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Onchobothrium convolutum (YOSHIDA, 1917) SOUTHWELL, 1925 and *O. triacis* (YAMAGUTI, 1952) n. comb. (Tetraphyllidea, Onchobothriidae) from Sharks in Japanese Waters

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Abstract The description of *Onchobothrium convolutum* (Tetraphyllidea, Onchobothriidae) is emended based on seven specimens collected from the type host and locality. Examination of the type material of *Acanthobothrium triacis* YAMAGUTI, 1952 led to an emendation of the original description and transfer of this species to genus *Onchobothrium* resulting in the new combination *Onchobothrium triacis*. The hooks of *O. convolutum* and *O. triacis* were found to be very similar. In both species the lateral hook is composed of a hollow axial prong, a talon, and a hollow abaxial process that appears to be homologous to the full abaxial prong seen in several other onchobothriid genera.

YOSHIDA (1917) originally described *Calliobothrium convolutum* from the spiral valve of *Cynias* (=*Mustelus*) *manazo* (BLEEKER) in Japan. SOUTHWELL (1925), based on YOSHIDA's description, moved this species to the genus *Onchobothrium* BLAINVILLE, 1928. Despite YOSHIDA's careful description, some uncertainty existed regarding several morphological features of this species, including hooks and mature proglottid. No figure of the latter was presented. No further records of *O. convolutum* appear in the literature, and we have been unable to locate the type material; it is neither at the National Science Museum, Tokyo, nor at the Meguro Parasitological Museum, Tokyo, Japan.

In 1971, 7 specimens of a tapeworm that is morphologically consistent with most of the details given in YOSHIDA's description of *O. convolutum* were collected by one of us (M.M.) from the type host and locality. Based on these specimens the description of *O. convolutum* is emended.

The hooks of *Acanthobothrium triacis* YAMAGUTI, 1952 are very similar to those of *O. convolutum*, and they are redescribed from the type material. An understanding of the nature of the hooks of *A. triacis* required transfer of the species to the genus *Onchobothrium*.

Materials and Methods

All specimens of *O. convolutum* were fixed in 70% ethanol. Five specimens were stained with alum carmine or Ehrlich's hematoxylin and mounted for light microscopy according to conventional techniques. One specimen was embedded in paraffin and sectioned at 10 μm intervals with an American Optical microtome. The last specimen was prepared for scanning electron microscopy (SEM) as given in CAIRA (1985 a). The hook terminology of CAIRA (1985 b) was followed so that, owing to the positions of the hooks with relation to the longitudinal axes of the scolex, the large hook is termed the *medial* hook and the small hook is termed the *lateral* hook.

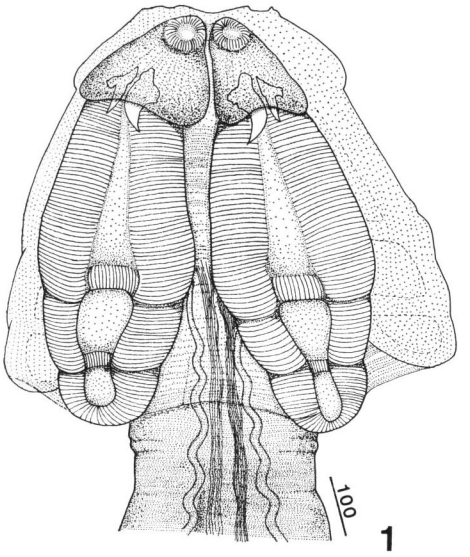
Figure 2 illustrates the hook lengths measured for both species. These lengths are designed to be consistent with the measurements of the equivalent structures by EUZET (1959) for *Acanthobothrium* spp., and by CAIRA (1985 a) for *Phoreiobothrium* spp. All measurements are in micrometers. For each character the range is given followed in parentheses by the mean, the standard deviation, the total number of worms examined, and the total number of observations when more than one structure or proglottid was measured per worm. Illustrations were drawn with the aid of a drawing tube.

