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A NEW FAMILY OF PARASITIC COPEPODS (CYCLOPOIDA, SHIINOIDAE)

BY

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INTRODUCTION

In 1968 Kabata published a description of a curious parasitic copepod, *Shiinoa occlusa*, which had been collected from the fish *Scomberomorus commersoni* (Lacépède) in Australia. His description was based on a single immature female. Recently, as part of a study of copepods parasitic on scombrids, I collected additional material of *S. occlusa* from the Indo-Pacific and a new species of *Shiinoa* from the western Atlantic. The new material forms the basis of this paper.

All drawings were made with the aid of a Wild drawing tube.

All new material is deposited in the collection of the Smithsonian Institution.

SHIINOIDAE nov. fam.

Belonging to the Cyclopoida, Poecilostoma.

Female. — Body cylindrical, segmentation somewhat obscure anteriorly but discernable from posterior thoracic through abdominal segments. Abdomen well-developed, 4-segmented. Caudal rami well-developed. Rostral area produced and bearing first and second antennae; separated from mouth parts by a short necklike constriction. Mouthparts typically poecilostomatous. Maxilliped absent. Legs 1 and 2 biramose. Leg 3 uniramose. Legs 4, 5, and 6 absent. Egg sacs of normal cyclopoid type. Parasitic on nasal lamellae of marine fish.

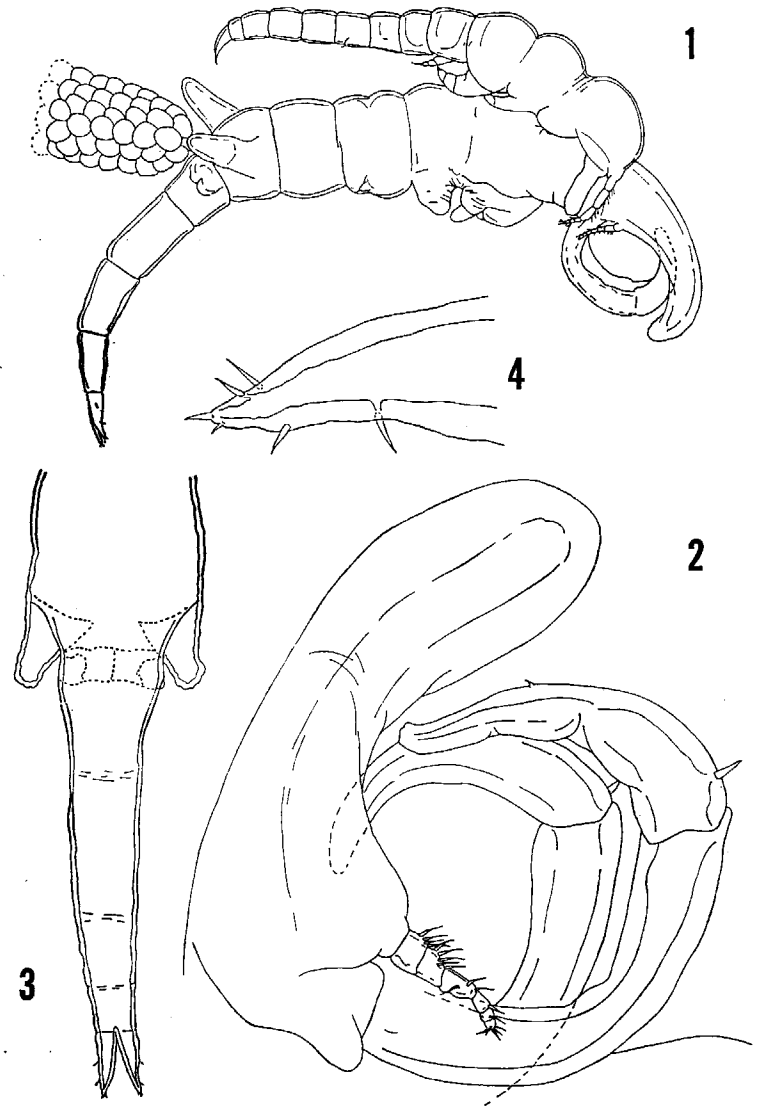
Male. — Generally as in female, except rostral area not produced. Sexual dimorphism most pronounced in morphology of second antenna but exopod of leg 2 also affected. Maxilliped absent. Always embracing female behind rostral area.

