

***Litobothrium alopias* and *L. coniformis*, Two New Cestodes  
Representing a New Order from Elasmobranch Fishes**

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## *Litobothrium alopias* and *L. coniformis*, Two New Cestodes Representing a New Order from Elasmobranch Fishes<sup>1</sup>

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A massive infection of two unusual cestodes was found in the spiral valve of two bigeye thresher sharks, *Alopias superciliosus* (Lowe, 1840) (O. Pleurotremata, Fam. Aloiidae). The first shark was caught on 22 October 1966, in about 183 meter (100 fathoms) of water, one and one half nautical miles off Newport Beach, California. The second host was found on 24 August 1968, shot through the head, on Bolsa Chica State Beach, Huntington Beach, California.

Under the existing systems of cestode classification (Hyman, 1951; Wardle and McLeod,

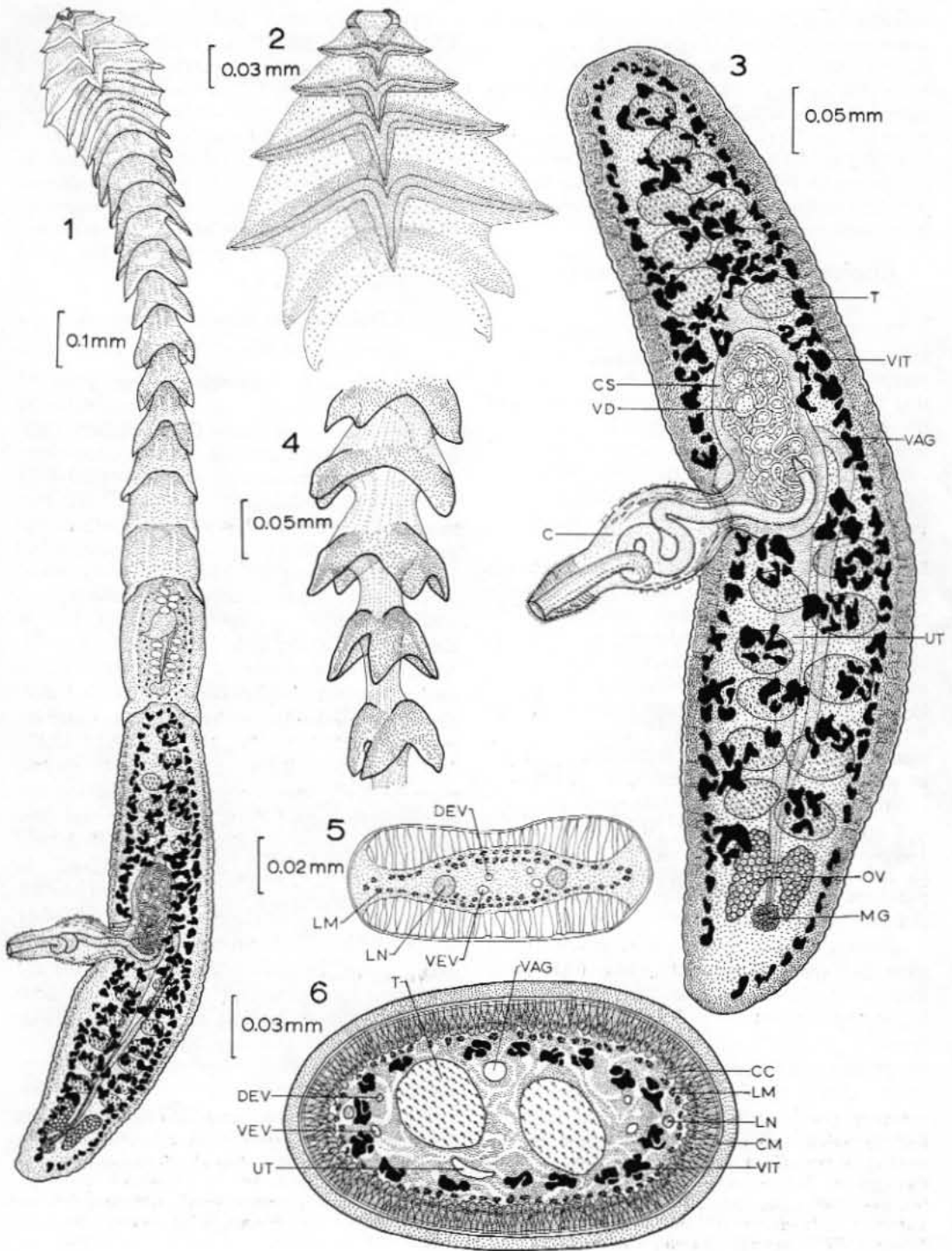
1952; Yamaguti, 1959; Joyeux and Baer, 1961), holdfast morphology is used as the distinguishing characteristic at the ordinal level. In light of the unique holdfast features which restrict placement of these two distinct cestodes in any existing orders, coupled with the fact that the parasite is well established, being found in large numbers in two separate hosts examined almost two years apart, the new order Litobothrida is proposed.

