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A NEW SPECIES OF MACROBOTHRIIDAE (CESTODA: DIPHYLLIDEA) FROM THORNBACK RAY *PLATYRHINA SINENSIS* IN CHINA

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ABSTRACT: A new cestode, *Macrobothridium sinensis* n. sp., is described from the spiral intestine of *Platyrrhina sinensis* from coast of Xiamen, China. It is the first record of the order Diphyllidea in China. The new species can be distinguished from the 3 previously described species of *Macrobothridium* by the testes number (16–24 vs. 29–37, 27–46, and 5–6, in *M. rhynchobati*, *M. euterpes*, and *M. syrtensis*, respectively) and a single-row arrangement of testes; *M. sinensis* is most similar to *M. euterpes* in strobila length (1.77–6.23 vs. 2–4.5 mm) and number of segments (6–8 vs. 5–9). In addition, *M. sinensis* differs from *M. rhynchobati* and *M. syrtensis* in the strobila length, ovary shape, and number of apical hooks. The uterine pore is the first described in the Diphyllidea; thus, the present uterine pore can now be used to distinguish *Macrobothridium* from *Echinobothrium* and *Ditrachybothridium* in the Diphyllidae.

Macrobothridium was erected by Khalil and Abdul-Salam (1989) with its type species *Macrobothridium rhynchobati* Khalil and Abdul-Salam, 1989, from *Rhynchobatus granulosus* in Kuwaiti coastal waters (Arabian Gulf). Wojciechowska et al. (1995) reported a single incomplete specimen of *Macrobothridium* sp. from *Bathyrhaja eatonii* at Heard Island. Olson and Cairn (1999) and Olson et al. (2001) discussed the interrelationships of tapeworms and referred to another species of *Macrobothridium* from *Rhinobatus typus* in the Timor Sea, Australia. Neifar et al. (2001) described 2 species, *M. euterpes* Neifar, 2001 from *Rhinobatus rhinobatos* and *M. syrtensis* Neifar, 2001 from *Rhinobatus cemiculus* in the Gulf of Gabès, Tunisia. The new species described below was collected from the spiral intestine of *Platyrrhina sinensis* at a fish market in Xiamen, China in 2005.

MATERIALS AND METHODS

The cestodes were collected from the spiral intestine of the thornback ray *Platyrrhina sinensis*, which was identified according to Zhu (1984); they were washed in saline, killed with hot saline, and transferred immediately into 5% formalin. Fixed cestodes were stained in alum carmine, dehydrated in ethanol, cleared in methyl salicylate, and mounted permanently in neutral balsam. Four specimens prepared for scanning electron microscopy (SEM) were rinsed in saline, postfixed in 2.5% glutaraldehyde water solution, dehydrated in ethanol series, replaced in isoamyl acetate, dried through the CO₂ critical point, and viewed with scanning electron microscope (XL 30). Drawings were made with the aid of a drawing tube. All measurements are present in the text in micrometers unless otherwise stated. Measurements are given as ranges followed by the mean ± standard deviation and sample size in parentheses. Type specimens have been deposited in Parasitology Research Laboratory, Xiamen University in China.

DESCRIPTION

Macrobothridium sinensis n. sp. (Figs. 1–14)