Type and only genus: *Shiinoa* Kabata, 1968.

Shiinoa inauris nov. sp. (figs. 1-15)

Material. — Holotype female (USNM 142660), Allotype (USNM 142661), and 3 female and 1 male paratypes (USNM 142662) collected from the nasal lamellae of two *Scomberomorus regalis* (Bloch) from Cienfuegos, Cuba; one female from the same host, Gulf of Venezuela; one female from the same host off Surinam; two females from two *Scomberomorus maculatus* (Mitchell), Aransas Pass, Texas; one male and three females from two *S. maculatus*, Key West, Florida; one female from *S. maculatus*, Placida, Florida; and one female and one male from *S. maculatus*, off Argentina. All material from the nasal laminae of the hosts.

Female. — Body form cylindrical (fig. 1). Total length of holotype 3.67 mm, greatest width (measured at first thoracic segment) 0.71 mm. Two paratypes measure 3.45 × 0.56 mm and 3.56 × 0.63 mm, third paratype broken. Rostrum produced anteriorly, curved ventrally with distal half covering terminal portion of second antennae (fig. 2). These two elements form a ring or loop by which the female attaches to its host through a hole (apparently produced by the parasite) in a nasal lamella. Segmentation of body not obvious, especially in anterior half.



Figs. 1-4. *Shiinoa inauris* n. sp., female. 1, lateral view with attached male; 2, rostral area, lateral view; 3, genital segment and abdomen, ventral; 4, caudal ramus, ventral.

Cephalic portion comprising about one-third total body length, thoracic portion another third, and abdomen posterior third.

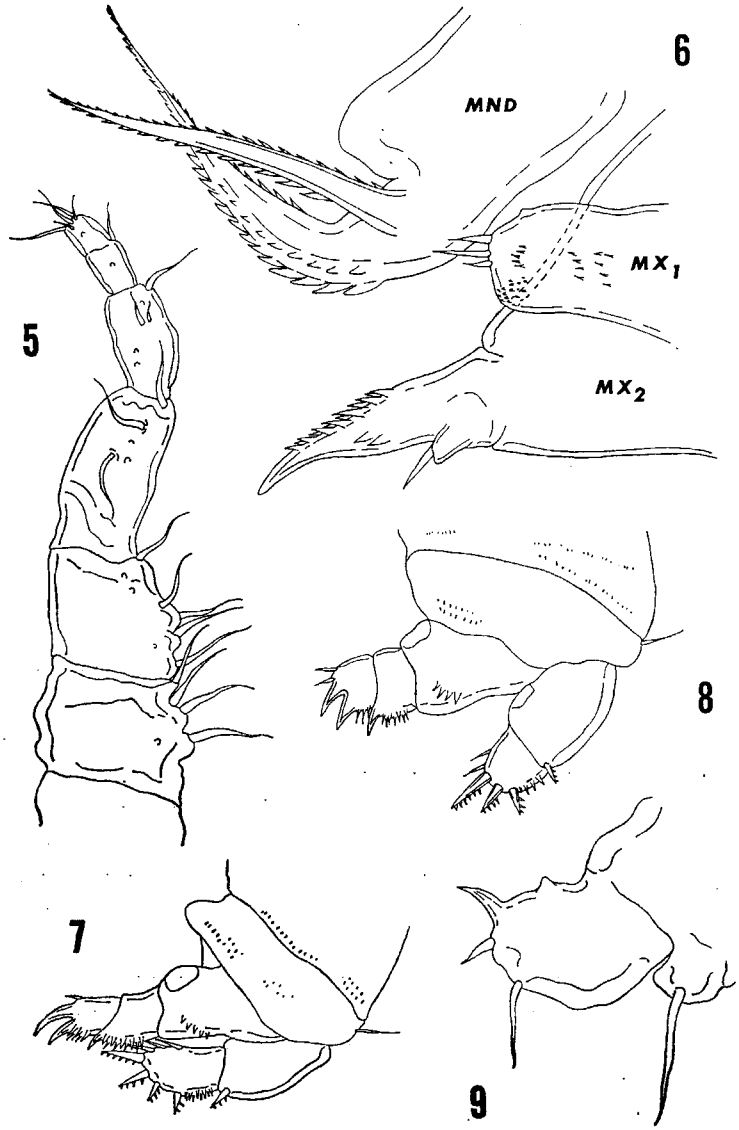
Genital segment somewhat longer than wide (812 μ × 739 μ); posterior outer corners produced to form short, dorsally directed processes; tips of processes covered with knobs or bumps. Abdomen (fig. 3) 4-segmented, segmentation indistinct except in lateral aspect, segments measure 207 μ, 425 μ, 401 μ, and 325 μ in length respectively, anteriormost widest (290 μ). Caudal ramus (fig. 4) longer than wide (246 μ × 70 μ), and bearing six short setae as indicated in the figure.