### Methods

Worms were removed from the spiral valve and fixed in Lavdowsky's fluid (AFA) and Bouin's fluid. Whole mounts were stained with

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Figures 1-6. *Litobothrium alopias* gen. n., sp. n. 1. Strobilate worm. 2. Anterior end of specimen showing apical sucker and modified segments. 3. Mature proglottid. 4. Segments number 16-19 showing isthmus between four muscular, lacinated projections. 5. Transverse section through muscular region of Figure 4. 6. Transverse section through preovarian region of mature proglottid. Abbreviations: C, cirrus; CC, cuticular cells; CM, circular muscle; CS, cirrus sac; DEV, dorsal excretory vessel; LM, longitudinal muscle; LN, lateral nerve; MG, Mehlis gland; OV, ovary; T, testis; UT, uterus; VAG, vagina; VD, vas deferens; VEV, ventral excretory vessel; VIT, vitellarium.



celestine blue B and Semichon's carmine. Specimens were sectioned singly and *in situ* at 6, 8, and 10  $\mu$  and stained with haematoxylin-eosin and Mallory's trichrome. All material was dehydrated in ethanol, cleared in xylene and mounted in Piccolyte. Drawings were made with the aid of a drawing tube. All measurements are in microns unless otherwise stated. Average measurements are given, with ranges in parentheses.

*Litobothrium alopias* gen. n., sp. n.  
(Figs. 1-6, 11-13)

The following description is based on 30 specimens. Specific diagnosis: small, laciniated, craspedote, anapolytic worms, measuring 2.27 mm (1.65-3.70) in length. Strobila consists of 29 (20-34) segments (Fig. 1). In gravid worms, mature proglottid approximately 7 times longer than broad, 780 (330-1570) long by 190 (125-290) wide. Apical sucker cup or clamp shaped, strongly muscled, measuring 38.0 (30.0-59.0) in diameter by 26.5 (18-37) in depth (Fig. 2). Anterior four segments modified into accessory holdfast structures which are cruciform in cross section. Strobila swelling in width immediately posterior to apical sucker, reaching maximum body width at fourth segment 220 (120-340) decreasing to 190 (125-290) in mature and gravid segments (Fig. 2). Segments 16-19 on all specimens show an unusual formation with an isthmus between four muscular, laciniated projections which fold about the next segment (Figs. 4, 5). Testes spherical to subspherical, 20 (15-27) in number, 39 (28-50) in diameter, in two distinct rows, approximately equal numbers occurring pre- and postporally. Vas deferens forming large mass of coils in mature proglottid. Cirrus sac large, extending more than half proglottid width, 164 (108-210) long by 87 (70-125) wide. Cirrus armed with minute spines distally and small peg-like projections proximally. Genital aperture lateral, irregularly alternating, approximately midsegment. Ovary posterior, bilobed, X-shaped in transverse section. Vitellaria large amorphous follicles encircling proglottid (Fig. 6).

