified as *D. papillifera* by Scholz et al. (1996) (C,F); from the gall-bladder of *Poeciliopsis gracilis* (G,I); and from the liver of *Poecilia sphenops* (H,J).

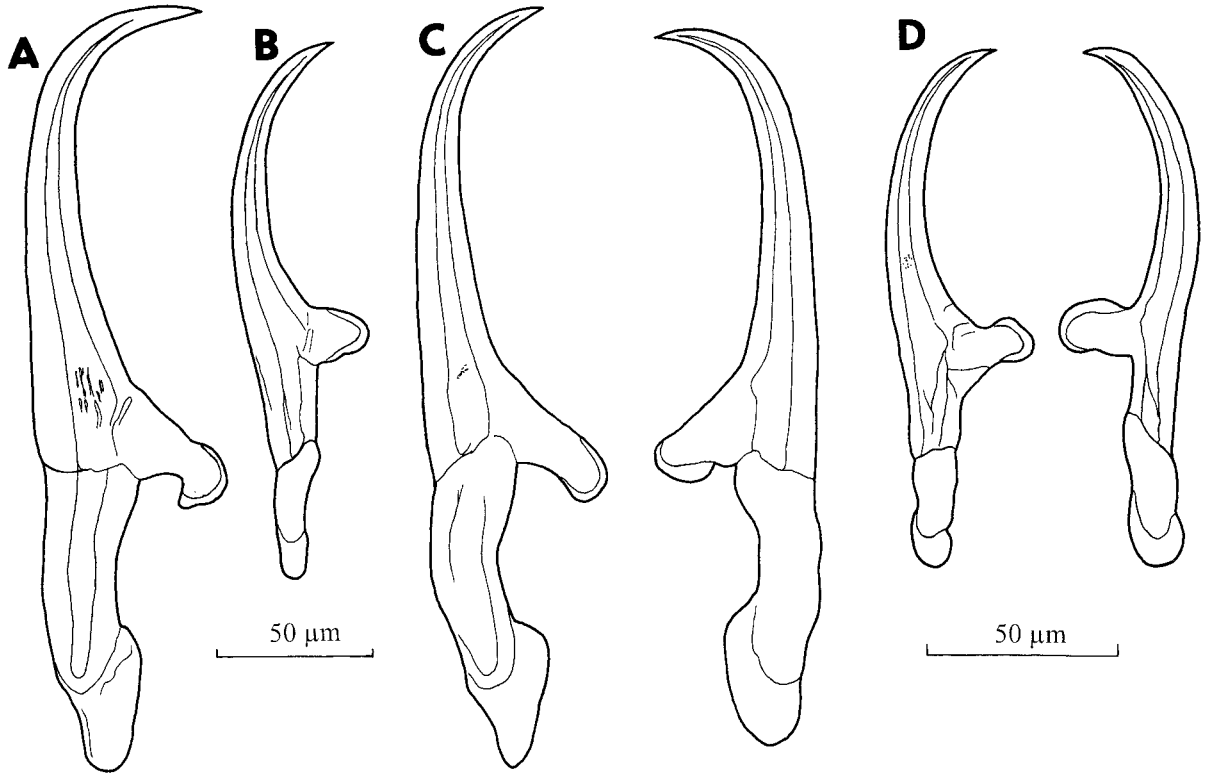

Figure 4. Glossocercus caribaensis (Rysavy & Macko, 1973) – rostellar hooks of metacestodes from the mesenteries of *Cichlasoma urophthalmus* (A,B) and *Fundulus persimilis* (C,D). A,C, distal hooks; B,D, proximal hooks.

Specimens deposited: CHME 378; CNHE 4122-3; IPCAS C-282; USNPC 90351.

Comments

Metacestodes found in *C. urophthalmus* and *F. persimilis* are very similar in their morphology and are considered conspecific. They correspond to *Parvitaenia caribaensis* Ryšavý & Macko, 1973 (syn. *P. heardi* Schmidt & Courtney, 1973), now transferred to *Glossocercus* by Bona (1994). This species was described from *Ardea herodias* Linnaeus in Cuba and occurs occasionally in Pelecaniformes that are probably not suitable hosts (see Bona, 1975, p. 658, note 3). Adults of *G. caribaensis* from Cuba possess distal hooks 215 long and proximal hooks of 143-151 (Ryšavý & Macko, 1973), which correspond to Schmidt & Courtney's (1973) data, namely 200-210 and 140-150, respectively.

The specimens from Yucatán represent the first record of metacestodes of *G. caribaensis* and a new geographical record for the parasite. However, one metacestode of *G. caribaensis* was found among voucher specimens of the species *G. cyprinodontis* Chandler, 1935 collected by Chandler (1935) in the mesenteries of *Fundulus heteroclitus* (Linnaeus) from Galveston Bay, Texas (USNPC 80404; Figure 5A-C). The hooks of this specimen measure 205 (blade/handle ratio 1.43) and 141 (1.02), respectively. *G. caribaensis* is now known to occur in Cuba, Mexico and the USA.

The only species of *Glossocercus* Chandler, 1935 previously reported as a metacestode from fish was *G. cyprinodontis*, described by Chandler (1935) from the body cavity of the cyprinodontid fish *Cyprinodon variegatus* Lacépède from Galveston Bay in Texas. This species has hooks of a similar size (183-190 and 132-135 as measured in a paratype and vouchers from the type locality – USNPC 39528 and 80403) and blade/handle ratio (1.40-1.41 and 1.00-1.03) as *G. caribaensis*, but it differs distinctly in the shape of the hooks, in particular of the blade which is much more curved in the former species than in *G. caribaensis* (Figure 5D, E).