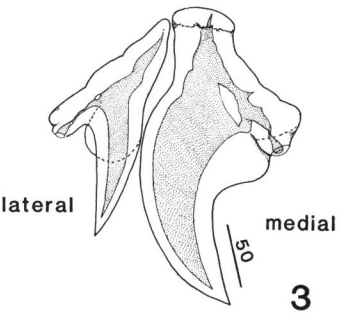
Onchobothrium convolutum (YOSHIDA, 1917) SOUTHWELL, 1925 emend.

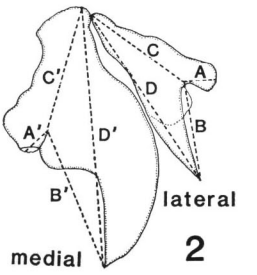
(Figs. 1–4, 7, 8)

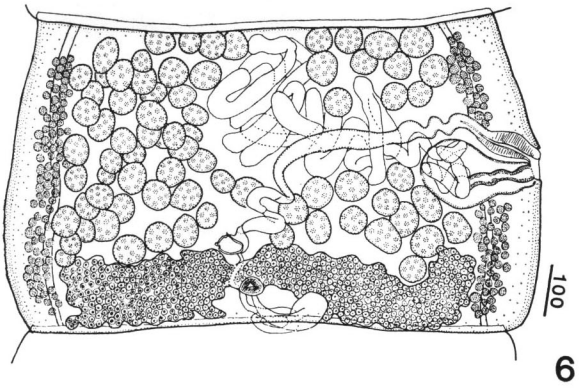
Material examined. Vouchers, NSMT (National Science Museum, Tokyo) No. Pl 1466, HWML (Harold W. MANTER Laboratory, University of Nebraska State Museum) No. 23124 (includes one SEM stub and sections of one scolex), ex *Mustelus manazo* (BLEEKER), Japan. Total of 7 worms, 4 with scoleces.

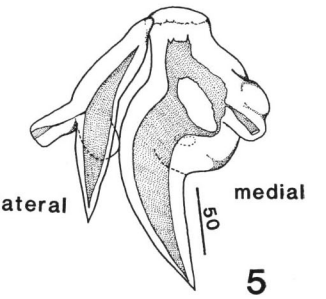
The following information should supplement the description of *O. convolutum*: Each bothridium with one pair of dissimilar, hollow hooks. Bases of hooks adjacent or overlapping, not joined. Each hook with axial prong, talon, and blunt abaxial process. Prong and process hollow each opening to outside via pore; channel of process inconspicuous, continuous with channel of prong. Pore of prong proximal, at base of talon; pore of process apparently distal at posterior margin. Lateral hook: Process from tip to most elevated point uniting prong and process (A in Fig. 2) 25–35 (28 ± 6.4; 4; 11) long; prong from tip to same point (B in Fig. 2) 69–102 (85 ± 10.6; 4; 9) long; axial extremity of base to same point (C in Fig. 2) 83–104 (97 ± 7.1; 4; 10) long; tip of prong to axial extremity of base (D in Fig. 2) 148–185 (168 ± 10.6; 4; 9) long. Medial hook: Process from tip to most elevated point uniting prong and process (A′ in Fig. 2) 29–48 (36 ± 5.6; 4; 12) long; prong from tip to same point (B′ in Fig. 2) 104–146 (134 ± 11.2; 4; 12) long; axial extremity of base to same point (C′ in Fig. 2) 89–108 (100 ± 5.8; 4; 12) long; tip of prong to axial extremity of base (D′ in Fig. 2) 193–231 (219 ± 9.9; 4; 13) long. Prongs protruding from bothridial tissue; talon and process of hook buried in bothridial muscle tissue (Fig. 8). Prongs not covered with

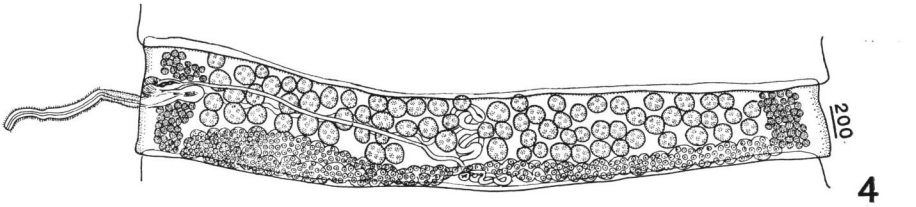












Figs. 1–4. *Onchobothrium convolutum*. 1. Scolex (voucher, HWML No. 23124). 2. Hook measurements taken. 3. Hooks (voucher, HWML No. 23124). 4. Mature proglottid (voucher, HWML No. 23124).