HOST: Bigeye thresher shark *Alopias superciliosus*.

LOCATION: Spiral valve.

LOCALITY: Newport Beach, California.

TYPE SPECIMENS: Holotype and paratypes USNM Helm. Coll. Nos. 71324, 71325.

REMARKS: In transverse section the X-shaped cerebral ganglion is found 90-100 posterior to the apical sucker. It is similar to that shown by Rees (1959) for *Ditrachybothrium macrocephalum*. The apical sucker is elliptical in shape (Fig. 12) and in *en face* view an internal, horizontal slit is seen extending the diameter of the sucker. The sucker functions in a clamp-like manner during attachment to the spiral valve mucosa (Fig. 13).

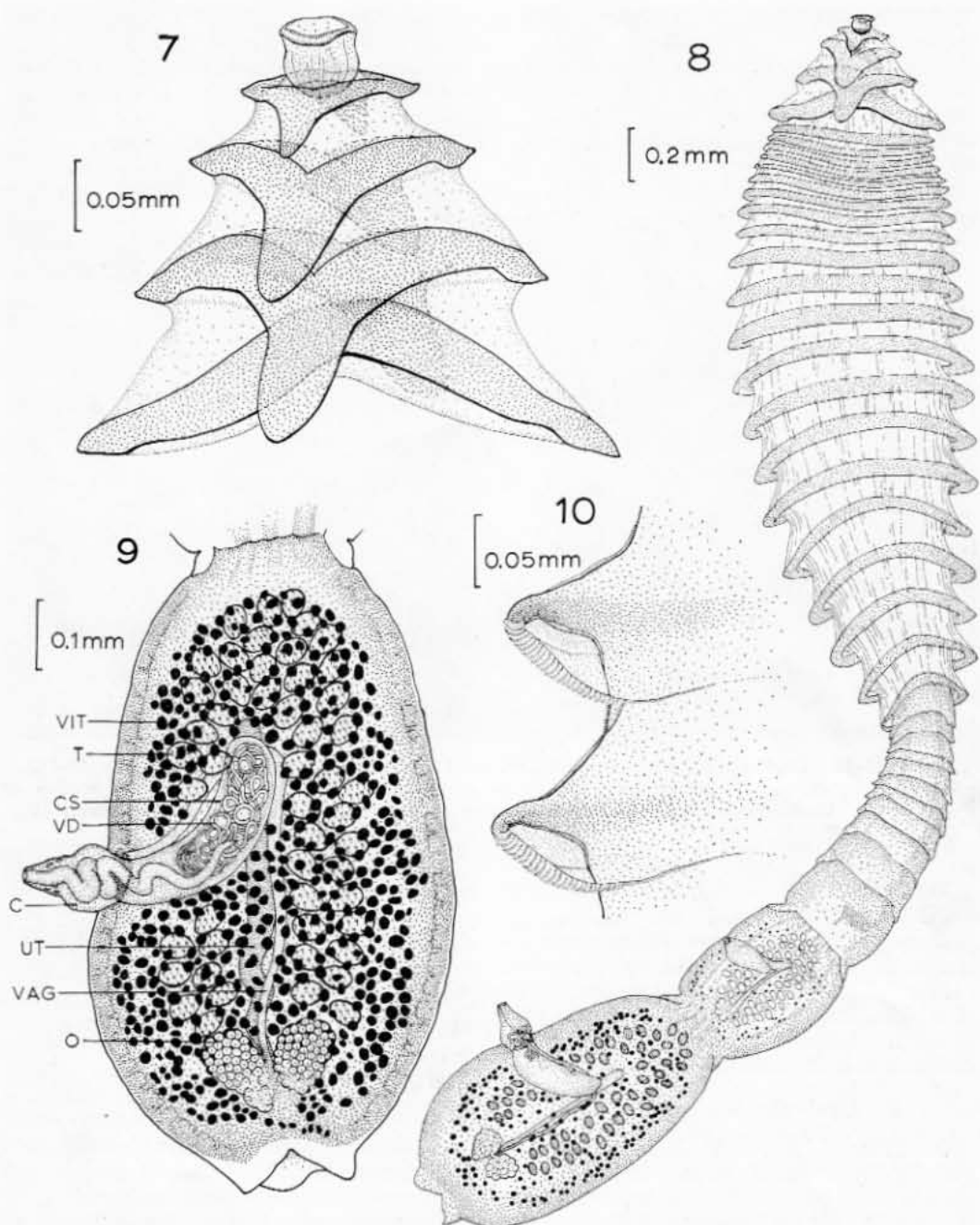
*Litobothrium coniformis* sp. n.  
(Figs. 7-10)