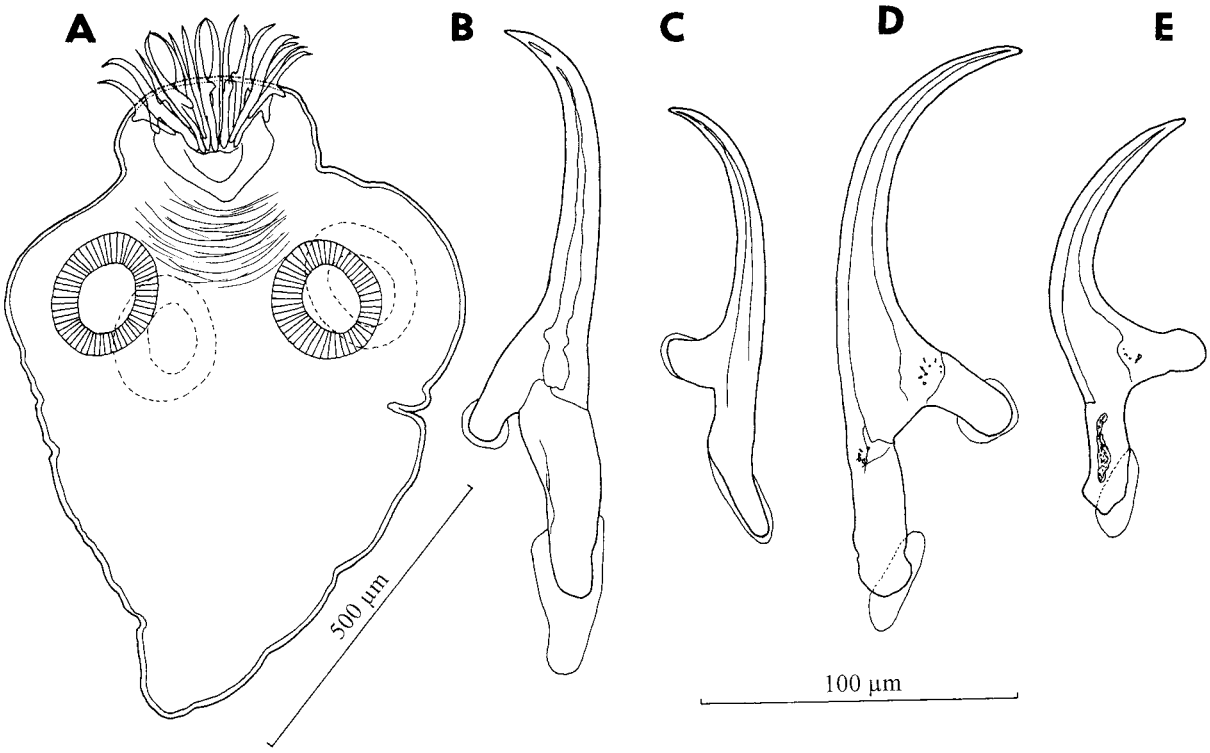

Figure 5. Glossocercus caribaensis (Rysavy & Macko, 1973) – metacestode from the mesenteries of *Fundulus heteroclitus* (A-C) (USNPC 80404); *G. cyprinodontis* Chandler, 1935 – metacestode from the mesenteries of *Cyprinodon variegatus* (USNPC 80403), both Galveston Bay, Texas. A, total view; B,D, distal hooks; C,E, proximal hooks.

***Paradilepis caballeroi* Rysavy & Macko, 1973**
(Figure 6A,B,D,E)

Description

(Based on 1 specimen from *Cichlasoma callolepis* (Regan) and 2 specimens from *Chirostoma jordani* Woolman). Metacestodes with scolex invaginated, 376-520 × 304-352. Suckers oval, 123-142 × 90-92; rostellum widely oval, 106-138 × 150-176, bearing 2 circles of 24 hooks. Distal hooks 110-121 long; blade 55-59 long; handle 53-62 long; blade/handle ratio 0.90-1.09. Proximal hooks 83-88 long; blade 39-41 long; handle 43-49 long; blade/handle ratio 0.80-0.97 (Figure 6A, D).
Hosts and localities: *Chirostoma jordani* (Atherinidae) – Guanajuato: La Biznaga (3/38; 2); *Cichlasoma callolepis* (Cichlidae) – Campeche: Silvituc (1/1; 1).
Site: Liver, mesenteries.
Specimens deposited: CNHE 4124; IPCAS C-3 13.

Comments

According to Rysavy & Macko (1973), who described this species from *Phalacrocorax auritus* (Lesson) in Cuba, the hooks are 105-112 (distal) and 79-82 μm (proximal) in the holotype and paratype. This is the first record of metacestodes of *P. caballeroi* and a new geographical record of this species, previously known only from Cuba.

In the morphology of the rostellar hooks, *P. caballeroi* is almost indistinguishable from *Paradilepis scolecina* (Rudolphi, 1819), a common parasite of cormorants widely distributed in Europe, Africa and Asia (Ryzhikov et al., 1985). The hooks of adults of *P. scolecina* measure 108-119 (distal) and 74-84 μm (proximal) (blade/handle ratio 0.94-1.09 and 0.96-1.09) (Bona, 1975); those of metacestodes 101-115 and 74-80 μm (Baccarani et al., 1998).

Rysavy & Macko (1973) differentiated both species by the number of hooks (24 in *P. caballeroi* versus 20-22 in *P. scolecina)* and the size of the scolex and rostellum, which are larger in the former species. In all three metacestodes studied, 24 hooks were

