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OTOBOTHRIUM PENETRANS (CESTODA; TRYPANORHYNCHA) IN THE FLESH OF BELONID FISH FROM PHILIPPINE WATERS

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Abstract—PALM, H., MÖLLER, H. and PETERSEN, F. 1993. *Otobothrium penetrans* (Cestoda; Trypanorhyncha) in the flesh of belonid fish from Philippine waters. *International Journal for Parasitology* **23:** 749–755. In April 1990, 488 marine fish belonging to 30 species from central Phillipine waters were examined for flesh parasitic infections that may affect their consumability. One species of hemirhamphids and 3 species of belonids harboured plerocercoids of *Otobothrium penetrans* Linton, 1907 (*Proceedings of the U.S. National Museum* **33**, 85–126). This is the first record of this parasite from Pacific fish species. The highest intensity of infection found was 8 in *Tylosurus crocodilus*. Most of the larvae were located between the dorsal spines of the vertebral column, only 32% were found in the fillets. Based on the present material we give a description of the plerocercoid stage of the species using scanning electron microscopy of the armature and morphometrical measurements. Comparison to results from earlier findings of *O. penetrans* by Linton (1907; 1924, *Proceedings of the U.S. National Museum* **64**, 1–114) and to *O. kurisi* by Shields (1985, *International Journal for Parasitology* **15**: 635–643) lead to the conclusion that the latter species is a synonym for *O. penetrans*.

INDEX KEYWORDS: *Otobothrium penetrans*; *O. kurisi*; Trypanorhyncha; flesh parasite; Belonidae; Hemiramphidae; Philippines.

INTRODUCTION

CESTODE flesh parasites belonging to the order Trypanorhyncha have been reported from various oceans (Collins, Marshall & Lanciani, 1984; Dollfus, 1942; Overstreet, 1977; 1978; Reimer, 1984; Sakanari & Moser, 1986; Seyda, 1976; Subhapradha, 1955; Szuks, Kamann & Brandt, 1975). Their presence in the flesh can reduce the market value of the fish affected. The steady decline in the landings of barracouta (*Thyrsites atun*) in New Zealand since 1938, for example, has been a result of reduced commercial demand due to high incidence of such flesh parasites (Mehl, 1970). Infestation with plerocercoids of *Nybelinia surmenicola* and *Pyramicocephalus phocarum* as well as with third-stage larvae of *Anisakis simplex* and *Phocanema decipiens* was the reason that for a long period of time Alaska pollack (*Theragra chalcogramma*) had been considered not aceptable for human consumption (Grabda, 1977). Trypanorhynchids mature in elasmobranchs. Human infections thus are scarce and accidental (Fripp & Mason, 1983; Heinz, 1954; Kikuchi, Takenouchi, Kamiya & Ozaki, 1981).

In April 1990, 30 fish species from the Visayan Sea in the central Philippines were investigated for the occurrence of parasites in their flesh (Petersen, Palm, Möller & Cuzi, 1993). The aim of that study was to identify the risk of human infections by parasites through eating raw fish, particularly the local dish kinilaw, which is prepared from slightly marinated marine fish. The identification and description of the cestode larvae found during that survey are the subject of this investigation.

No former records on cestodes in the flesh of marine fish from the Philippines are available. The present material is compared to earlier findings of larval *O. penetrans* in belonid fish from the Bermudas (Linton, 1907) and of adult *O. kurisi* in a hammerhead shark (Shields, 1985) from the Californian coast.