The following description is based on 25 specimens recovered from the spiral valve of two bigeye thresher sharks from Southern California. Specific diagnosis: Small, craspedote, apolytic worms measuring 4.14 mm (2.0-8.0) in length. Strobila consists of 41 (29-51) segments. Only terminal proglottid mature, approximately 4 times longer than broad, 1,103 (600-2,160) long by 363 (200-600) wide. Apical sucker bowl shaped, not clamp like, weakly muscled, measuring 62.0 (46-90) in diameter by 46.0 (22.0-70.0) deep (Fig. 7). Anterior three segments with dorso-ventral projections. Strobila swelling in width immediately posterior to apical sucker, reaching maximum width at 18-19 segment 515 (320-790) narrowing to 363 (200-600) in mature segment (Fig. 8). Segments numbering approximately 4-24 fit into each other and possess rows of minute spines under their lateral projections (Fig. 10). Testes 50 (47-52) in number, spherical or subspherical, 36 (22-50) in diameter; 10 (1-11) preporal, 32 (31-34) antiporal, 8 (7-9) postporal. Vas deferens highly coiled in mature proglottid. Cirrus sac moderate, extending just to center of proglottid, 209 (120-320) long by 205 (110-320). Cirrus unarmed. Genital aperture lateral, irregularly alternating, approximately midsegment. Ovary bilobed, irregularly shaped. Vitellaria follicular, occurring as small discrete spheres encircling proglottid (Fig. 9).

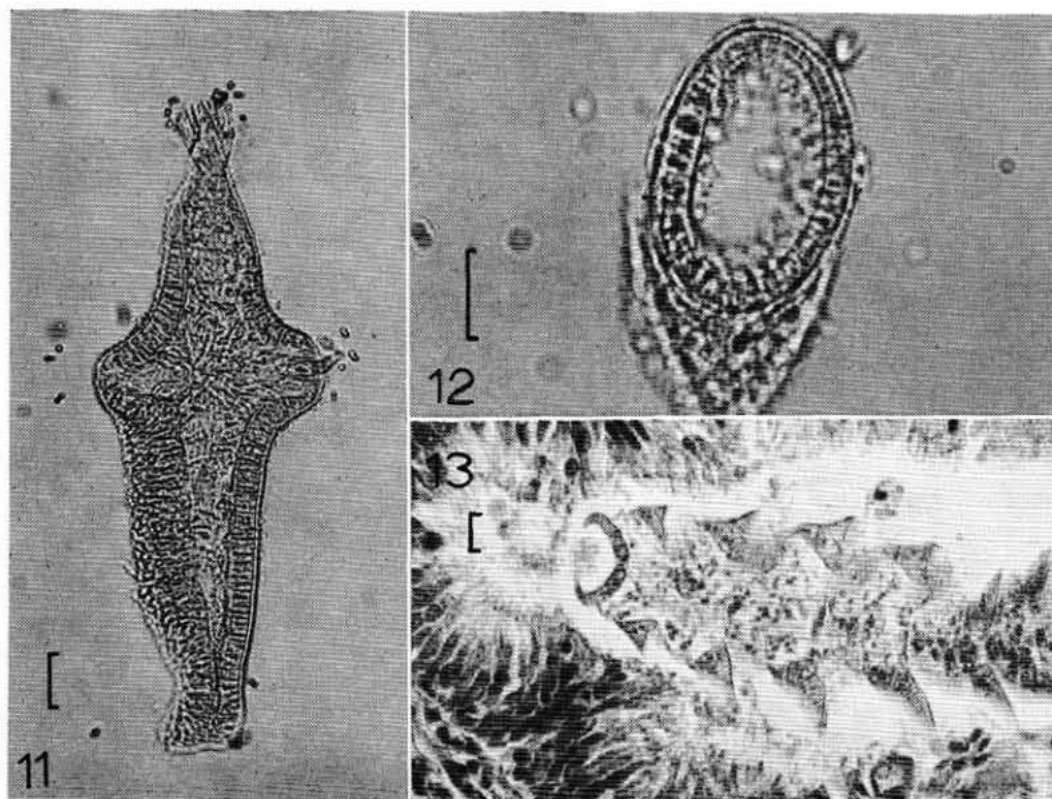
HOST: Bigeye thresher shark *Alopias superciliosus*.