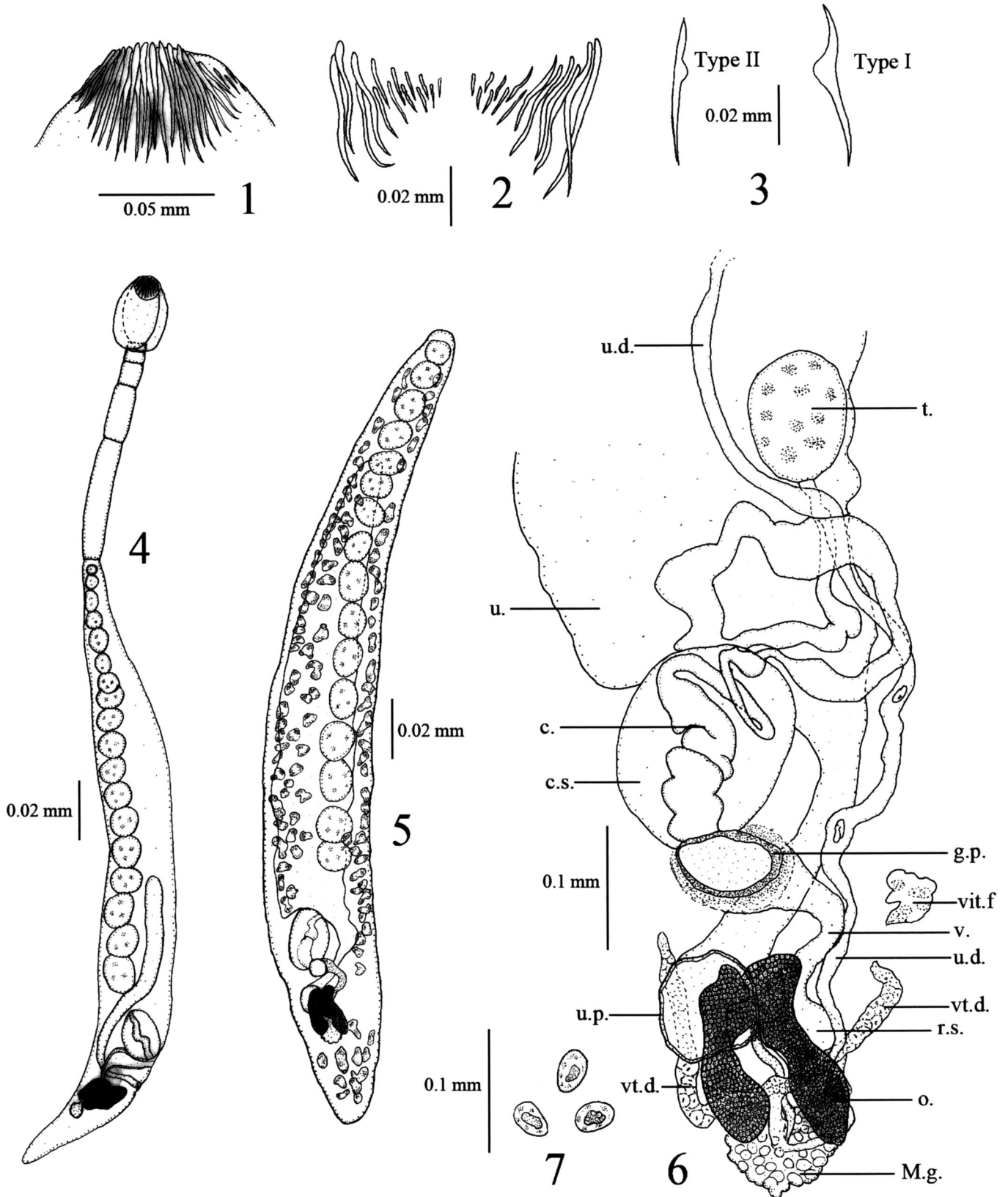
Description (based on 9 complete specimens and 15 incomplete specimens): Small cestodes; mature specimens 1.77–6.23 (4.87 ± 0.44, n = 6) mm long, composed of 6–8 (7 ± 1, n = 9) proglottids. Scolex bipartite, consisting of scolex proper and short unarmed cephalic peduncle. Scolex proper 187.5–250 (219.6 ± 18.6, n = 12) long, 124.8–168 (150.2 ± 15.9, n = 5) wide, consisting of armed rostellum and 2 large bothria, 1 dorsal and 1 ventral. Rostellar armature consisting of 1 dorsal and 1 ventral group of 33 large central apical hooks flanked on each side by 8 smaller lateral hooklets. Each group of large central