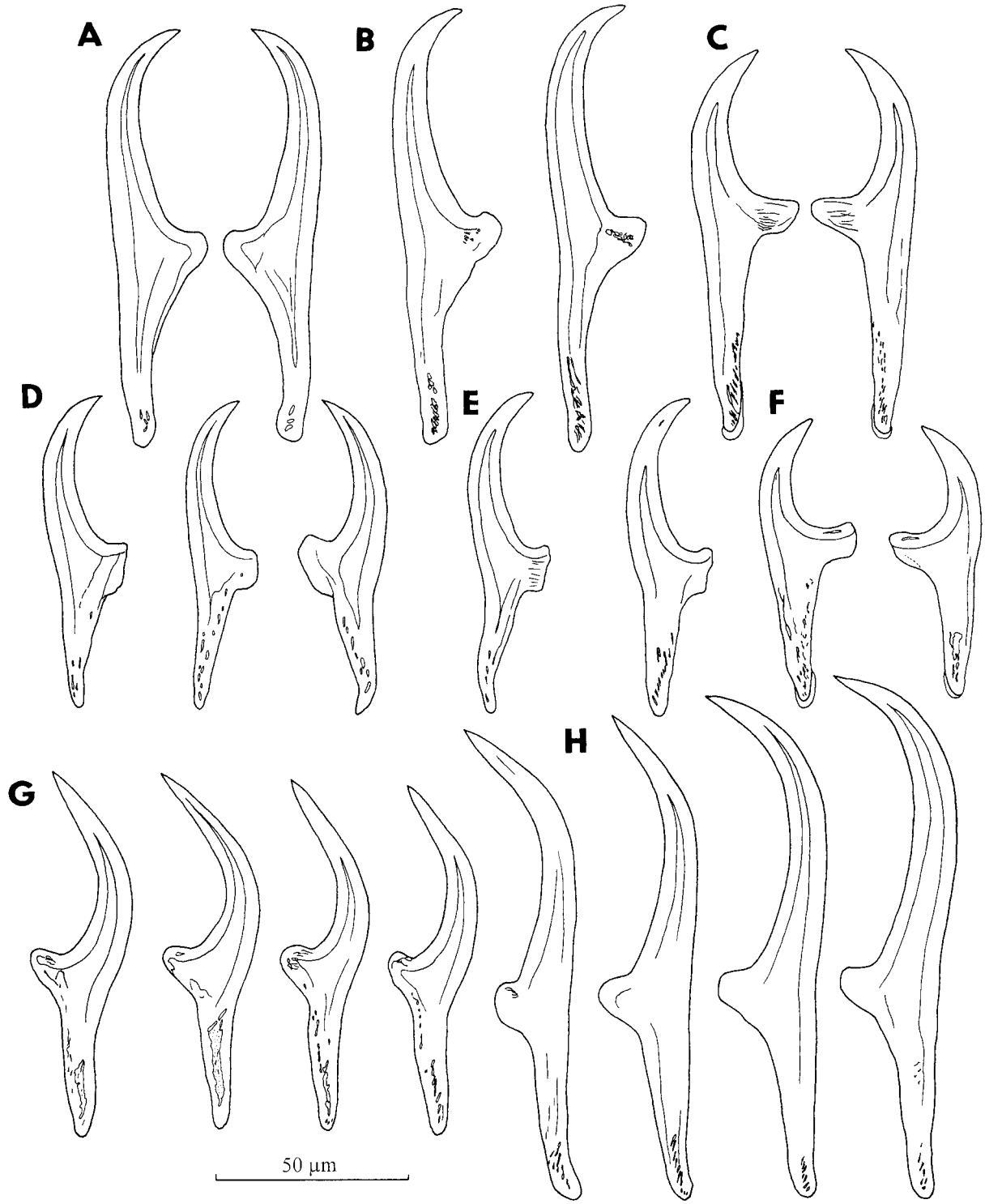

Figure 6. Paradilepis caballeroi Rysavy & Macko, 1973 – metacestodes from the intestine of *Cichlasoma callolepis* (A,D) and the liver of *Chirostoma jordani* (B,E); *?Paradilepis* sp. – metacestodes from the liver of *C. jordani* (C,F); *Paradilepis* cf. *urceus* (Wedl, 1855) – metacestodes from the liver of *C. jordani* (G,H). A-C,H, distal hooks; D-G, proximal hooks.

present, which corresponds to the species diagnosis of *P. caballeroi*.

***Paradilepis* cf. *urceus* (Wedl, 1855)** (Figure 6G,H)

Description

(Based on 6 stained, unflattened specimens from *Chirostoma jordani*). Metacestodes oval to elongate, 568-620 × 224-328, with invaginated scolex, 312-352 × 122-160. Suckers 85-99 × 65-85; oval rostellum bearing 20 rostellar hooks. Distal hooks 125-138; blade 72-83; handle 55-62; blade/handle ratio 1.06-1.33. Proximal hooks 91-96; blade slightly curved, 47-54; handle straight, with numerous dents, 46.5-50; blade/handle ratio 1.00-1.11 (Figure 6G,H).
Host and locality: *Chirostoma jordani* (Atherinidae) – Guanajuato: Presa Ignacio Allende (5/23; 4-12 [mean 8]).
Site: Liver.
Specimens deposited: BMNH 2000.11.8.5-6; CNHE 4125-6; IPCAS C-315; USNPC 90555.

Comments

The morphology and the size of the hooks most resemble those of *P. urceus* (Wedl, 1855), a parasite of Ciconiiformes (see Bona, 1975), but they differ in the shape, particularly in the blade/handle ratio of the distal hooks (length 106.5-126; blade/handle ratio 0.67; proximal hooks 73.5-93; blade/handle ratio 0.88) (Matevosyan, 1963; Bona, 1975).

****?Paradilepis* sp.** (Figure 6C,F)

Description

(Based on one specimen from *Chirostoma jordani*). Metacestode with scolex invaginated; 1,070 × 873; rostellum ovate, 176 × 163; suckers 126-129 × 70-77. Hooks massive, with short, curved blade, similar in shape. Distal hooks 101-103; blade 41-44; handle 61-63; blade/handle ratio 0.65-0.71. Proximal hooks 71-75; blade 29-31; handle 44-49; blade/handle ratio 0.60-0.68 (Figure 5C,F).
Host and locality: *Chirostoma jordani* (Atherinidae) – Guanajuato: La Biznaga (1/38; 1).
Site: Liver.
Specimens deposited: IPCAS C-314.

Comments

The only metacestode available resembles in its hook morphology members of the genus *Paradilepis* Hsü, 1935. However, it cannot be identified at the species level because the shape and size of the hooks do not correspond to any of the known species of this genus (Bona, 1975, 1994).

***Parvitaenia cochlearii* Coil, 1955** (Figure 7A-E)

Description

(Based on 18 flattened specimens from *Gobiomorus maculatus* (Günther) and 4 specimens from *Dormitator latifrons* (Richardson); measurements of the latter in parentheses). Metacestodes elongate, 780-934 (670-800) × 205-376 (336-344), divided into spherical scolex and oval posterior part, (448-560) × (336-368). Scolex 256-320 (224-237) × 282-392 (198-224); suckers 65-92 (71-85) × 58-86 (53-63); rostellum 48-88 (58-59) × 57-77 (53-67), bearing 20 hooks arranged in 2 circles. Distal hooks 49-56.5 (49-55), straight except for abruptly curved distal end of blade; blade 26.5-32.5; handle 23-26.5 long; blade/handle ratio 1.09-1.36. Proximal hooks 32.5-37 (32-36), with more curved blade and guard near mid-length of hooks; blade 16.5-19.5; handle 17-18.5; blade/handle ratio 0.96-1.36.
Hosts and localities: *Atherinella crystallina* (Jordan & Culver in Jordan) (Atherinidae) – Nayarit: Río Santiago (Aguamilpa) (1/48; 1); *Dormitator latifrons* – Jalisco: Marismas de Chalacatepec (2/2; 3), Salinas de Careyes (2/2; 2); Rio San Nicolás (5/12; 8 [3-18]); *Gobiomorus maculatus* (Eleotridae) – Jalisco: Río Cuitzmala (3/15; 31 [6-76]); *Agonostomus monticola* Bancroft in Griffith & Smith (Mugilidae) – Jalisco: Río Cuitzmala; *Poeciliopsis gracilis* (Poeciliidae) – Guerrero: Presa Tepecoacuilco.
Site: Liver.
Specimens deposited: BMNH 2000.11.8.7; CNHE 4127-8; IPCAS C-254; USNPC 90352, 90556-8.