First and second antennae distinctly separated from mouth parts, with area between somewhat constricted providing an attachment area for the male. All males collected were attached to the female as illustrated in figure 1.

First antenna (fig. 5) with 5 or 6 segments (segmentation indistinct) each segment with short naked setae as indicated in the figure. A complete first antenna was found in only one specimen; consequently, the setation on the terminal segment figured may be incomplete. Second antenna (see fig. 2) well-developed. Each antenna curved to form a nearly complete ring and lying parallel to each other; the distal third within the curvature of the rostrum. Mandible (fig. 6) terminating in a long flagellum bearing many well-developed denticlelike spines; seta arising on inner side near base of flagellum also bearing denticlelike spines, seta extends to tip of flagellum. First maxilla (fig. 6) small, bearing three short setae (middle longest) near inner anterior corner and groups of denticles on surface of maxilla as indicated in the figure. Second maxilla (fig. 6) with broad base tapering distally to attachment of terminal claw; claw bearing on inner side of base a short, posteriorly directed seta, consisting of two elements (see figure), anterior margin of claw with a double row of well-developed denticles. The second seta present on the claw of *S. occlusa* could not be found on the new species described here. Maxilliped absent.

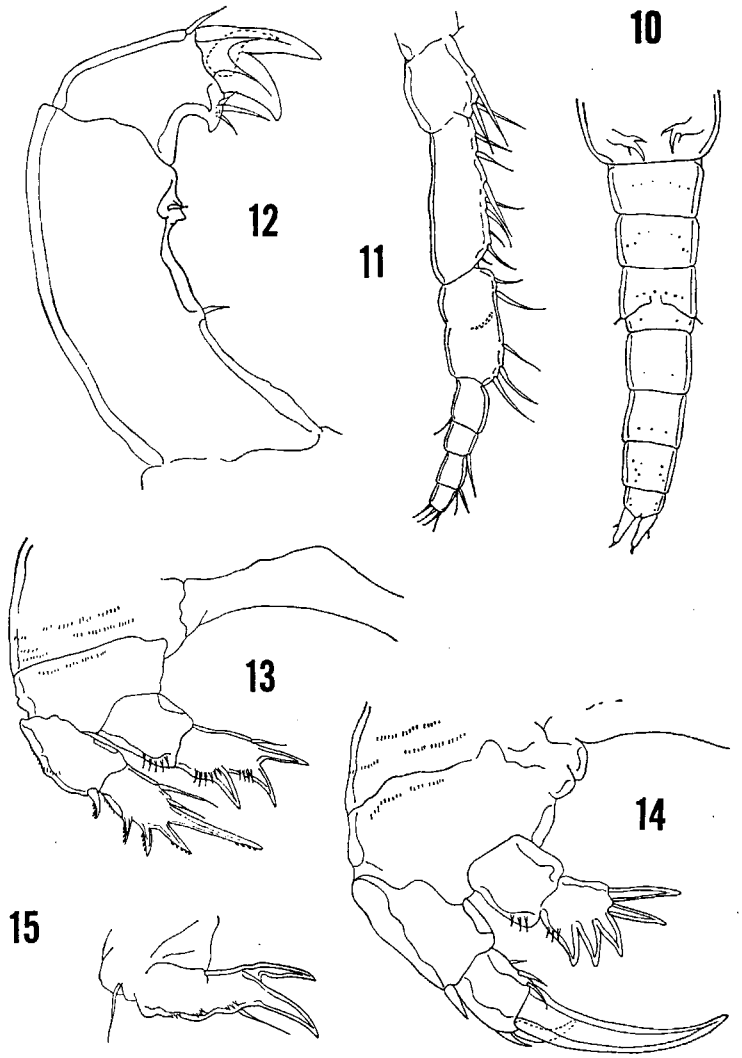
First leg (fig. 7) with seta on outer side of basipod; biramose; exopod 2-segmented, first segment with a short toothed spine on outer distal corner, second segment with four toothed spines spaced along outer to terminal edge and three weak setae along inner margin; endopod 3-segmented, first segment without spines or setae, outer distal corner of second segment produced as a non-articulated spine, third segment with two non-articulated spines terminally and a small seta on inner margin, patches of spinules on both rami as indicated in figure. Second leg (fig. 8) biramose; exopod 2-segmented and armed as in first leg except for one less spine and seta