apical hooks arranged in 2 staggered rows forming an anterior row of 17 hooks (Type I) and posterior row of 17 hooks (Type II). Each group of lateral hooklets arranged in 2 staggered rows forming anterior row of 4 hooklets and posterior row of 4 hooklets. Type I hook lengths 45–65 (52.4 ± 4.8, n = 41), type II hook lengths 35–55 (47.2 ± 5.2, n = 48). Anterior row hooklets 5–25 (11.5 ± 5.0, n = 30), posterior row hooklets 5–27.5 (13.4 ± 7.8, n = 21). Bothria oval, 156–192 (170.6 ± 11.3, n = 20) long by 124.8–168 (150.2 ± 15.9, n = 5) wide; distal surfaces covered with slender pectinate with 3 long digits (Fig. 11). Proximal bothrial surfaces covered with palmate microtriches, each bearing 6–7 digits (Fig. 13); border between proximal and distal bothrial surfaces marked abrupt change in microtrich type from 6–7 digits palmate microtriches to 3 digits pectinate (Fig. 14). Cephalic peduncle 37.5–62.5 (49.3 ± 10.0, n = 7) long, 45–70 (57.9 ± 8.9, n = 7) wide, unarmed, covered with palmate microtriches (Fig. 7).

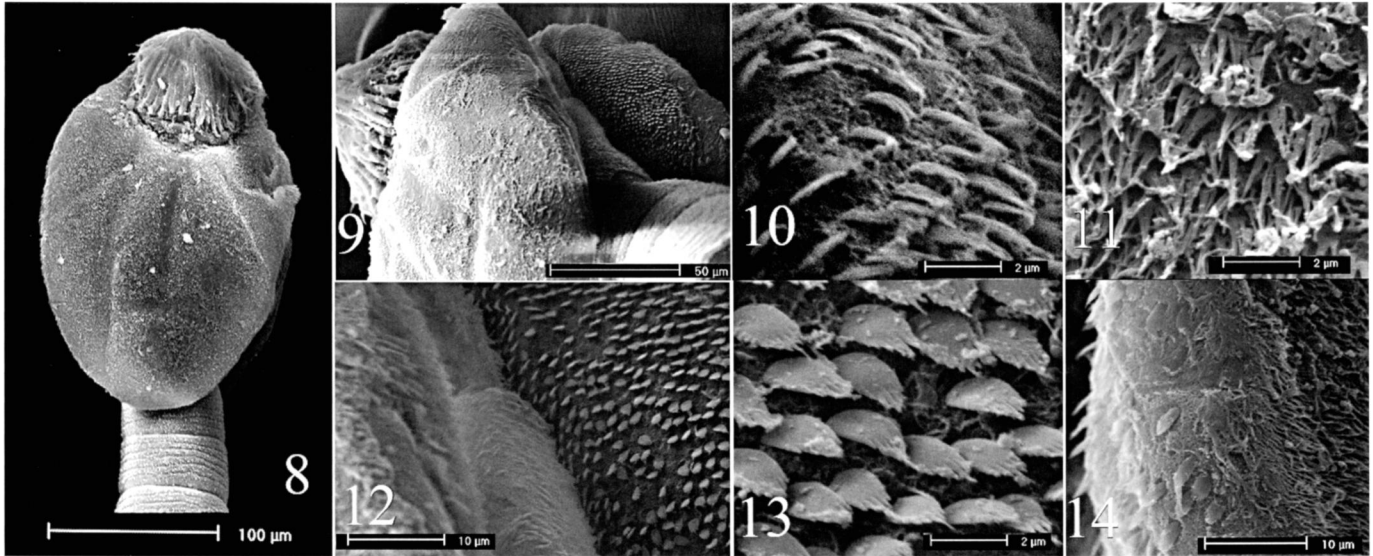
Immature proglottids wider than long, becoming longer than wide on maturation. Mature proglottid acraspedote, 1,584–3,417.6 (2,631.2 ± 485.1, n = 24) long by 201.6–432 (292.6 ± 53.3, n = 21) wide. Testes oval, 16–24 (19 ± 2, n = 26) in number, 74.4–144 (106.5 ± 17.4, n = 43) long by 43.2–120 (82.8 ± 17.2, n = 43) wide, arranged in single column extending from anterior margin of proglottid to cirrus sac. Cirrus sac ovoid, 127.2–201.6 (172.0 ± 23.7, n = 12) long by 98.4–132 (119.4 ± 11.7, n = 12) wide in lateral view and 103.2–213.6 (155.6 ± 35.0, n = 6) long by 79.2–132 (98.0 ± 18.2, n = 6) wide in ventral view; cirrus 48–67.2 (56.4 ± 7.4, n = 6) in maximum diameter, without obvious spinitriches; vas deferens medial, coiled, entering cirrus sac anteriorly. Ovary H-shaped in ventral view, bilobed in cross section; ovarian lobes elongate, subequal, 120–240 (184.5 ± 33.5, n = 21) long, 67.2–93.6 (79.7 ± 8.1, n = 10) wide in lateral view and 36–72 (53.9 ± 12.1, n = 11) in ventral view. Genital pore midventral, anterior to ovary, 45.6–96 (76.3 ± 19.2, n = 5) by 36–88.8 (61.9 ± 20.5, n = 5), 17.66–24.71% (21.61 ± 2.29, n = 14) from posterior end of proglottid. Uterine pore ventral, posterior to genital pore, 79.2–156 (101.4 ± 36.5, n = 4) by 74.4–120 (88.2 ± 21.4, n = 4), 14.56–19.49% (17.50 ± 1.90, n = 9) from posterior end of proglottid. Vagina not coiled, extending anteriorly from junction with uterus duct along midline of proglottid, joining cirrus at genital pore. Vaginal sphincter present, 12–21.6 (17.6 ± 3.3, n = 12) thick. Receptaculum seminis present, 72–108 (99.1 ± 13.1, n = 7) long by 60–93.6 (78.2 ± 12.6, n = 7) wide. Vitelline glands lateral, in 2 ventral columns, extending entire length of proglottid, interrupted by ovary. Vitellaria follicular, 43.2–84 (56.9 ± 10.6, n = 17) by 19.2–48 (28.2 ± 7.5, n = 17). Uterine duct, 8.4–24 (14.0 ± 6.5, n = 8) in diameter, running to the anterior part of uterus. Mehlis' gland posterior to ovarian isthmus, 60–86.4 (72.0 ± 8.1, n = 18) in diameter. In the vicinity of the ovary vitelline duct 12–14.4 (13.2 ± 1.3, n = 6) in diameter, from each side run in the median direction, uniting into a common vessel that joins the vagina close to the junction of the latter with the uterine duct.