Comments

The species was described by Coil (1955b) from *Cochlearius cochlearius* (Linnaeus) from Mexico and has not been found since. Coil (1955b) reported the rostellar hooks of adults to measure 49.5-52.5 and 33-34.5 (distal and proximal hooks, respectively), which

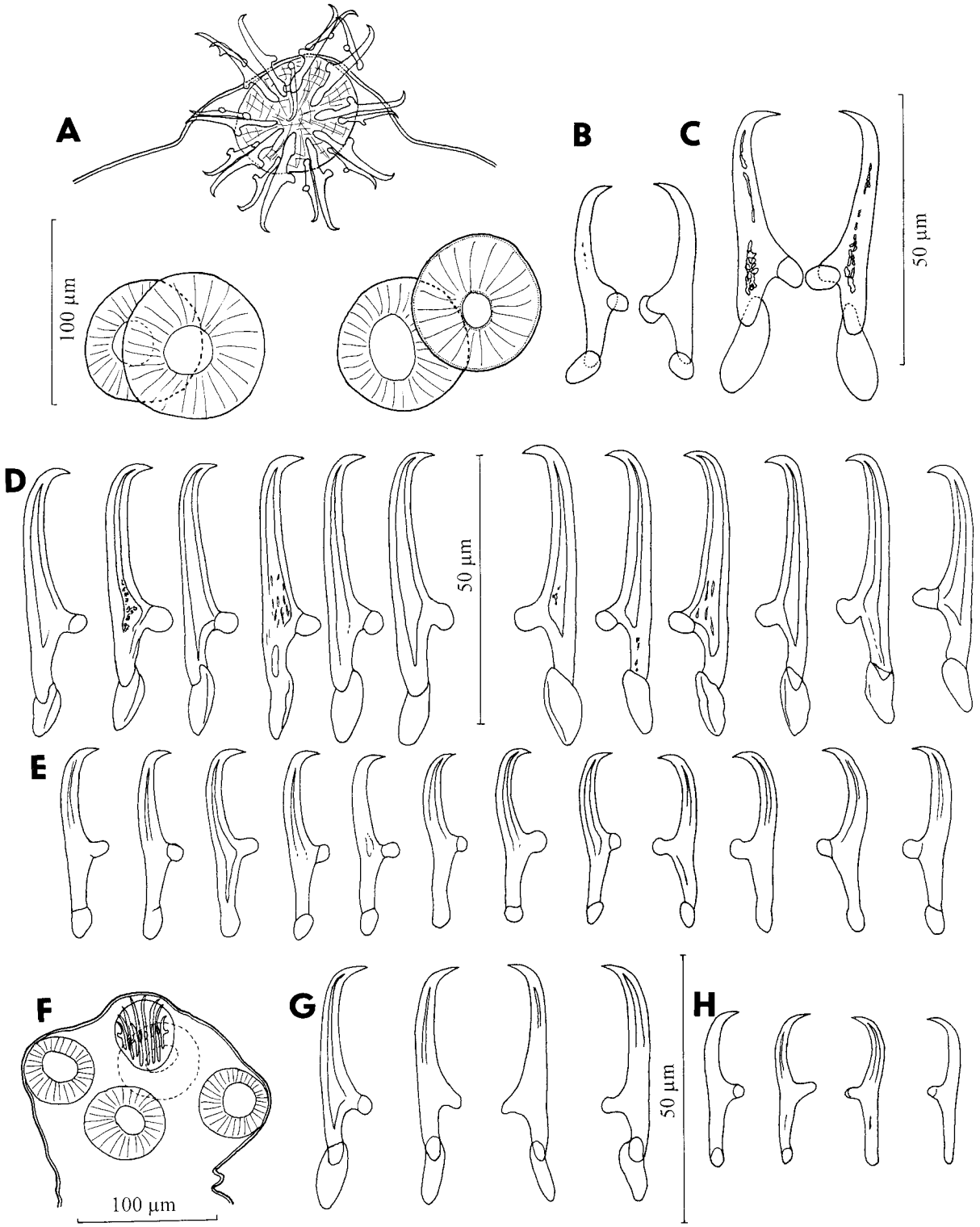

Figure 7. Parvitaenia cochlearii Coil, 1955 – metacestodes from the liver of *Gobiomorus maculatus* (A,D,E) and *Poeciliopsis gracilis* (B,C); *P. macropeos* (Wedl, 1855) – metacestodes from the intestine of *Cichlasoma istlanum* (F-H). A, rostellum; B,E,H, proximal hooks; C,D,G, distal hooks; F, scolex.

entirely corresponds to the size of the hooks of these metacestodes that are reported for the first time.

However, Bona (1975), who redescribed the type, found the hooks, especially the distal ones, to be larger than reported in Coil's description: distal 59-60 (blade 30; handle 30-32); proximal 36-37 (blade 18; handle 19-20). Larger size of the hooks in adults compared with metacestodes is apparently related to the longer handle, which represents the part of the hooks that may increase somewhat in adult worms because of post-larval growth at the handle extremity (Bona, 1975, p. 339, plate 37).

* ***Parvitaenia macropeos* (Wedl, 1855) Baer & Bona, 1960** (Figure 7F-H)

Description

(Based on 4 flattened specimens from *Cichlasoma istlanum* Jordan & Snyder). Metacestodes elongate, 432-528 × 168-184, with invaginated scolex; body proper 528 × 189. Scolex subspherical, 143-208 × 106-224; suckers 49-65 × 52-62; weekly muscular rostellum 45-59 × 43-52. Rostellum bearing 2 circles of 20 fine hooks which differ in size and position of guard. Distal hooks 43-46, straight, with blade curved at distal part; blade 24.5-26.5; handle 18.5-21.5; blade/handle ratio 1.15-1.45. Proximal hooks 26-30; blade 12-15; handle 15-17; blade/handle ratio 0.71-0.89.
Host and locality: *Cichlasoma istlanum* (Cichlidae) – Guerrero: Presa Tepecoacuilco (3/11; 1-9 [4]).
Site: Liver.
Specimens deposited: CNHE 4129; IPCAS C-283; USNPC 90558.

Comments

Metacestodes found in the intestine of *Cichlasoma istlanum* correspond well with those of *P. macropeos* (see Bona, 1975). Adults of *P. macropeos* have been found in *Nycticorax nycticorax* (L.) in Europe (Hungary, Italy), Asia (Japan, Sri Lanka, Java) and central Africa (Zambia) (see Bona, 1975, for references). This is the first record of *P. macropeos* in the American continent and of its metacestodes in fish.

* ***Valipora campylancristrota* (Wedl, 1855) Baer & Bona, 1960** (Figure 8H-Q)

Description

(Based on 13 specimens from *Girardinichthys multiradiatus, Chirostoma humboldtianum.* Valenciennes in Cuvier & Valenciennes and *C. riojai* Solórzano & López; measurements of hooks of metacestodes from different hosts are in Table 1). Metacestodes elongate, 368-568 × 160-252 when scolex is evaginated, 224-307 × 138-192 with scolex invaginated. Evaginated scolex 147-232 × 160-198; bladder (posterior part) 202-224 × 128-170; suckers 54-59 × 45-50. Rostellum bearing 2 circles of 10 hooks each, with sharply curved blade and almost straight handle. Distal hooks 23-30.5; blade with long distal end, straight or slightly curved anteriorly (concave) (Figure 8H,I,N), 9-14.5; handle 14-18.5; blade/handle ratio 0.60-0.91. Proximal hooks 12.5-16.5; blade 3.5-6; handle 9-12; blade/handle ratio 0.34-0.56.