on last segment, endopod 3-segmented and armed as in first leg except for an additional seta on last segment. Third leg (fig. 9) small, consisting of a broad 1-segmented exopod bearing one non-articulated spine on inner distal corner and two short setae terminally; a long seta present on outer margin of basipod. Legs 4, 5, and 6 absent.

Egg sac appears to be of typical cyclopoid type, containing many small eggs. The egg sacs on all ovigerous females were broken.



Figs. 5-9. *Shiinoa inauris* n. sp., female. 5, first antenna; 6, mandible, first maxilla, and second maxilla; 7, leg 1; 8, leg 2; 9, leg 3.

Male. — Body form as in figure 1 (male attached to female). All males collected were attached to the females in this way. Total length of allotype 1.88 mm; greatest width 0.41 mm. Body cylindrical with segmentation well defined. Cephalon comprises only about one-sixth of total body length, thoracic segments about one-half and abdomen about one-third. Abdomen (fig. 10) 4-segmented, segments measure 177 μ, 153 μ, 130 μ, and 89 μ in length respectively, anteriormost widest and each segment somewhat narrower than preceding one. Caudal rami as in the female.



Figs. 10-15. *Shiinoa inauris* n. sp., male. 10, genital segment and abdomen, ventral; 11, first antenna; 12, second antenna; 13, leg 1; 14, leg 2; 15, leg 3.

First antenna (fig. 11) 8-segmented, each segment (except for the first) with short setae as indicated in the figure, segments 2-7 measure 153 μ, 230 μ, 177 μ, 77 μ, 47 μ, 41 μ, and 35 μ respectively (segment 1 was partially obscured). Second antenna (fig. 12) 3-segmented; first segment longest and bearing two short setae on inner margin, one near midmargin and other near the distal corner; second segment with a seta on outer distal corner and three setae on a sclerotized ridge at inner distal corner; third segment in form of bifurcate claw with an accessory spine arising near base. The second antennae are used to grasp the female, encircling her just posterior to her second antennae at the constriction which

separates the mouth parts from the anterior portion of the head. Mouth parts as in female. Maxilliped absent.

