

VARIATIONS IN THE MORPHOLOGY OF  
*FISTULICOLA PLICATUS* RUDOLPHI (1802)  
(CESTODA:PSEUDOPHYLLIDEA) FROM  
THE SWORDFISH, *XIPHIAS GLADIUS* L.,  
IN THE NORTHWEST ATLANTIC OCEAN

During the course of a survey of the helminth parasites of the swordfish, *Xiphias gladius* L., from the Northwest Atlantic Ocean, several morphological variations were observed in specimens of the pseudophyllidean tapeworm, *Fistulicola plicatus*. The most notable of these variations were pseudoscolex form and proglottid shape and size. Methods of scolex attachment to the organ wall, descriptions of pseudoscolex structures, and organ specific variations in the morphology of *F. plicatus* are given.

#### Materials and Methods

A sample of 303 gills and gastrointestinal tracts of swordfish was collected from four geographical areas in the Northwest Atlantic Ocean in the late summer and early fall of 1980. The areas sampled and the number of swordfish collected from each geographical area are as follows: Cape Hatteras (74), Georges Bank (90), Scotian Shelf (69), and Grand Bank (70); all collected by longline gear and frozen at sea. The swordfish were later dissected and examined for helminth parasites in the laboratory.

Pseudophyllidean cestodes were removed from the infected organ and fixed whole in 70% alcohol or 10% Formalin<sup>1</sup>. Several infected organs were fixed whole in Bouin's fluid or 10% Formalin. Specimens used for taxonomic examinations were stained in Erlich's hematoxylin, Blachin's lactic acid carmine, or Semichon's aceto-carmine. Camera lucida drawings were made from fixed, unstained specimens.

#### Results

*Fistulicola plicatus* has been reported from the swordfish by Linton (1901), Cooper (1918), Nigrelli (1938), and Iles (1970). In this study *F. plicatus* was found in the intestines and rectums of swordfish from all four sampling areas. Considerable morphological variation was found between individuals of this species. Variations were in scolex form, overall parasite length, and proglottid shape and size. About 50% of specimens recovered exhibited a scolex and proglottid structure characteristic of specimens

described by Yamaguti (1959). Scolices from these were arrow-shaped and possessed two simple, leaf-shaped bothridia (Fig. 1). Any variation from this scolex form were considered to be pseudoscolices. Proglottids from specimens described by Yamaguti (1959) were short and broad with foliate lateral edges. Internal proglottid morphology was not easily seen in any of the specimens examined during the present study, although nerve trunk location (near lateral margins), cirrus-sac and vagina location (on opposite lateral margins), and egg shell structure (thick-shelled and operculate) were occasionally observable.

A total of 29 specimens recovered had penetrated the wall of the infected organ. Occasionally the tapeworms penetrated the organ wall and retained typical scolex form, i.e., arrow-shaped with simple, well-developed bothridia but, in the majority of cases, complete perforation of the organ wall resulted in the formation of a pseudoscolex. Attachment to the organ wall (rectum and intestine) was achieved in the following four ways:

- 1) By complete perforation of the organ wall, the scolex and a portion of the neck encapsulated in a rounded, host-produced cyst attached to the organ serosa. Scolices recovered from these cysts were usually arrow-shaped with typical bothridia, or occasionally found as a round, transparent, fluid-filled bag, which possessed rudimentary or no apparent bothridia (Fig. 2).
- 2) By complete perforation of the organ wall, the scolex and a portion of the neck encased in a tubular, host-produced sheath, attached along its entire length to the organ serosa. Occasionally this sheath was entwined with the mesenteries associated with the infected organ. Pseudoscolices found within these sheaths were long, rounded, and slender, and exhibited no bothridia (Fig. 3).
- 3) By complete penetration of the organ wall, the scolex markedly enlarged (up to 6 cm in length), lying free, and unencapsulated in the peritoneal cavity. Pseudoscolices of this type were long, broad, pseudosegmented, and possessed well-developed bothridia (Fig. 4).
- 4) In this case the scolex did not fully penetrate the organ wall, but perforated the wall to a slight depth, and remained in that position. Often specimens were found to exhibit this slight organ wall penetration and re-emerge into the lumen of the organ. In these cases the