MATERIALS AND METHODS

Fish were bought at local markets or directly from fishermen on the islands of Cebu, Mactan and Leyte. All fish came from the Visayan Sea in the central Philippines. Among 488 specimens from 30 species investigated, 30 fish belonged to 2 species of hemirhamphids and 47 fish to 4 species of belonids. The fresh fish were examined for the presence of parasites in their flesh. They were measured, filleted and the skin removed. The fillets were pressed between 2 acrylic plates to a thickness of approximately 3–5 mm. The search was done macroscopically. All parasites were fixed and stored in 70% alcohol. The parasites were examined with light and scanning electron microscopy. For SEM investigations, specimens were dehydrated in an alcohol series, transferred to ether, air-dried and mounted with silver paint on to stubs. Stubs were coated with gold–palladium in an argon atmosphere at 1.2 kV/40 mA/0.1 Torr and examined and photographed in a Jeol JSM-35C scanning electron microscope at 15 kV. Eight specimens were studied in the 26–10000 × range of magnification. All measurements given are in micrometers (μm) with ranges in parentheses unless otherwise indicated.

RESULTS

Plerocercoids of the trypanorhynch cestode *Otobothrium penetrans* Linton, 1907 were found in fish species belonging to the hemirhamphids and belonids (Table 1). A total of 28 parasites was recovered from 11 fish with a maximum intensity of 8 in one *Tylosurus crocodilus*. Nineteen of the 28 plerocercoids found were located between the dorsal spines of the vertebral column, thus not affecting the fillets.

TABLE 1—OCCURRENCE OF *O. penetrans* IN THE FLESH OF BELONID AND HEMIRHAMPHID FISH FROM THE VISAYAN SEA

Fish species investigated	Number examined	Number infected	Maximum* intensity
Hyporhamphus dussumieri	10	2	2
Hemirhamphus far	20	0	0
Platybelone sp.	10	2	6
Platybelone argalus ssp.	3	0	0
Tylosurus acus	22	5	3
Tylosurus crocodilus	12	2	8

*Highest number of *O. penetrans* in the fish species.

The blastocysts removed from *T. acus*, *T. crocodilus* and *Hyporhamphus dussumieri* appear white and elongate with one enlarged end, containing the scolex with attachment organs and the presumptive germinal region (Fig. 1). Removed from the blastocyst, the scolex exhibits two patelliform bothridia (Fig. 2). They are covered with short, three-fingered microtriches (length: 2–3; width: 0.7–1). The margins of the bothridia carry 2 eversible horse-shoe shaped ciliated pits (Figs. 2 and 3A,B). In the everted form, long and slender, two-fingered cilia are visible (length: 5–8; width: 0.3–0.5). The median part of the scolex is elongated and slender and followed by a swollen pars bulbosa with laterally recurved bulbs (Fig. 2). At high magnification microtriches covering the surface of the parasite become evident. A round, long appendix of 1740 (1020–2220) covers most of the base of the scolex. A velum is absent. Measurements of the specimens and the bulb ratios (width to length) are given in Table 2.

The strong tentacles of the specimens investigated were more or less everted (approx. 30–80% of total length). The armature is heteroacanthous, heteromorphous atypical; bothridial and antibothridial surfaces of metabasal region with 7 principal hooks of different size and shape, arranged in ascending half-spiral rows, and two intercalary hooks (Figs. 4A, 5A,B and 6A,B). From the internal to the external surface large hooks (type 1: 80–125 long by 40–60 high by 60–80 in basal length) are followed by 4 rows of rose-thorn shaped hooks (type 2–5) diminishing in size (type 2: 45–55 long by 40–50 high by 45–50 in basal length; type 3: 40–45 long by 35–40 high by 40–50 in basal length; type 4: 20–30 long by 20–30 high by 25–30 in basal length; type 5: 20–25 long by 20–25 high by 20–25 in basal length). The external surface of the tentacle is occupied by a strong conspicuous (20–60 high) and a spiniform hook (15–20 high) (type 6 and 7). Two spiniform intercalary hooks (35–40) are situated nearby type 5 and 6 (Fig. 4B). In general, size of the metabasal hooks from the top to the base of the tentacle is increasing. The typical basal armature on the internal surface is represented by slender, strongly recurved hooks. On the external surface, among small and spiniform hooks, three leaf-like, triangular and strongly recurved hooks (30–60 high) become evident. In contrast to all other hooks of the basal armature the broad base is inserting horizontally (Figs. 4A,B, 5A and 6B).