Detached gravid proglottids 2,361.6–3,888 (3,396.8 ± 583.3, n = 6) long by 336–441.6 (377.6 ± 39.7, n = 6) wide. Eggs ovate, unembryonated, 24–28.8 (27.4 ± 1.4, n = 26) long, 14.4–21.6 (18.4 ± 2.1, n = 26) wide.

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FIGURES 1-7. *Macrobothridium sinensis* n. sp. (1) Ventral view of rostellar armature. (2) Lateral view of rostellar armature. (3) Alternate hook types. (4) Whole worm. (5) Mature proglottid. (6) Detail of genitalia. (7) Eggs. c., cirrus; c.s., cirrus sac; g.p., genital pore; M.g., Mehlis' gland; o., ovary; r.s., receptaculum seminis; t., testes; u., uterus; u.d., uterine duct; u.p., uterine pore; v., vagina; v.d., vas deferens; vit.d., vitelline duct; vit.f., vitelline follicle.



FIGURES 8–14. Scanning electron micrographs of *Macrobothridium sinensis* n. sp. (8) Scolex. (9) Lateral view of scolex. (10) Palmate microtriches on cephalic peduncle. (11) Three digits pectinate on distal bothrial surfaces. (12) Lateral view between 2 bothria. (13) Six–seven digits pectinate on proximal bothrial surfaces. (14) Border between distal and proximal bothrial surfaces marked abrupt change in microtrich type from 3 digits pectinate to 6–7 digits palmate microtriches.

Taxonomic summary

Type host: *Platyrrhina sinensis* (Bloch et Schneider, 1801) (Rajiformes: Platyrrhinidae).