First leg (fig. 13) lacking setae on basipod; biramose; exopod 2-segmented first segment with a toothed spine on outer distal corner, second segment with four non-articulated toothed spines along outer and terminal margins (terminal spine twice as long as others) and two weak setae on inner margin; endopod 2-segmented, first segment without spines or setae, second segment with three non-articulated spines of equal length along outer and terminal margin and a weak seta on inner margin; rami with rows of spinules as in figure. Second leg (fig. 14) biramose; exopod 2-segmented, first segment with a short spine on outer distal corner, second segment with three terminal spines, innermost very strong, slightly recurved toward midline and as long as ramus of exopod, three weak setae on inner margin; endopod 2-segmented, first segment without spines or setae, last segment with three non-articulated spines on outer margin (all of equal length) and two articulated spines (innermost slightly longer) terminally; each segment with a few spinules as indicated in figure. Third leg (fig. 15) uniramose; ramus of one segment terminating in two non-articulated spines (outermost longest) and an outer weakly developed seta; a few spinules as indicated in figure; a seta on outer distal corner of basipod.

Spermatophores developing within males did not seem fully developed in specimens available for study. It did appear, however, that the two spermatophores in each male were not developing at the same rate, i.e., one was considerably larger than the other. This was better seen in a male of *S. occlusa* (illustrated in fig. 16).

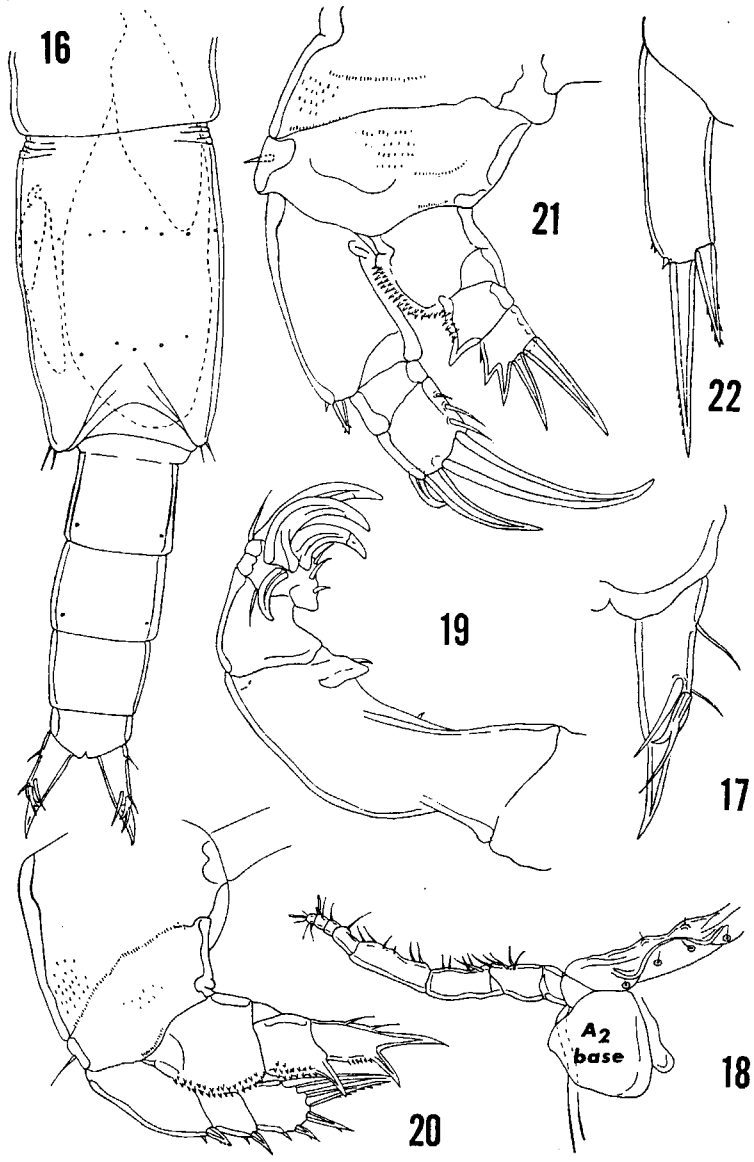
Remarks. — This new species has so far only been collected from species of *Scomberomorus* found in the western Atlantic Ocean between Florida and Argentina. It differs from *S. occlusa* in the following ways. The abdomen of the female *S. inauris* comprises about one-third of the total body length; in *S. occlusa* it represents only about one-sixth. The exopods of legs 1 and 2 are 3-segmented in *S. occlusa* whereas they are 2-segmented in *S. inauris*. The males can be separated easily since both rami of legs 1 and 2 of *S. occlusa* are 3-segmented but 2-segmented in *S. inauris*. They can be further separated by the number and nature of the spines and setae on legs 1-3.