Plerocercoids isolated from *Platybelone* sp. had a white oval appearance and were about half the size of those isolated from the other 3 fish species. Likewise the scolex measurements were smaller. The ratio of *pars vaginalis* to *pars bothridialis* was nearly the same (3.1–2.9). The bulb ratio of 3.9 was higher compared to that from *T. acus* 2.8 (2.2–3.5) and *T. crocodilus* 2.9 (2.5–3.1). The form of the bothridia, the ciliated pits and the armature of the proboscides were identical (Figs. 5A,B).

DISCUSSION

Linton (1907) described *O. penetrans* as a new species from the flesh of *T. acus* in the Bermudas. Linton (1924) reported the same plerocercoid from the flesh of another belonid, the needle-fish *T. raphidoma*, at Beaufort, N.C. The first finding of the adult form was from the hammerhead shark, *Cestracion* (= *Sphyrna*) *zygaena*, and from *Carcharhinus commersonii* in 1908 and 1907 (Linton, 1924). Shields (1985) enumerated *O. penetrans* as one of 14 valid species of *Otobothrium* and described a new species, *O. kurisi*, from the smooth hammerhead shark *Sphyrna lewini*, which differs from *O. penetrans* by having a smaller scolex (1900–2720 vs 4000–5000), a smaller bulb ratio (1.8 vs 2.9) and a bigger *pars vaginalis* to *pars bothridialis* ratio (2.8 vs 2.2).

Our material from Philippine waters closely resembles to both species, *O. penetrans* and *O. kurisi*. In parasites from *T. acus*, *T. crocodilus* and *Hyporhamphus dussumieri*, the scolex length is very variable, with an average of 3290, ranging from 2890 to 3780.

TABLE 2—SCOLEX MEASUREMENTS OF *O. penetrans* (μm)

Host	*Platybelone* sp.	*Tylosurus acus*	*Tylosurus crocodilus*
Number measured	1	7	3
Scolex length	1850	3380 (3020–3780)	3070 (2890–3240)
Pars bothridialis	370	910 (760–1070)	790 (710–890)
Pars vaginalis	1140	2670 (2450–2930)	2300 (2180–2450)
Pars bulbosa	410	680 (530–760)	740 (710–760)
Scolex width at			
Pars bothridialis	670	1740 (1560–2040)	1810 (1780–1870)
Median part	670	1210 (760–1780)	1570 (1470–1780)
Pars bulbosa	1380	2600 (2310–2890)	2790 (2670–2890)
Appendix length	1780	1810 (1020–2220)	1560 (1330–1780)
Bulb ratio	3.9	2.8 (2.2–3.5)	2.9 (2.5–3.1)
Pars vaginalis/ *Pars bothridialis*	3.1	2.9 (2.6–3.3)	2.9 (2.7–3.2)
Pars bothridialis/ *Pars bulbosa*	0.9	1.4 (1.1–1.7)	1.1 (1–1.2)