Figs. 5–6. *Onchobothrium triacis* n. comb. (holotype, MPM No. SY-5062). 5. Hooks. 6. Mature proglottid.

thin tissue layer. Proglottids 606–754 (676±60.9; 4; 4) in number per strobila. Testes 126–164 (149±12.4; 2; 10) in number per proglottid. Immature proglottids 40–186 (89±44; 6; 19) long by 810–1823 (1258±252; 6; 17) wide. Mature proglottids 122–389 (268±89; 6; 18) long by 932–3580 (1895±881; 6; 19) wide. Gravid proglottids 616–1134 (787±141; 5; 16) long by 1223–3126 (2023±819; 5; 16) wide. Ratio of mature proglottid length to width 1: 4.8–12 (1: 6.9±1.5; 6; 8).

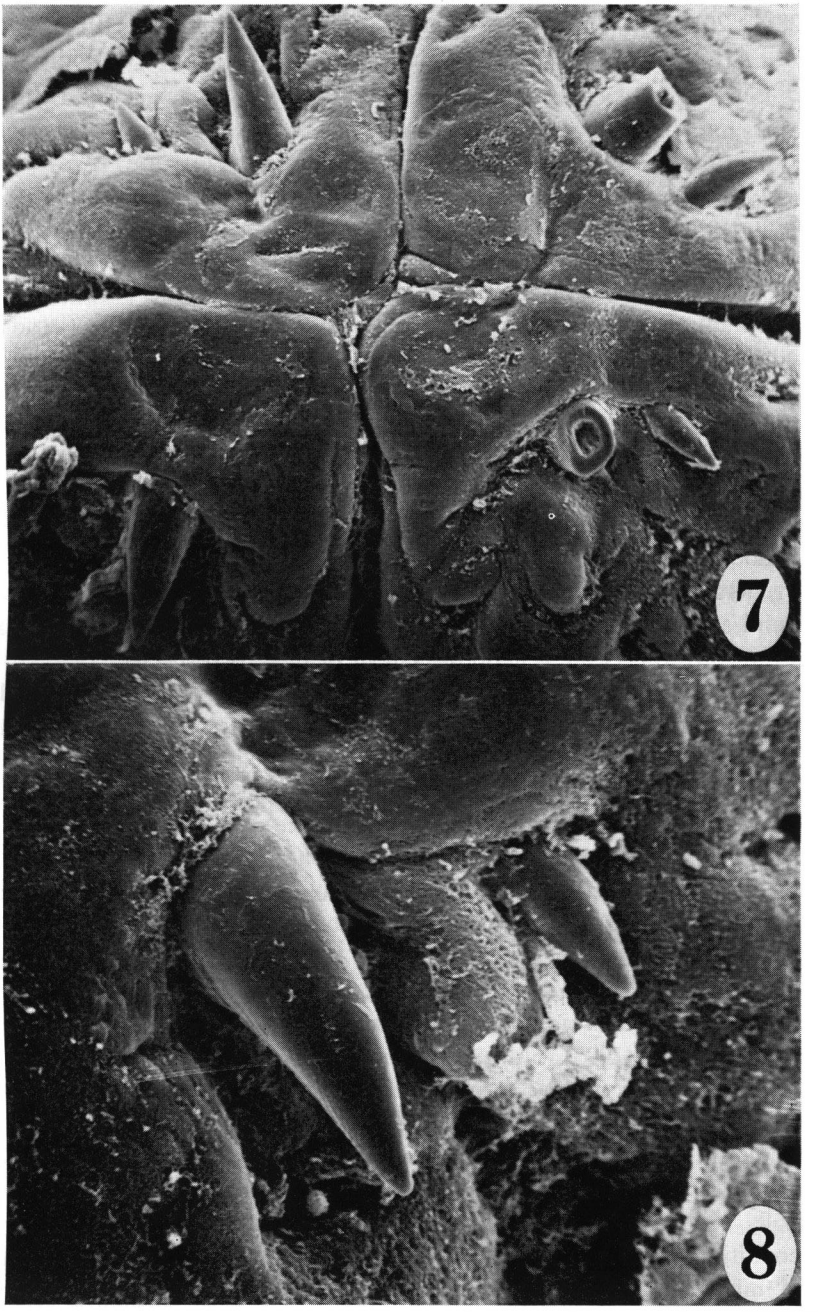
Remarks. Light microscopy indicates that each bothridium is equipped with a single, small, muscular accessory sucker (Fig. 1) as was described by YOSHIDA (1917). These suckers, however, do not appear to have much external structure. With scanning electron microscopy each is visible only as a very slight depression on the anterior border of the muscular pad (Fig. 7). Owing to this apparent discrepancy one specimen was sectioned. The sections indicate that a small sucker with a definite muscular border is, in fact present. This sucker configuration may be responsible for some of the uncertainty associated with the nature of this region in other species of *Onchobothrium*. For example, the bothridia of *Onchobothrium uncinatum* (RUDOLPHI, 1819) BLAINVILLE, 1828 were originally described without accessory suckers, but EUZET (1959) confirmed their presence.