Hosts and localities: *Chirostoma humboldtianum* Valenciennes in Cuvier & Valenciennes – State of México: Presa Villa Victoria (1/46; 2); *C. jordani* – State of México: Presa Ignacio Ramírez (1/3; 12); *C. riojai* (all Atherinidae) – State of México: Presa Ignacio Ramírez (2/20; 2), *Girardinichthys multiradiatus* (Goodeidae) – State of México: La Lagunilla ciénaga (2/50; 1), Presa Ignacio Ramírez (7/15; 13); Presa Trinidad Fabela (1/31; 1); *Rhamdia guatemalensis* (Pimelodidae) – Yucatán: Ixin-há cenote 2/131; 1-2).
Site: Gall bladder.
Specimens deposited: BMNH 2000.11.8.8; CNHE 4130-34; IPCAS C-27; USNPC 90807-9.

Comments

Metacestodes found in the gall-bladder of several species of atherinid, goodeid and pimelodid fish were identified as *V. campylancristrota* on the basis of the size and shape of the hooks (see Bona, 1975). The metacestodes of this species have frequently been reported from freshwater fish, in particular cyprinids, in the Palearctic Region (Jarecka, 1970a; Dubinina, 1987; Priemer & Scholz, 1989; Scholz, 1989; Scholz & Ergens, 1990).

In the American continent, *V. campylancristrota* was first reported as metacestodes from the gall-bladder of the prochilodid fish *Prochilodus scrofa* Steindachner from the Paraná River in Brazil by R.M.

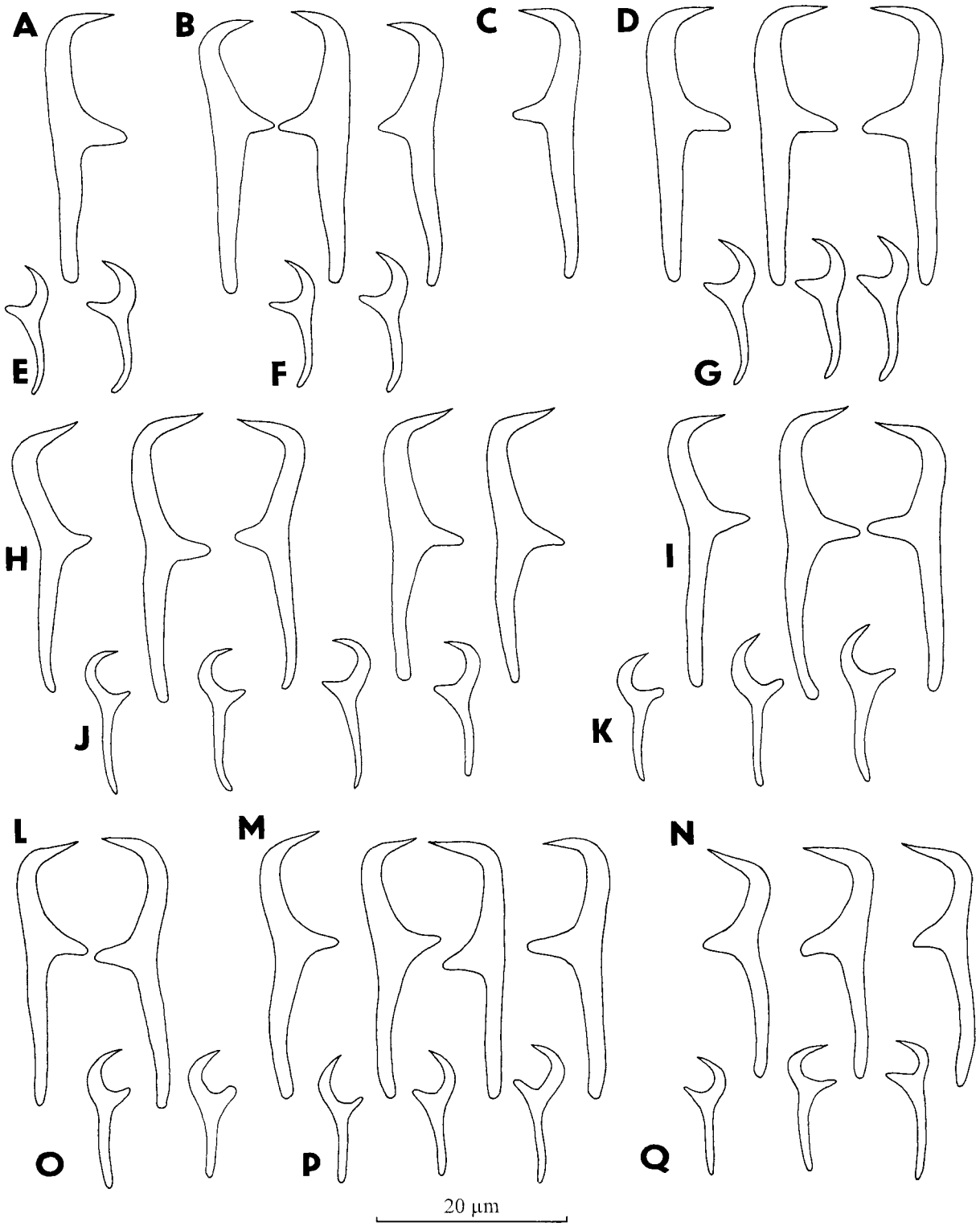

Figure 8. Valipora mutabilis Linton, 1927 – metacestodes from the gall-bladder of *Cichlasoma geddesi* (A,E), *C. beani* (B,F), *C. meeki* (C) and *Rhamdia guatemalensis* (D,G); *V. campylancristrota* (Wedl, 1855) – metacestodes from the gall-bladder of *R. guatemalensis* (H,J), *Girardinichthys multiradiatus* (I,K), *Chirostoma jordani* (L,O), *C. riojai* (M,P) and *C. humboldtianum* (N,Q). A-D,H,I,L-N, distal hooks; E-G,J,K,O-Q, proximal hooks.

Table 1. Measurements (in micrometres) of rostellar hooks of *Valipora campylancristrota* and *V. mutabilis* from different hosts.