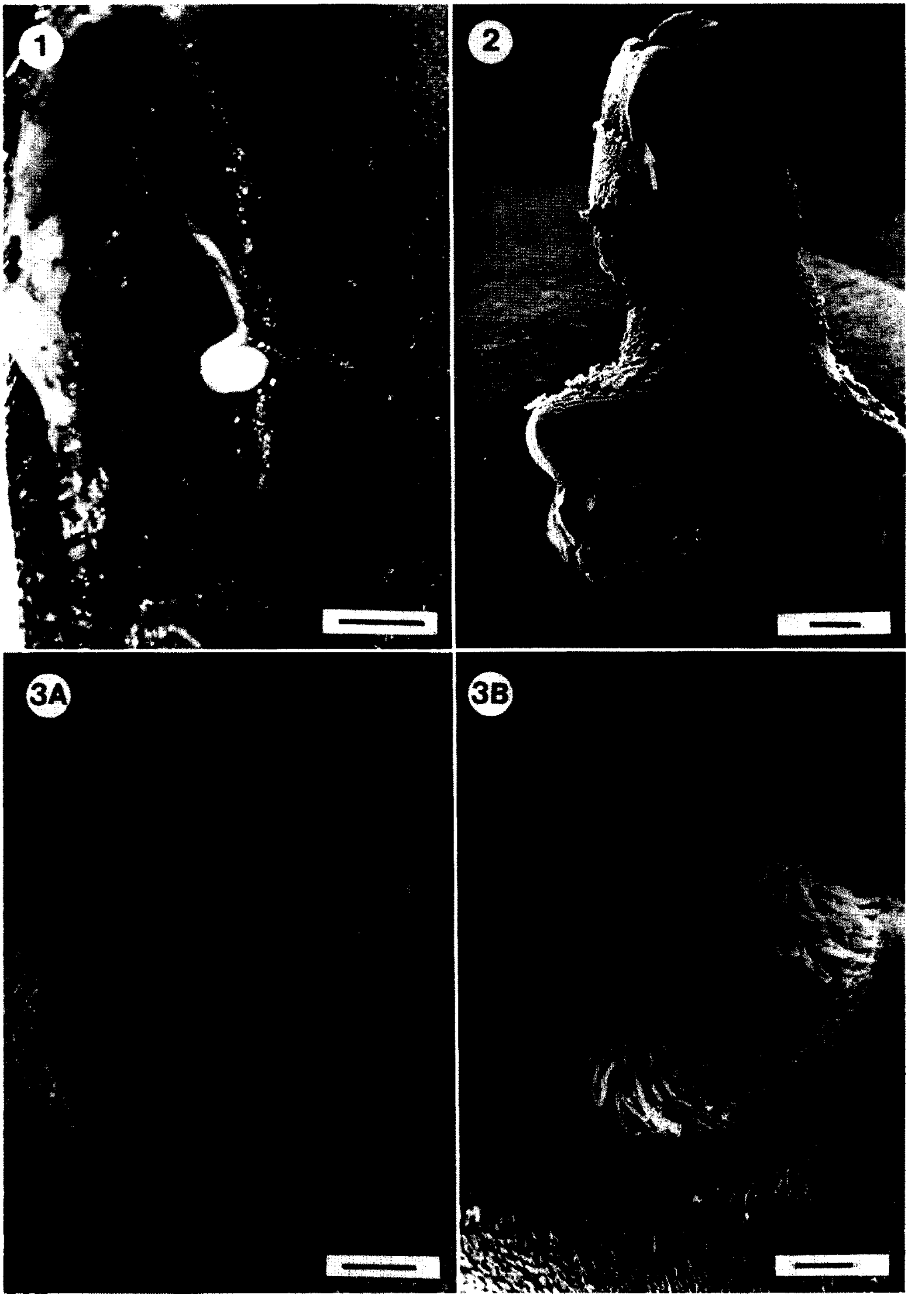
These measurements fall between the scolex lengths of *O. kurisi* (1900–2720) and *O. penetrans* (4000–5000), but they do not overlap. In a parasite from *Platybelone* sp. the scolex length was only 1850 and quite smaller than values given for both otobothriid species. SEM-micrographs of the armature of this specimen show, however, that it belongs to the same trypanorhynchid species found in the other belonids.

The mean bulb ratios of the plerocercoids from *Platybelone* sp. (3.9), *T. acus* (2.8) and *T. crocodilus* (2.9) fit the ratio of *O. penetrans* (2.9) and not to *O. kurisi* (1.8). Remarkable is the large degree of variation for the bulb ratios of parasites from *T. acus* (2.2–3.5). Other similarities to *O. penetrans* are the habitus of the plerocerci (Fig. 2; Figs. 39–45 in Linton, 1907) and habitus and measurements of the hooks on the surface of the proboscis (Figs. 4A–6B; Figs. 46–48 in Linton, 1907). Linton characterized the armature of his specimens found in the flesh of *T. acus* from the western Atlantic by 2 rows of large strongly recurved hooks (90–125) on the internal surface. On the sides of the proboscis rose-thorn shaped hooks are standing in half-ascending rows. The external surface is covered with several small hooks (20–50) of different size and shape. On Fig. 48 two intercalary hooks become evident.