LOCATION: Spiral valve.

LOCALITY: Newport Beach, California.



Figures 7-10. *Litobothrium coniformis* sp. n. 7. Anterior end of specimen showing apical sucker and modified segments. 8. Strobilate worm. 9. Mature terminal proglottid. 10. Minute spines found under lateral projections of segments 4-24.



Figures 11-13. *Litobothrium alopias* gen. n., sp. n. 11. Transverse section approximately 90-100  $\mu$  posterior to apical sucker showing cruciform shape of modified segments. 12. Transverse section of apical sucker. 13. Section of specimen *in situ* showing attachment in spiral valve. Bars indicate 10  $\mu$ .

TYPE SPECIMENS: Holotype and paratypes USNM Helm. Coll. Nos. 71364, 71365.

REMARKS: *L. conformis* differs from *L. alopias* in shape and size of apical sucker, number of modified anterior segments, width of strobila, length of strobila, number of segments, number of testes, size of cirrus pouch, ornamentation of cirrus and shape of vitellaria.

#### Litobothridea ord. n.

ORDER DIAGNOSIS: Eucestoda. Scolex a single, well-developed apical sucker. Anterior proglottids modified; cruciform in transverse section. Neck lacking. Strobila dorso-ventrally flattened with numerous proglottids, reproductive organs single, medullary. Proglottids lacinated and craspedote; apolytic or anapolytic. Testes numerous, medullary, preovarian. Geni-

tal pores lateral. Ovary two or four lobed, posterior. Vitellaria follicular, encircling medullary parenchyma. Eggs not reaching onchosphere stage while in uterus. Adults in spiral valve of elasmobranchs.

#### Litobothridae fam. n.

FAMILY DIAGNOSIS: Litobothridea. Small worms, lacinated and craspedote. Scolex a single apical sucker followed by anterior modified segments. Strobila dorso-ventrally flattened; segmentation distinct. Inner longitudinal muscles well-developed, forming boundary between cortex and medulla. Excretory stems in medulla. Testes numerous, medullary. Cirrus sac present. Genital pores lateral, alternating irregularly. Ovary two or four lobed, posterior. Vitellaria follicular, encircling entire proglottid.

Eggs rounded to oval shaped. Parasitic in elasmobranchs.

TYPE GENUS: *Litobothrium* gen. n.

***Litobothrium* gen. n.<sup>1</sup>**

GENERIC DIAGNOSIS: Litobothridae. Scolex with single apical sucker followed by modified anterior segments; neck absent. Strobila swelling in width immediately behind apical sucker. Excretory stems medial to muscle sheath. Testes numerous, nearly symmetrical, medullary. Cirrus pouch reaching mid-segment. Vas deferens, coiled. Ovary median, posterior. Vitellaria encircling proglottid, extending posterior to ovary. Parasites of elasmobranchs.

TYPE SPECIES: *Litobothrium alopias*.