	Distal hooks				Proximal hooks			
	Length	Blade	Handle	B/H ratio	Length	Blade	Handle	B/H ratio
Valipora campylancristrota								
Chirostoma humboldtianum	**23-26**	9-11	14-15.5	0.60-0.75	**12.5-14.5**	3.5-4	9-11.5	0.34-0.42
Chirostoma jordani	**28-29**	11-12.5	17-17.5	0.64-0.72	**13-14.5**	4	9.5-11	0.39-0.43
Chirostoma riojai	**27.5-28.5**	10.5-13	15.5-17.5	0.60-0.84	**13-14.5**	4.5-5	9.5-11	0.42-0.52
Girardinichthys multiradiatus	**28-30.5**	11-13	17.5-18.5	0.60-0.75	**13-16.5**	4-6	9.5-12	0.43-0.56
Rhamdia guatemalensis	**28-30.5**	12-14.5	15.5-17.5	0.69-0.91	**13.5-15.5**	4-5	9.5-11.5	0.38-0.50
Valipora mutabilis								
Cichlasoma beani	**28.5-29.5**	11.5-12.5	17-18	0.68-0.72	**13.5-15**	4.5-5	9-10.5	0.47-0.56
Cichlasoma geddesi	**28-28.5**	12-13	16.5	0.60-0.75	**13.5-14**	5	9.5	0.50
Cichlasoma meeki	**28.5**	11	18	0.62	–	–	–	–
Rhamdia guatemalensis	**29-30**	12.5-13	17-17.5	0.71-0.76	**15-15.5**	4-5	10.5-11.5	0.41-0.47

Takemoto, G.C. Pavanelli and F. Bona in a contribution from a congress in Piracicaba (see Rego et al., 1999).

The hooks of metacestodes from European fish measure 26-30.5 and 10-14, respectively (see Baccarani et al., 1998). In the present material, higher variability in the length of the hooks was observed (Table 1).

**Valipora minuta* (Coil, 1950) Baer & Bona, 1960

(Figure 3C,F,G-J)

Description

(Based on 9 specimens from *Poeciliopsis gracilis* and *Poecilia sphenops*).

Metacestodes oval, 214-270 × 167-224, with invaginated scolex. Scolex almost spherical, 86-118 × 110-127; suckers 38-46 in diameter; muscular rostellum 63-64 × 41-45, bearing 2 circles of 10 hooks each. Distal hooks 36-39 (38-40); blade 14.5-17 (18-19); handle 23.5-24.5 (21-21.5); blade/handle ratio 0.60-0.65 (0.85-0.88). Proximal hooks 18-21.5 (19.5-21.5); blade 5.5-7 (7.5-8.5); handle 13.5-15.5 (12-14); blade/handle ratio 0.46-0.49 (0.55-0.59) (Figure 2B,C).

Hosts and localities: *Rhamdia guatemalensis* (Pimelodidae) – Quintana Roo: San Pedro 2 cenote (1/8; 1); Yucatán: Ixin-há cenote (4/131; 1-2); *Poecilia sphenops* – Guerrero: Presa Tepecoacuilco (2/6; 1-15 [6]); *Poeciliopsis gracilis* (Poeciliidae) – Guerrero: Presa Tepecoacuilco (3/16; 1-8 [4]).

Site: Gall-bladder, ? liver.

Specimens deposited: CNHE 4135-6; IPCAS C-240; USNPC 90810-11.

References: Scholz et al. (1996 – as *Dendrouterina papillifera)*; Present data.

Comments

The hooks of the present material correspond exactly to those of *V. minuta* (Coil, 1950), a species described from *Butorides virescens* (= *B. striatus virescens* (Linnaeus)) from the USA: 35-40 and 17-20 (Coil, 1950). Re-examination of voucher specimens (IPCAS C-240) of the material described by Scholz et al. (1996) has shown that it also belongs to *V. minuta* and not to *Dendrouterina papillifera*, as first identified. In the latter species, the size and shape of the hooks are different. The blade of the distal hooks of *D. papillifera* is less curved and the handle of the proximal ones much longer (Figure 3B,E; Bona, 1975, plate 1).

Metacestodes of *V. minuta* were previously found in the gall-bladder of *Micropterus punctatus*, *M. salmoides* and *Gambusia affinis* from Texas and Arizona (Hoffman, 1999).

**Valipora mutabilis* Linton, 1927 (Figure 8A-G)

Syns *Dendrouterina lintoni* Olsen, 1937; *D. nycticoracis* Olsen, 1937; *Ophiovalipora nycticoracis* (Olsen, 1937) Coil, 1950 (for complete list see Bona, 1975, p. 103)

Description

(Body measurements based on *5* flattened specimens from *Cichlasoma geddesi* (Regan) and *C. meeki* (Brind); measurements of the hooks of specimens from different hosts are presented in Table 1). Body 496-780 x 232-320, divided to scolex and bladder; latter 264-320 x 224-320. Scolex almost spherical, 232-288 x 232-272; suckers 62-107 x 57-70; muscular rostellum bearing two circles of 10 hooks each. Distal hooks 28-30; blade 11-13; handle 16.5-18; blade/handle ratio 0.60-0.76. Proximal hooks 13.5-15.5; blade 4-5; handle curved 9-11.5; blade/handle ratio 0.41-0.56 (Figure 8A-G).
Hosts and localities: *Cichlasoma beani* (Jordan) – Nayarit: Río Santiago (1/25; 1); *C. geddesi* – Campeche: Zoh Laguna (2/10; 1-2); *C. meeki* (all Cichlidae) – Campeche: Zoh Laguna (2/10; 1-4); *Rhamdia guatemalensis* (Pimelodidae) – Yucatán: Ixin-há cenote (1/131; 1).
Site: Gall-bladder.
Specimens deposited: CNHE 4137-8; IPCAS C-302; USNPC 90812.

Comments

The shape and size of the hooks correspond to those of *V. mutabilis*, as redescribed by Bona (1975, see plate 21). Bona (1975) reported the rostellar hooks of *V. mutabilis* to measure 28-32 (distal hooks) and 14-17 (proximal hooks), respectively.

In the hook morphology, metacestodes of *V. mutabilis* closely resemble those of *V. campylancristrota*. They overlap in the size of the hooks (see Table 1), but they differ slightly in shape. The distal hooks of *V. mutabilis* are more robust than those of *V. campylancristrota* and their point is shorter and never directed anteriorly, thus do not become concave as in *V. campylancristrota* (compare Figure 8A-D and 8H,I,L-N). The proximal hooks of *V. mutabilis* have curved handle while the handle of the hooks of *V. campylancristrota* is almost straigh (Figure 8E-G,J,K,O-Q).

Metacestodes of *V. mutabilis* are reported here for the first time. Adults of *V. mutabilis* have been found in *Nycticorax nycticorax* and *Butorides striatus virescens* from the USA, Cuba, Italy and China (Rysavy & Macko, 1973; Bona, 1975).

Discussion

A total of 13 species of the Dilepididae have been found as metacestodes in fishes from Mexico. Ten species are here first reported from this country, and larval stages of nine dilepidids are described from fish hosts for the first time. Such a high number of previously unreported taxa apparently reflects the little attention that has been paid to the occurrence of dilepidid larvae in fish, particularly in the Americas (Hoffman, 1999; Rego et al., 1999). Due to the almost complete absence of information on dilepidid metacestodes in this continent, the present data cannot be compared with previous reports.