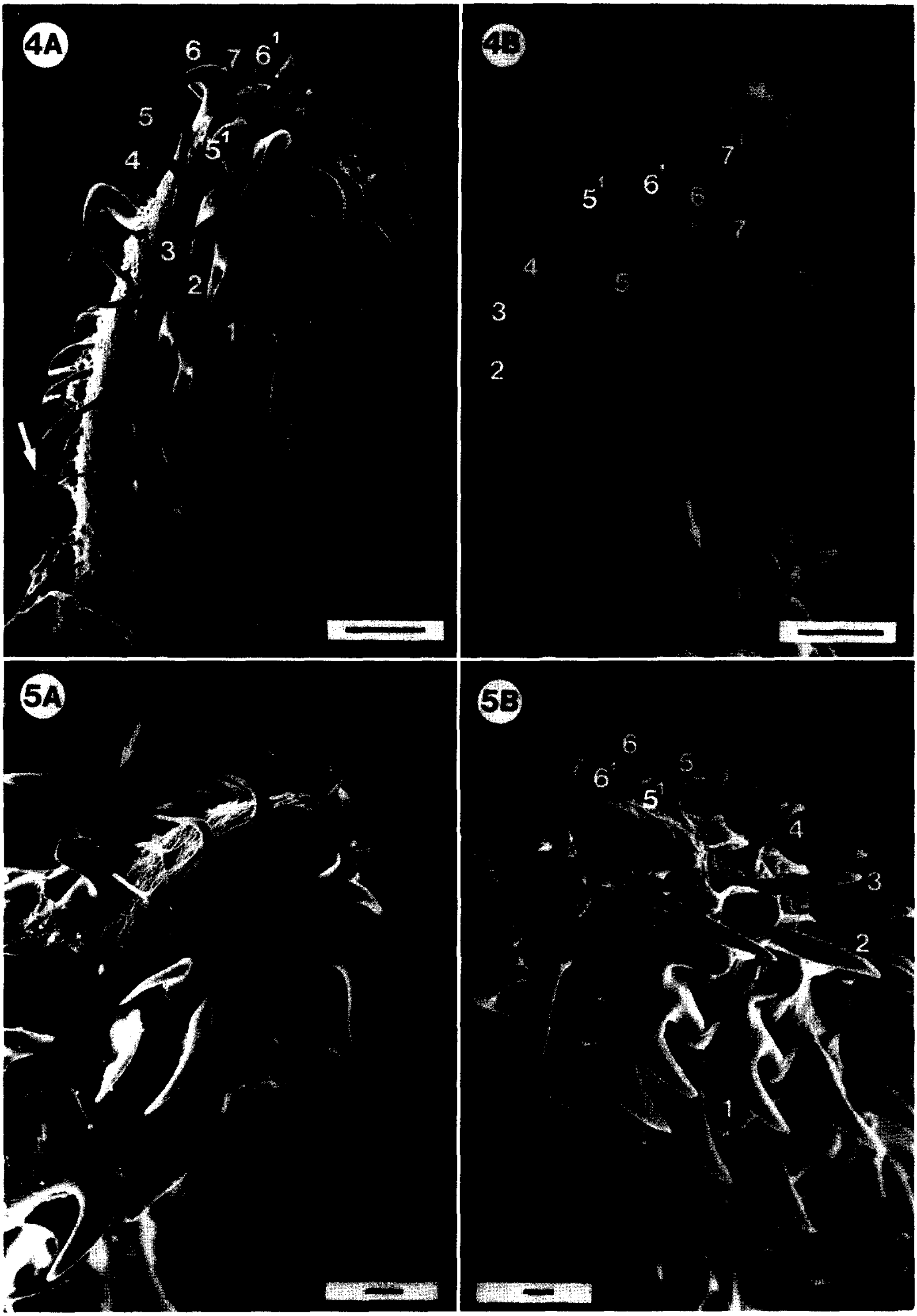
The ratios *pars vaginalis* to *pars bothridialis* (3.1, 2.9, 2.9) correspond to the value of *O. kurisi* (2.8). Also measurements of the hooks on the internal and external surface resemble to those given for *O. kurisi* by Shields (1985).