Etymology. — *inauris*, latin, feminine, = earring, alluding to the method of attachment.

Shiinoa occlusa Kabata, 1968 (figs. 16-20)

Material. — Holotype female collected from the gills of *Scomberomorus commersoni* (Lacépède) in Queensland, Australia (deposited in the British Museum); two females and one male from the nasal lamellae of the same host from the Arabian Sea (24°54'N 63°52'E); one female and one male from nasal lamellae of *Grammatorcynus bicarinatus* (Quoy & Gaimard) off N. Celebes.

Female. — The female was well described by Kabata and its description will not be repeated here. Its overall appearance is very much like the new species above with the major differences cited in the above remarks.



Figs. 16-22. *Shiinoa occlusa* Kabata, male. 16, genital segment and abdomen; 17, caudal ramus, ventral; 18, rostrum and first antenna; 19, second antenna; 20, leg 1; 21, leg 2; 22, leg 3.

Male. — Body form as in *S. inauris*. Total length of Arabian Sea specimen 2.9 mm; greatest width 0.58 mm. Genital segment (fig. 16) longer than wide (725 μ × 471 μ), sides nearly parallel widening slightly near middle of segment. Abdomen (fig. 16) 4-segmented; segments measure 188 μ, 203 μ, 188 μ, and 116 μ respectively. Caudal ramus (fig. 17) about twice as long as wide (137 μ × 72 μ), armed with two setae on outer lateral margin, a stronger subterminal seta

arising ventrally, a bipartite subterminal spine consisting of an inner hook and outer terminal setalike tip; ramus terminates as a non-articulate strong spine.

First antenna (fig. 18) 8-segmented, each bearing short setae except the first, each of the last two also bears a short aesthete. Rostral area cushionlike, bearing short sensillae. Second antenna (fig. 19) 3-segmented, terminal segment with three distal clawlike spines, a smaller but strong spine arising near base of terminal three, five short setae near terminus as indicated in figure; first segment with a small seta near inner mid-margin and a sclerotized ridge bearing a short seta near inner distal corner. Mouth parts as in female. Maxilliped absent.

Leg 1 (fig. 20), with seta on outer side of basipod; biramose, both rami 3-segmented; exopod with spines on outer distal corners of first two segments, last segment with four outer to terminal spines (terminalmost longest and first very small) and two inner setae; first segment of endopod unarmed, except for rows of spinules on outer edge, second segment with a non-articulated spine on outer distal corner and rows of spinules on outer edge, last segment with two terminal non-articulated spines and two weak setae on inner edge. Leg 2 (fig. 21) with short stout seta on outer side of basipod; biramose, both rami 3-segmented; exopod with a spine on outer distal corner of first segment, second segment unarmed, last segment with three terminal spines, innermost nearly as long as ramus and slightly recurved inwardly, three weak setae present on inner margin of segment; first segment of endopod with rows of spinules on outer margin, second segment has a non-articulated spine on outer distal corner, last segment with two non-articulated spines terminally. Leg 3 (fig. 22) uniramose bearing two articulated spines terminally (outer twice as long as inner) and a few spinules on outer distal corner; no basipodal seta. Legs 4 and 5 absent. Leg 6 presumably represented by two short setae on outer posterior corner of genital segment. Spermatophores developing within genital segment, one considerably larger than the other suggesting that they may not develop at the same rate or at the same time.