Onchobothrium triacis (YAMAGUTI, 1952) n. comb. emend.

(Figs. 5, 6)

Material examined. Holotype, MPM (Meguro Parasitological Museum, Tokyo) No. SY-5062 and paratype, MPM No. SY-5064; ex *Triakis scyllia* MUELLER et HENLE, Hamazima, Japan. Total of 2 worms, each with intact scolex.

The following information should supplement the description of *O. triacis*: Each bothridium with one pair of dissimilar, hollow hooks; bases of hooks adjacent or overlapping, not joined. Each hook with axial prong, talon, and blunt abaxial process. Prong and process hollow, each opening to outside via pore; channel of process inconspicuous, continuous with channel of prong. Pore of prong proximal, at base of talon; pore of process apparently distal at posterior margin. Lateral hook: Process from tip to most elevated point uniting prong and process (A in Fig. 2) 23–31 (27± 3.1; 2; 7) long; prong from tip to same point (B in Fig. 2) 65–87 (76±7.7; 2; 8) long; axial extremity of base to same point (C in Fig. 2) 89–106 (99±6.2; 2; 8) long; tip of prong to axial extremity of base (D in Fig. 2) 150–173 (165±6.9; 2; 6) long. Medial hook: Process from tip to most elevated point uniting prong and process (A′ in Fig. 2) 31–44 (38±5.0; 2; 5) long; prong from tip to same point (B′ in Fig. 2) 100–129 (118± 10.3; 2; 7) long; axial extremity of base to same point (C′ in Fig. 2) 94–108 (99±5.0; 2; 8) long; tip of prong to axial extremity of base (D′ in Fig. 2) 187–212 (206±8.5; 2; 8) long. Prongs protruding from bothridial tissue; talon and process of each hook buried in bothridial muscle tissue. Proglottids 445–460 (453±10.6; 2; 2) in number per strobila. Immature proglottids 45–210 (93±47.3; 2; 20) long by 585–825 (688± 77.7; 2; 20) wide. Mature proglottids 285–600 (399±88.5; 2; 20) long by 780–1140



Figs. 7–8. Scanning electron micrographs of scolex of *Onchobothrium convolutum* (HWML No. 23124). 7. Apical view illustrating muscular pads with inconspicuous accessory suckers. 120×. 8. Enlarged view of one pair of bothridial hooks. Note lack of thin tissue layer covering hooks. 240×.

(988±128; 2; 20) wide. Gravid proglottids 645–900 (782±93; 2; 10) long by 900–1080 (998±48; 2; 10) wide. Ratio of mature proglottid length to width 1: 1.6–3.3 (1: 2.2±0.6; 2; 10).