It is proposed that, in spite of some different morphometrical characteristics of the material from the Philippines, they all belong to *O. penetrans*, described from the Bermudas. This view is supported by the same second intermediate host species, the general shape and an identical arrangement of the armature of the plerocercoids from Philippine fish to those from the original description by Linton (1907).

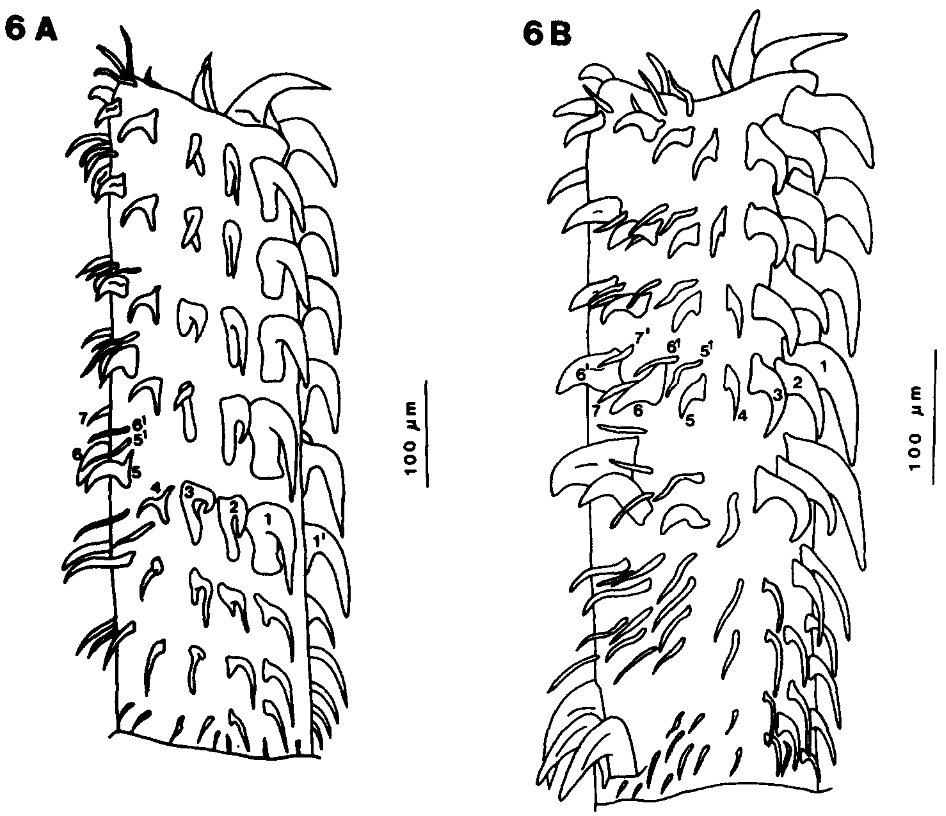
A comparison of the adults of *O. kurisi* and *O. penetrans* shows a strong similarity in the total length, the size of the immature segments as well as characteristics of the mature proglottides (e.g. general proportions, form of the ovary and a marginal genital atrium) (Figs. 67–68 in Linton, 1924 vs Fig. 2 in Shields, 1985). The surface of the scolex between the bothridia and the bulbs is covered by microtriches in both adults and in the plerocercoids of *O. penetrans*. Therefore *O. kurisi* may not be a valid species but a synonym for *O. penetrans*.