<sup>1</sup>Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

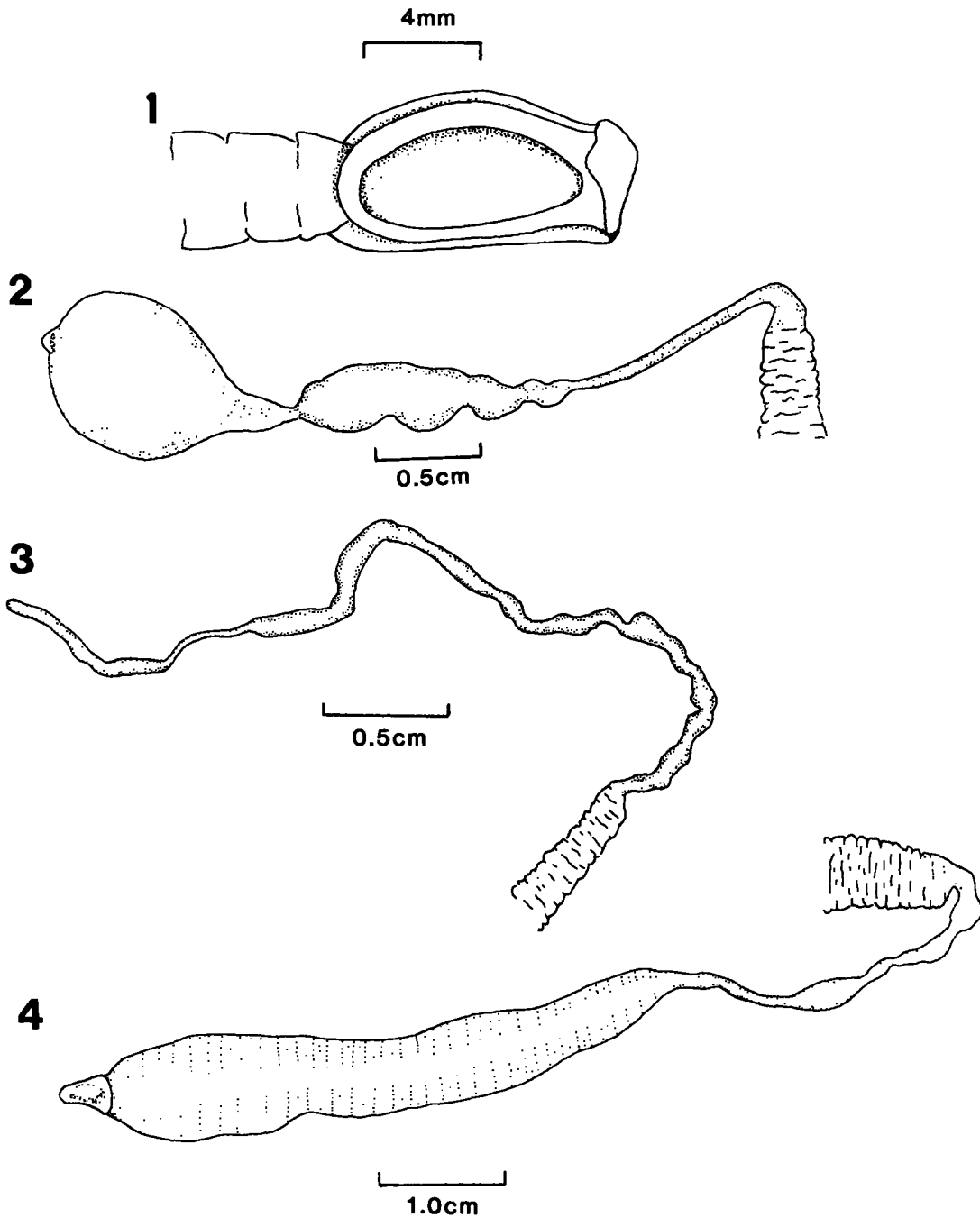


FIGURE 1.—Typical scolex from *Fistulicola plicatus*, as described and figured by Yamaguti (1959).

FIGURE 2.—Pseudoscolex (1st type).

FIGURE 3.—Pseudoscolex (2d type).

FIGURE 4.—Pseudoscolex (3d type).

- 1) scolex type described by Yamaguti (1959) was retained.

*Fistulicola plicatus* specimens recovered from the lumen of the intestines were morphologically different from those collected from the rectum. They were long, up to 1 m in length, and exhibited longer, less-broad strobila than those characteristic of the rectal forms. All specimens of *F. plicatus* recovered from the anterior portion of the intestine exhibited the previously described first type of scolex attachment to the organ wall, i.e., the scolex perforated the organ wall and was encapsulated in a rounded, host-produced cyst attached to the intestinal serosa. The scolex penetrated the anterior portion of the intestine, with the strobila projecting posterior through the length of the organ. Very small *F. plicatus* were found in the posterior portion of the intestine. These exhibited shallow penetration by an unmodified scolex.