Type locality: Xiamen, Fujian, China. 24°28'N, 118°10'E.

Site of infection: Spiral intestine.

Type specimens: Holotype no. C2005121801 and 5 paratypes, Nos. C2005110401–C2005110403 and C2005120101–C2005120102, are deposited in Parasitology Research Laboratory, School of Life Sciences, Xiamen University, Xiamen, Fujian, China.

Etymology: This species is named for the type host *Platyrrhina sinensis*.

Remarks

Since the erection of *Macrobothridium* by Khalil and Abdul-Salam (1989), 3 species and 2 unidentified species have been described. All the species in *Macrobothridium* have armed apical rostellum and unarmed cephalic peduncle. *Macrobothridium sinensis* is most similar to *M. euterpes* in strobila length (1.77–6.23 vs. 2–4.5 mm) and number of fragments (6–8 vs. 5–9). However, it can be distinguished from *M. euterpes* by the number (16–24 vs. 27–46) and single-row arrangement of testes. Testes number and arrangement are also differences among *M. syrtensis*, *M. rhynchobati*, and *M. sinensis*. In addition, *M. sinensis* differs from *M. rhynchobati* in the number of proglottids (6–8 vs. 82–115), length of strobila (1.77–6.23 vs. 30–40 mm), shape of ovary (H vs. V); *M. sinensis* also differs from *M. syrtensis* in strobila length (1.77–6.23 vs. 1–1.5 mm), number of apical hooks (33 vs. 19–21) and ovary shape (H vs. V).

DISCUSSION

Ivanov and Hoberg (1999) suggested that *Macrobothridium* (specifically *M. rhynchobati*) may belong within *Echinobothrium* Van Beneden, 1894, based on the morphological characters. Neifar et al. (2001) pointed out that the Ivanov and Hoberg (1999) analysis was only preliminary, and that the paucity of morphological characters used in their analysis left a robust phylogeny out of reach. Therefore, they thought the phylogenetic analysis by Ivanov and Hoberg (1999) was not sufficient to synonymize *Macrobothridium* with *Echinobothrium*, and maintained the validity of *Macrobothridium*. Based on the ob-

vious morphological character of unarmed cephalic peduncle, the authors also support the presence of the *Macrobothridium*.

Macrobothridium sinensis is the first record of Diphyllidea in China and the first reported cestode parasite in *Platyrrhina sinensis*. The discovery of *M. sinensis* brings the total number of species in *Macrobothridium* to 4. All the species have an armed apical rostellum and unarmed cephalic peduncle. In the lateral surfaces of the *M. sinensis* rostellum, hooklets form 2 staggered rows, thereby joining the hooks in the ventral/dorsal surfaces (Fig. 2). In contrast, hooklets on the lateral surfaces of other species in *Macrobothridium* and *Echinobothrium* are arranged in a single row. The lateral hooks of *E. fauleyae* Tyler and Caira, 1999 are arranged in 2 staggered rows according to the figures in their article.

Neifar et al. (2001) described the mode of attachment by species of *Macrobothridium* to the gut mucosa of their respective hosts. In *M. syrtensis* and *M. euterpes*, only the anterior part of scolex proper is inserted into the crypt; *M. sinensis* has the same attachment mode with the apical hooks inserted into the gut mucosa of host, which is different from the species of *Echinobothrium*.

According to Khalil (1994), a uterine pore is absent in species of Diphyllidea. However, the uterine pore of a species of *Macrobothridium* is described here for the first time. The absence of description of other species in *Macrobothridium* does not mean the lack of a uterine pore in the other 3 species.

Neifar et al. (2001) suggested that all 3 known species of *Macrobothridium* reported are parasites of *Rhinobatos* sp. The exception is the host species, *P. siensis*, for *M. siensis*. Caira and Tracy (2002) reported that species of *Yorkeria* are parasites of bamboo sharks, i.e., *Chiloscyllium* sp.; *Y. southwelli* Deshmukh, 1979, from *Ginglymostoma concolor* is also an exception.

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