FIGS. 1–3.



FIGS. 4, 5.



FIGS. 6A–B. Schematical drawings of the armature of *O. penetrans* and morphological variability of the scolex. Hook numbering system follows Dollfus (1942). A. Bothridial surface. B. Antibothridial surface.

This first description of plerocercoids of *O. penetrans* from the Pacific Ocean shows the large variation in scolex morphology of this species, probably due to age and/or stage of fixation and storage. *O. penetrans* seems to have a worldwide distribution in the tropical zone with sharks of the genus *Sphyrna* as main final hosts and various belonid fish species serving as second intermediate hosts.

The necessity of SEM investigations on fully everted tentacles to identify the typical kind of armature for an exact identification of trypanorhynchid cestodes has to be emphasized.

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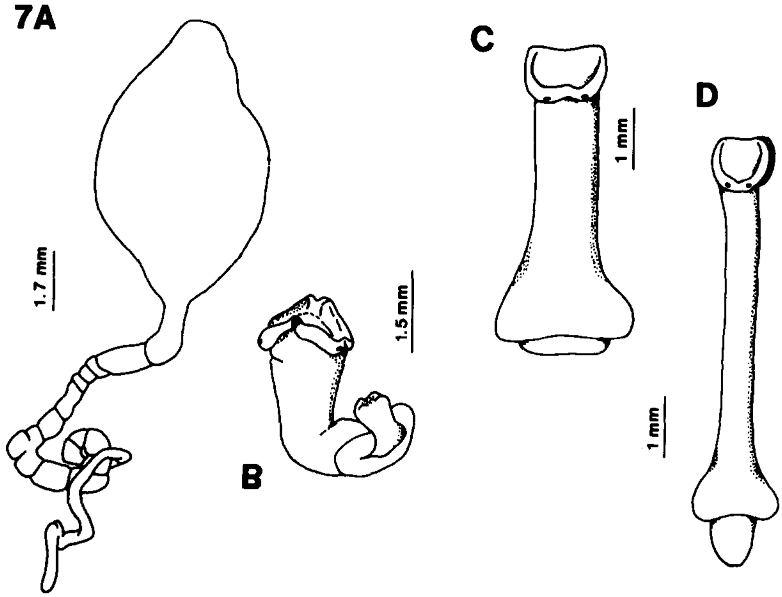
REFERENCES

COLLINS M. R., MARSHALL M. J. & LANCIANI C. A. 1984. The distribution of *Poecilancistrium caryophyllum* (Trypanorhyncha) plerocercoids in spot, *Leiostomus xanthurus* Lacepede, and spotted seatrout, *Cynoscion nebulosus* (Cuvier). *Journal of Fish Biology* **25:** 63–68.

DOLLFUS R. P. 1942. Études critiques sur les tétrarhynques du

FIGS. 1–3. General Morphology of *O. penetrans*. 1. Plerocercoid of *O. penetrans* in the flesh of *T. acus* (scale bar = 1 cm). 2. Scolex of *O. penetrans*. Note the ciliated pit on the bothridia (arrow) (scale bar = 250 µm). 3A. Invaginated sensory ciliated pit (scale bar = 5 µm). 3B. Evaginated sensory ciliated pit (scale bar = 5 µm).

FIGS. 4, 5. Tentacular armature of *O. penetrans*. Hook numbering system follows Dollfus (1942). 4A. Metabasal and basal armature of *O. penetrans* from *T. acus*, bothridial surface. Note the leaf-like hook of the basal armature (arrow) (scale bar = 50 µm). 4B. Metabasal and basal armature of *O. penetrans* from *T. acus*, external surface. Note the leaf-like hooks of the basal armature (arrow) (scale bar = 50 µm). 5A. Basal armature of *O. penetrans* from *Platybelone* sp., bothridial surface. Note the leaf-like hooks of the basal armature (arrow) (scale bar = 10 µm). 5B. Metabasal armature of *O. penetrans* from *Platybelone* sp., internal surface (scale bar = 10 µm).