**Discussion**

Many previous classifications of the Cestoda have been published. A review of these attempts is found in Southwell (1925). Southwell (1925) suggests dividing the Cestoda into five orders "based primarily on the characters of the head." He lists the orders Pseudophyllidea, Cyclophyllidea, Tetracyllidea, Trypanorhyncha, and Heterophyllidea, the latter order being erected to contain those forms found in elasmobranchs that do not fit into Tetracyllidea or Trypanorhyncha. The Proteocephala and Lecanicephala are considered families of Cyclophyllidea.

Southwell (1930) revised his classification into two orders (Cestodaria and Eucestoda) and six superfamilies (Dibothriocephaloidea, Tetracyllidea, Phyllobothroidea, Lecanicephaloidea, Proteocephaloidea, and Taenioida). No mention is made of Heterophyllidea and those genera previously placed in that order are now listed as "Genera of uncertain Systematic Position."

Since Southwell (1930), some other cestode classifications have been proposed by Hyman (1951), Wardle and McLeod (1952), Riser (1955), Euzet (1959), Yamaguti (1959), and Joyeux and Baer (1961).

Hyman's (1951) classification is modified from Southwell (1930). Elasmobranch cestodes are placed into four orders: Tetracyllidea, Trypanorhyncha or Tetrarhynchoidea, Diphylloidea, and Lecanicephaloidea. These orders are retained by Yamaguti (1959) with

only a spelling modification of Lecanicephaloidea. Wardle and McLeod (1952) retain the orders Tetracyllidea, Trypanorhyncha, and Lecanicephala but differ from the preceding authors in the addition of Disculiceptidea and the deletion of Diphylloidea. Riser (1955) divided the Cestoda into two superorders, Trixenidea and Dixenidea, based on the number of hosts in the life cycle. Riser includes all the elasmobranch cestodes in the orders Tetracyllidea and Trypanorhyncha (=Tetrarhynchoidea). Euzet (1959) and Joyeux and Baer (1961) also use these two groups to include all elasmobranch cestodes with the exception of the echinobothriids, which they retain in order Diphylloidea. Of these classifications, the author agrees with the latter two workers that the Lecanicephala should be included in Tetracyllidea and Diphylloidea should be retained based on scolex types.

The scolex of Litobothridea ord. n. consists of a single apical sucker. This feature, coupled with the auxiliary holdfast modification of the anterior segments, is unique and restricts placement of these two distinct cestodes in any existing order.

Features of Litobothridea ord. n. resemble a combination of cestodes found in several existing orders. The single apical sucker is reminiscent of that described by Yamaguti (1939) for *Nippotaenia chaenogobii*, the representative species for the order Nippotaeniidea. However, this is the only common feature between these two orders and even these are morphologically distinct. The extensive swelling in width behind the holdfast organ approximates that shown for *Discobothrium cobraeformis* (= *Hornellobothrium cobraeformis*) and *Eniochobothrium gracile* Shipley and Hornell (1906).

The mature proglottid resembles that of Tetracyllidea in the preovarian position of the testes, the position of the vagina dorsal to the uterus, and the opening of the vagina anterior to the cirrus, while the continuous, sleeve-like distribution of the yolk glands and the muscular cirro-vaginal atrium are trypanorhynchan in nature.

The bigeye thresher shark has been reported from Southern California only six times prior to this report (Dr. Sheldon Applegate, Los Angeles County Museum, personal communication). The finding of massive infections of

<sup>1</sup> *Litos* (Gr.) = simple, plain; *bothrios* (Gr.) = pit.

these cestodes in both bigeye thresher sharks examined over a 2-year period indicates that this parasite is well established. It is the opinion of the author that this fact, in addition to the unique morphological features possessed by these cestodes, justifies the erection of a new order. It is highly probable that additional cestodes with this unique type of hold-fast will be found on subsequent examinations of other elasmobranchs. At that time the various morphological characters can be evaluated to determine their importance at the familiar and generic levels.

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