Discussion

Careful examination reveals that the hooks of *O. convolutum* and *O. triacis* are almost identical. In both species the medial hook is larger than the lateral hook and each hook consists of (1) a large pointed axial prong (2) a blunt, proximal talon and (3) a short, blunt abaxial process. This similarity in hook morphology (in addition to scolex and proglottid morphology) indicates that the two are congeners, but there is some question as to whether they belong in the genus *Acanthobothrium* or *Onchobothrium*.

According to WARDLE and MCLEOD (1952) and YAMAGUTI (1959), each of the bothridia of the members of *Acanthobothrium* bears a pair of forked (=bipronged) hooks whereas each of the bothridia of the members of *Onchobothrium* bears a pair of simple hooks that each may possess a secondary tubercular or hair-like process. The two genera are distinguished solely on the basis of this difference in hook morphology, and as a result the interpretation of the hook process in *O. convolutum* and *O. triacis* critically affects the generic placement of these two species.

YAMAGUTI (1952; 41) described the bothridial hooks of *A. triacis* as "bifid in one pair for each bothridium, unequal in length . . . outer prong of each hook shorter than inner." Because YAMAGUTI considered the process to be a prong he placed the species in the genus *Acanthobothrium*. YOSHIDA (1917; 578) described the bothridial hooks of *O. convolutum* as ". . . one pair of thorn-like simple dark brown hooks . . . the one being much larger than the other . . . . The paired hooks are closely apposed basally. Each hook is accompanied by a small process situated externally to its base and embedded in the tissue so as to be invisible from exterior."

YOSHIDA did not consider the process to be a prong and placed this species in the genus *Calliobothrium*. As *Calliobothrium* spp. typically possesses two pairs of simple hooks (single pronged with no process) per bothridium, this species was subsequently moved by SOUTHWELL (1925) to the genus *Onchobothrium*.

On the basis of its hollow nature, and position relative to the talon and axial prong, we consider the abaxial hook process to be homologous to the abaxial prong of other onchobothriids such as *Acanthobothrium* spp., *Phoreibothrium* spp., and *Platybothrium* spp. This homology is reflected in our measurements as distances A and A′ are normally reserved for abaxial prong length (CAIRA, 1985 a). However, in its present condition, with regard to any generic decisions, this structure should not qualify as full prong because (1) it is short and blunt rather than long and pointed, and (2) it is buried in bothridial tissue and therefore does not protrude from the bothridial musculature (Fig. 8); consequently there is only one functional prong per hook. This being the case both species clearly conform with the morphology of the genus

Onchobothrium and we support the current position of *O. convolutum* and advocate the transfer of *A. triacis* to the genus *Onchobothrium*.

One other species of *Onchobothrium* has been described with a potentially homologous hook structure. According to SOUTHWELL (1925; 28) the hooks of *Onchobothrium farmeri* (SOUTHWELL, 1911) SOUTHWELL, 1925 possess "curved tapering hair-like spinules" in addition to the talon and large axial prongs. These processes apparently do not protrude from the bothridial musculature. It is not clear from SOUTHWELL's description as to whether or not these structures are hollow, further study of this species is indicated.

In addition to *O. convolutum* and *O. triacis*, six species are currently recognized in the genus *Onchobothrium*: *O. farmeri; O. ganfini* MOLA, 1927; *O. lintoni* MOLA, 1927; *O. magnum* CAMPBELL, 1977; *O. schizacanthum* LOENNBERG, 1893; and *O. uncinatum*. Both *O. convolutum* and *O. triacis* differ from these six species in the medial hook being distinctly larger than the lateral hook, and in the presence of a blunt, hollow, abaxial process on each hook. The most conspicuous feature distinguishing *O. triacis* from *O. convolutum* is the ratio of mature proglottid length to width; in *O. triacis* this ratio ranges 1: 1.6–3.3, whereas in *O. convolutum* it ranges 1: 4.8–12. In addition, *O. triacis* has fewer proglottids (445–460 as compared to 606–754 in *O. convolutum*).

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