FIGS. 7A–D. Schematical drawings of the armature of *O. penetrans* and morphological variability of the scolex. Hook numbering system follows Dollfus (1942). A. Form of the plerocercus. B–D. Scolexvariability of fixed specimens.

Muséum de Paris. *Archives du Muséum National d'Histoire naturelle Paris* **19:** 1–466.

FRIPP P. J. & MASON P. R. 1983. Spurious human infection with a trypanorhynchiid tapeworm. *South African Journal of Science* **79:** 473.

GRABDA J. 1977. Studies of the parasitation and consumability of Alaska Pollack, *Theragra chalcogramma* (Pall.). *Acta Ichthyologica et Piscatoria* **7:** 15–34.

HEINZ H. J. 1954. A case of tetrarhynchid (cestode) infection in man. *Revista Ecuatoriana de Entomologia y Parasitologia* **2:** 227–230.

IKUCHI Y., TAKENOUCHI T., KAMIYA M. & OZAKI H. 1981. Trypanorhynchiid cestode larva found on the human palatine tonsil. *Japanese Journal of Parasitology* **30:** 497–499.

LINTON E. 1907. Notes on parasites of Bermuda fishes. *Proceedings of the U.S. National Museum* **33:** 85–126.

LINTON E. 1924. Notes on cestode parasites of sharks and skates. *Proceedings of the U.S. National Museum* **64:** 1–114.

MEHL J. A. P. 1970. Two flesh parasites of barracouta (Teleosti: Gempylidae) from eastern Cook Strait. *New Zealand Journal of Marine and Freshwater Research* **3:** 241–247.

OVERSTREET R. M. 1977. *Poecilancistrium caryophyllum* and other trypanorhynch cestode plerocercoids from the musculature of *Cynoscion nebulosus* and other sciaenid fishes in the Gulf of Mexico. *Journal of Parasitology* **63:** 780–789.

OVERSTREET R. M. 1978. Trypanorhynch infections in the flesh of sciaenid fishes. *Marine Fish Review* **40:** 37–38.

PETERSEN F., PALM H., MÖLLER H. & CUZI M. A. 1993. Flesh parasites of fish from central Philippine waters. *Diseases of Aquatic Organisms* **15**: 81–86.

REIMER L. W. 1984. Häufig auftretende Helminthenlarven im Fleisch tropischer Fische. *Wissenschaftliche Konferenz an der Wilhelm Piek-Universität Rostock*: 82–84.

SAKANARI J. A. & MOSER M. 1986. Lesion induction by the plerocercoid *Lacistorhynchus tenuis* (Cestoda) and wound healing in the striped bass, *Morone saxatilis* (Walbaum). *Journal of Fish Biology* **28:** 289–296.

SEYDA M. 1976. On a case of a mass invasion of cestode *Gymnorhynchus* (*Gymnorhynchus*) *gigas* (Cuvier, 1817) larvae in muscles of *Brama raii* (Bloch, 1791). *Acta Ichthyologica et Piscatoria* **6:** 59–65.

SHIELDS J. D. 1985. Surface morphology and description of *Otobothrium kurisi* new species (Cestoda: Trypanorhyncha) from a hammerhead shark, *Sphyrna lewini*. *International Journal for Parasitology* **15:** 635–643.

SUBHAPRADHA C. K. 1955. Cestode parasites of fishes of Madras coast. *Indian Journal of Helminthology* **7:** 41–132.

SZUKS H., KAMANN U. & BRANDT K. 1975. Zur Parasitierung von *Brama raii* Bloch, 1791 aus dem nordwestafrikanischen Schelfgebiet. *Wissenschaftliche Zeitschrift der Pädagogischen Hochschule Guestrow* **2:** 199–213.