*Fistulicola plicatus* specimens found in the rectum of swordfish were usually <20 cm in length and possessed very broad strobila. These rectal forms exhibited all of the previously described types of scolex attachment and structure, penetrating the organ wall near the rectal sphincter (Fig. 5). Occa-

sionally, several tapeworms were found with their necks passing through a single perforation of the rectal wall, their scolices jointly encapsulated in a rounded serosal cyst.

#### Discussion

Apex type predators such as the swordfish eat and digest large amounts of prey species and, consequently, the intestines and rectums of these fish exhibit high levels of muscular activity. Without perforation of the organ wall (by the scolex and neck), many tapeworms would probably be voided with the faeces. The development of the pseudoscolex is an adaptation for anchoring the simple, unarmed scolex to the organ wall. It is clear that *F. plicatus* secretes a powerful digestive enzyme which enables the scolex to penetrate the very muscular walls of the intestine and rectum of swordfish. Iles (1970) found many examples of pseudoscolex variation in 24 specimens from swordfish in the Northwest Atlantic Ocean. Several of these variations are similar to those found in this study. It is obvious from this study, and studies such as Iles (1970), that *F. plicatus* is a very adaptable tapeworm and will develop any pseudoscolex structure which is neces-

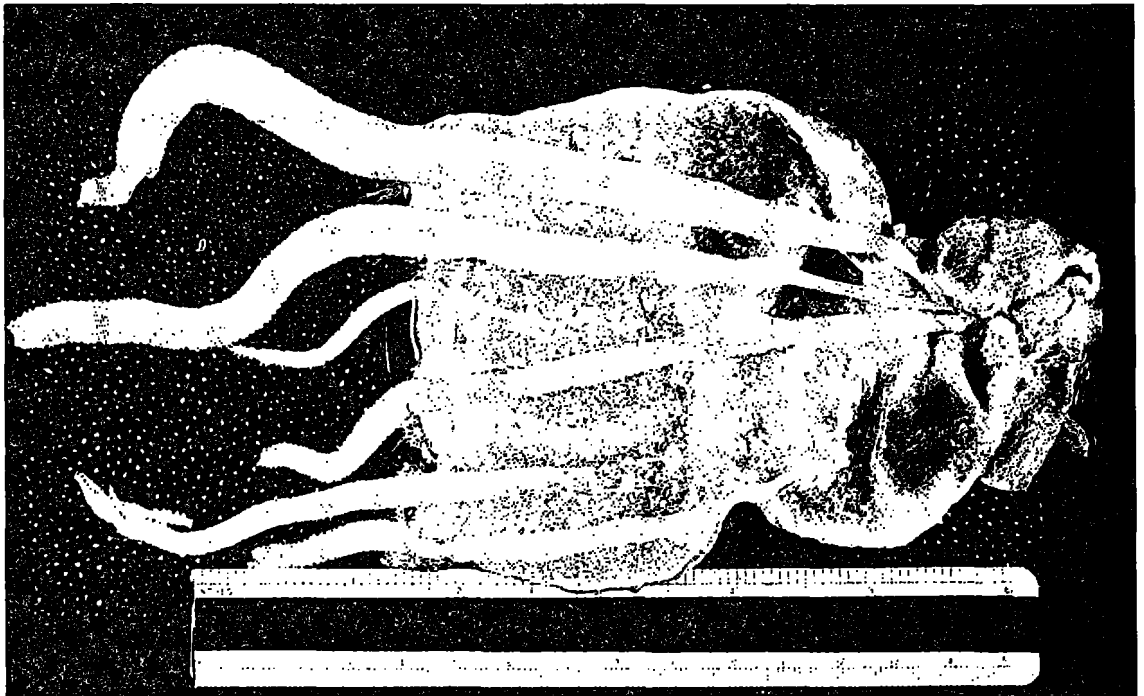


FIGURE 5.—*Fistulicola plicatus* (in situ) from rectum of *Xiphias gladius*.

sary to anchor itself to the organ wall. Large samples of swordfish intestines and rectums will invariably show many variations in the pseudoscolex structure of *F. plicatus*.

#### Acknowledgments

We thank L. S. Uhazy for initiating the study of these parasites, C. Iles for comments on the manuscript, P. W. G. McMullon for advice on figures, and B. Garnett for preparing the typescript.

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