The present study shows that metacestodes of tapeworms of the family Dilepididae are relatively common parasites of fish in Mexico, particularly in fish of certain families, such as cichlids, atherinids or eleotrids in central and southeastern Mexico. In *Rhamdia guatemalensis* and *Chirostoma jordani*, metacestodes of as many as four dilepidid species have been found, and in some hosts two species occurred concurrently. Species of *Valipora* and *Parvitaenia cochlearii* occurred in a wide spectrum of fish of different families, but other species have been found in fish of only one or two related families (*Glossocercus auritus*, *Cyclustera* cf. *ralli)* or even in one host species (*Cyclustera capito*, *Paradilepis* cf. *urceus*, ?*Paradilepis* sp., *Parvitaenia macropeos*).

Most metacestodes exhibit a narrow specificity as to their site of infection. Members of *Valipora* occur almost exclusively in the gall-bladder, species of *Paradilepis* and *Parvitaenia* in the liver, those of *Cyclustera* in the mesenteries and metacestodes of *Glossocercus* in the mesenteries and liver. However, much more data are necessary to evaluate actual host and site specificity of dilepidid larvae and their geographical distribution in Mexico.

Very few dilepidid metacestodes have been reported from freshwater fish in Canada and the USA. Chandler (1935) described larval stages of two dilepidid species, *Glossocercus cyprinodontis* and *Cysticercoides menididae*, from brackish water fish in Texas. Hoffman (1999) listed three taxa, namely *Dilepis unilateralis* (Rudolphi, 1819) from the gall-bladder of *Micropterus salmoides* in Canada; *Dilepis* sp. from different fish species in Canada and the USA; and *Ophiovalipora minuta* (= *Valipora minuta)* from the gall-bladder of *Micropterus punctatus*, *M. salmoides* and *Gambusia affinis* from the USA.

Five species recorded in this study *(Cyclustera capito, Glossocercus auritus, G. caribaensis, Paradilepis caballeroi* and *Valipora mutabilis)* were found as adults in fish-eating birds in Cuba (Rysavy & Macko, 1973). This indicates a close relationship of the cestode fauna of this island with that of Mexico, or at least its southeastern region (the Yucatan Peninsula).

The identification of dilepidid metacestodes from fish is based almost exclusively on the morphology of the rostellar hooks. This may cause difficulties because of the high intraspecific variation in the size of the hooks, the close resemblance of the hooks of anatomically very different species and the possibility of incomplete growth of the hook handle in some species (Bona, 1975). In addition, the hooks are difficult to observe, measure and illustrate in those specimens, the rostellum of which is not sufficiently flattened. Therefore, metacestodes, fixed with or without slight flattening, stained and mounted as permanent preparations in Canada balsam, are of limited use for taxonomic purposes and their correct species determination may be rather problematical. Inadequately processed material represented one of the greatest limitations to the identification of some metacestodes from Mexico, as well as in the examination of type-specimens of *Cyclustera ralli* and *Glossocercus cyprinodontis*.

For cyclophyllidean tapeworms, including dilepidids, Berlese fluid is used for the fixation of hooks that were previously squashed in order to be arranged in one layer. In this study, a different procedure, used for gill monogeneans such as dactylogyrids or gyrodactylids, was successfully applied, i.e. the fixation of worms with GAP (1 part of glycerin with 3 parts of ammonium picrate or picric acid) after their flattening by a coverslip (Ergens, 1969).

Comparison of the hooks of metacestodes with those of adult worms has revealed only slight differences and most larvae had completely formed hooks, i.e. composed of two parts: (1) a refractive sclerotised part that is formed in the first intermediate host, and (2) an 'amorphous' part (called "epiphyseal thickenings" in some cyclophyllidean families – Georgiev & Kornyushin, 1994) overgrowing the handle and/or the guard of the refractive part and responsible for the hook growth in the next host. The presence of this 'amorphous' part in metacestode hooks (see Figures 1,4,5) indicates its formation in the second intermediate host.

Recent phylogenetic analyses based on molecular (Mariaux, 1998) and morphological data (Hoberg et al., 1999) indicate paraphyly of the family Dilepididae and support the validity of the Gryporhynchidae Spasskii & Spasskaya, 1973, to which all the species described in this paper belong. However, the classification proposed by Bona (1994) is followed in this study until the taxonomy of this group of cyclophyllidean tapeworms is resolved.

As documented in this paper, the spectrum of dilepidid metacestodes parasitising fish in Mexico is relatively wide. Much more attention needs to be given to studies of their morphology, taxonomy and occurrence in fish hosts. Moreover, the life cycles of dilepidid tapeworms occurring in Mexico are unknown and investigations into their biology are highly desirable.

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References

Baccarani, E.M., Bona, F.V., Buriola, E. & Canestri Trotti, G. (1998) Larval cestode infections in tench (*Tinca tinca*). *Parassitologia*, **40** (Suppl. 1), 5.

Baer, J.G. & Bona, F.V. (1960) Révision des Cestodes Dilepididae Fuhrm., 1907 des Ardéiformes. Note préliminaire. *Bolletino Istituto de Museo Zoologico Universitá di Torino*, **6**, 91–143.

Bona, F.V. (1975) Etude critique et taxonomique des Dilepididae Fuhrm., 1907 (Cestoda) parasites des Ciconiiformes. Considérations sur la spécificité et la spéciation. *Monitore Zoologico Italiano*, N.S., *Monografia*, **1**, 1975, XII + 750 pp.

Bona, F.V. (1983) Variability and growth of cestodes: premises to a biometric analysis. *Dendrouterina pilherodiae meridionalis* n. subsp., parasite of *Egretta alba* (Ciconiiformes) in Argentina and redescription of the type of *D. pilherodiae* Mahon, 1956 (Cestoda, Dilepididae). Part II. *Rivista di Parassitologia*, **44**, 425–469.

Bona, F.V. (1994) Family Dilepididae Railliet & Henry, 1909. *In*: Khalil, L.F., Jones, A. & Bray, R.A. (Eds) *Keys to the cestode parasites of vertebrates*. Wallingford, Oxon: CAB International, pp. 443–554.

Chandler, A.C. (1935) Parasites of fishes in Galveston Bay. *Proceedings of the United States National Museum*, **83**, 123–157 + 7 plates.

Chubb, J.C. (1982) Seasonal occurrence of helminths in freshwater fishes. Part IV. Adult Cestoda, Nematoda and Acanthocephala. *Advances in Parasitology*, **20**, 1–292.

Coil, W.H. (1950) The genus *Ophiovalipora* Hsü, 1935, (Cestoda: Dilepididae) with the description of *Ophiovalipora minuta* sp. nov. from the green heron *(Butorides virescens* L.). *Journal of Parasitology*, **36**, 55–61.