Males were recovered attached to females in the same manner as illustrated for *S. inauris* sp. n.

DISCUSSION

Kabata, in his description of *Shiinoa occlusa*, suggested that the new genus appeared to be close to the chondracanthids and that future collections would confirm this. Ho, 1971, disagreed with this conclusion and stated that he felt this parasite represented a new family. Based on the discovery of the additional material reported here I must concur with Ho.

After careful consideration of the characteristics of poecilostome families I suggest that the family Shiinoidae is most closely related to the Ergasilidae. The cephalic appendages of each group are similar. The first antenna of shiinoids has only 1 segment more than that of most ergasilids. The female second antennae of both are uncinate, clawlike, and the primary means of attachment. The mandible of each bears two terminal flagella. The first maxilla of each is a simple lobe

bearing a few setae. The terminal segment of the second maxilla of each are very similar.

The means of attachment of *Shiinoa* females is not unlike that of ergasilids. In most ergasilids the female second antennae encircle or nearly encircle the gill filament. Those that do not encircle the filament pierce it with the tips of the antennae. The nasal lamellae which serve as the site of attachment for *Shiinoa* are very broad and would be more easily pierced than encircled.

I would further suggest a possible affinity with the family Philichthyidae. In spite of the lack of information regarding philichthyid copepods certain similarities suggest themselves. For one, philichthyid copepods are inhabitants of the cephalic canals of a wide variety of fish. It is not difficult to imagine a line of evolution from the gill parasities of the family Ergasilidae to the canal parasites of the Philichthyidae with the new family Shiinoidae representing an intermediate step as parasites of the nasal fossae. The maxilliped is lacking in the females of all three families but well-developed in ergasilid males, weakly developed in philichthyid males, and lacking in shiinoid males. The reduction of the philichthyid male maxilliped may indicate an affinity with shiinoids.

Further, a number of poecilostome families are associated with invertebrate hosts. The mouth-parts of shiinoids resemble some of these to a certain extent. I asked Dr. Richard Gooding to consider this possibility and he agreed that none of these families with which he was familiar show better evidence of a closer relationship than that suggested above.

These suggestions are put forth in the hope of stimulating further discusson rather than as definitive conclusions. Affinities of highly modified parasites are often difficult to determine and the shiinoidae are no exception.

The original record of *S. occlusa* from the gills of its host is probably accidental. All of my collections were from the nasal fossae — none were found on the gills.

ACKNOWLEDGMENTS

I thank Dr. R. Gooding for reading the manuscript and offering a number of helpful suggestions. The type of *Shiinoa occlusa* was kindly loaned to me by the British Museum (Natural History).

ZUSAMMENFASSUNG

Eine neue Familie wird errichtet, um das Genus *Shiinoa* Kabata — Parasiten in der Nasenhöhlen scombrider Fische — aufzunehmen. Vom westlichen Antlantischen Ozean wird eine neue Art, *S. inauris,* beschrieben. Diese Art unterscheidet sich von *S. occlusa* Kabata — einer Indopazifischen Art — durch den Besitz von 3-segmentigen Exopoden an Bein 1 und 2; bei *S. occlusa* sind die Exopoden 2-segmentig. Für die neue Art werden beide Geschlechter beschrieben, für *S. occlusa* das Männchen zum ersten mal. Die neue Familie scheint den Ergasilidae näher zu stehen als irgendeine vorher beschriebene poecilostome Familie.

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