Coil, W.H. (1955a) The morphology of *Cyclustera capito* (Rudolphi, 1819) Fuhrmann, 1901. *Transactions of the American Microscopical Society*, **74**, 353–357.

Coil, W.H. (1955b) *Parvitaenia cochlearii* sp. nov. (Cestoda: Dilepididae) a new tapeworm parasitic in boat-billed heron, *Cochlearius cochlearius*. *Proceedings of the Helminthological Society of Washington*, **22**, 66–68.

Dubinina, M.N. (1987) [Class Cestoda Rudolphi, 1808.] *In:* Bauer, O.N. (Ed.) *Key to the parasites of freshwater fishes*. Leningrad: Publishing House Nauka, Vol. 3, pp. 5–76. (In Russian).

Ergens, R. (1969) The suitability of ammonium picrate-glycerin in preparing slides of lower Monogenoidea. *Folia Parasitologica*, **16**, 320.

Eschmeyer, W.N. (1998) *Catalog of fishes. Parts 1, 2.* San Francisco: California Academy of Sciences, 1, 820 pp.

Espinosa-Pérez, H., Gaspar-Dillanes. M.T. & Fuentes-Mata, P. (1993) *Listados faunisticos de México. III. Los peces dulceacuícolas mexicanos*. Mexico City: Instituto de Biología, Universidad Nacional Autónoma de México, 99 pp.

Georgiev, B.B. & Kornyushin, V.V. (1994) Family Paruterinidae Fuhrmann, 1907 (*sensu lato)*. *In*: Khalil, L.F., Jones, A. & Bray, R.A. (Eds) *Keys to the cestode parasites of vertebrates.* Wallingford, Oxon: CAB International, pp. 559–584.

Hoberg, E.P., Jones, A. & Bray, R.A. (1999) Phylogenetic analysis among the families of the Cyclophyllidea (Eucestoda) based on comparative morphology, with new hypotheses for co-evolution in vertebrates. *Systematic Parasitology*, **42**, 51–73.

Hoffman, G.L. (1999) *Parasites of North American freshwater fishes*. Second Edition. Berkeley, Los Angeles, London: University of California Press, 486 pp.

Hoyo del, J., Elliott, A. & Sargatal, J. (Eds.) (1992) *Handbook of the birds of the world.* Vol. 1. Barcelona: Lynx Edicions, 696 pp.

Jarecka, L. (1970a) Life cycle of *Valipora campylancristrota* (Wedl, 1855) Baer and Bona, 1958–1960 (Cestoda - Dilepididae) and the description of cercoscolex – a new type of cestode larva. *Bulletin de l'Academie Polonaise des Sciences, Classe II*, **18**, 99–102.

Jarecka, L. (1970b) On the life cycles of *Paradilepis scolecina* (Rud., 1819) Hsü, 1935, and *Neogryporhynchus cheilancristrotus* (Wedl, 1855) Baer and Bona, 1958–1960 (Cestoda - Dilepididae). *Bulletin de l'Academie Polonaise des Sciences, Classe II*, **18**, 159–163.

Jarecka, L. (1975) Ontogeny and evolution of cestodes. *Acta Parasitologica Polonica*, 23, 93–114.

Lamothe-Agumedo, R., García-Prieto, L., Osorio-Sarabia, D. & Pérez-Ponce de León, G. (1997) *Catálogo de la colección nacional de helmintos.* México City: Universidad Nacional Autónoma de México, 211 pp.

Mahon, J. (1956) *Dendrouterina pilherodiae* sp. nov. (Dilepididae) from *Pilherodius pileatus* (Bodd.). *Canadian Journal of Zoology*, **34**, 28–34.

Mariaux, J. (1998) A molecular phylogeny of the Eucestoda. *Journal of Parasitology.* **84**, 114–124.

Matevosyan, E.M. (1963) *Dilepidoidea – tapeworm helminths of domestic and wild animals*. Moscow: Publishing House of the Academy of Sciences of the USSR, *Osnovy Tsestodologii*, **3**, 688 pp. (In Russian).

Priemer, J. & Scholz, T. (1989) Larvae of Dilepididae (Cestoda) in *Cyprinus carpio* from the GDR. *Angewandte Parasitologie*, **30**, 27–30.

Rego, A.A., Chubb, J.C. & Pavanelli, G.C. (1999) Cestodes in South American freshwater teleost fishes: keys to genera and brief description of species. *Revista Brasileira do Zoologia*, **16**, 299–367.

Rysavy, B. & Macko, J.K. (1973) Bird cestodes of Cuba. I. Cestodes of birds of the orders Podicipediformes, Pelecaniformes and Ciconiiformes. *Anales del Instituto de Biología, Universidad Nacional Autónoma de México, Serie Zoología*, **42** (1971), 1–28.

Ryzhikov, K.M., Ryšavý, B., Khokhlova, I.G., Tolkatcheva, L.M. & Kornyushin, V.V. (1985) *Helminths of fish-eating birds of the Palaearctic region II. Cestoda and Acanthocephales.* Praha: Academia, 412 pp.

Schmidt, G.D. & Courtney C.H. (1973) *Parvitaenia heardi* sp. n. (Cestoidea: Dilepididae) from the great blue heron, *Ardea herodias*, in South Carolina. *Journal of Parasitology*, **59**, 821–823.

Schmidt, G.D. & Neiland, K.A. (1971) Helminth fauna of Nicaragua. IV. *Sacciuterina mathevossiani* sp. nov. (Dilepididae) and other cestodes of birds. *Parasitology*, **62**, 145–149.

Scholz, T. (1989) Amphilinida and Cestoda, parasites of fish in Czechoslovakia. *Acta Scientiarum Naturalium Brno*, 23, No. 4, 56 pp.

Scholz, T. & Ergens, R. (1990) Cestodes of fish from Mongolia. *Acta Societatis Zoologicae Bohemoslovacae*, **54**, 287–304.

Scholz, T., Vargas-Vázquez, J., Moravec, F., Vivas-Rodríguez, C. & Mendoza-Franco, E. (1996) Cestoda and Acanthocephala of fish from cenotes (sinkholes) of the Peninsula of Yucatan, Mexico. *Folia Parasitologica*, **43**, 141–152.

Sepúlveda, M.S., Spalding, M.G., Kinsella, J.M., Bjork, R.D. & McLaughlin, G.S. (1994) Helminths of the roseate spoonbill, *Ajaia ajaja*, in southern Florida. *Journal of the Helminthological Society of Washington*, **61**, 179–189.

Underwood, H.T. & Dronen N.O. (1986) *Neocyclustera ralli* gen. et sp. n. (Cestoidea: Dilepididae) and other endohelminths from dapper rails, *Rallus longirostris*, from a marsh in Galveston County, Texas. *Proceedings of the Helminthological Society of Washington*, **53**, 59–62.