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A New Family of Poecilostomatoid Copepods (Polyankyliidae) from a Tide Pool on Mud Flat in Korea

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A new genus with a new species of poecilostomatoid copepod, *Polyankylis orientalis*, is described based on a pair of specimens collected from a tide pool on muddy shore in Korea. It represents a new family of the lichomolgoid complex with the following distinguishing characters: (1) 6-segmented antennule (resulted from the fusion of the third and fourth segments) with additional aesthetascs in male, (2) hook on mediodistal corner of antennal coxobasis (first segment), (3) proximal and distal scales on the outer margin of mandible present, (4) main axis of mandibular gnathobase short and lacking notches at the base of mandibular lash, and (5) inner margin of mandibular lash with denticulate processes. Additionally, maxillar syncoxa carries a large, pointed process on ventral surface, legs 1-4 do not show sexual dimorphism, and leg 4 is uniramous with 1-segmented exopod. A detailed discussion is given of its affinities with the ten existing families of the lichomolgoid complex.

Recently, Humes and Boxshall (1996) reviewed the superfamily Lichomolgoidea Humes and Stock, 1972, containing five families of poecilostomatoid copepods chiefly found as symbionts of other marine invertebrates. In addition to removing the family Urocopiidae from this lichomolgoid complex, Humes and Boxshall (1996) created six new families to accommodate 42 genera that were kept in Lichomolgidae, Pseudanthessidae, and Sabelliphilidae, respectively.

In September 1996, when one of us (I-HK) was collecting copepods from the waters of the mud flat tide pools at Jakyakdo Island off Inchon, Korea in the Yellow Sea, a pair of new poecilostome copepods were discovered among the specimens of *Kelleria*, *Hemicyclops*, *Pseudanthessius*, *Macrochiron*, and *Doridicola*. A close examination of them revealed that they are lichomolgoid copepods but can not be assigned to any of the ten families of this complex recognized by Humes and Boxshall (1996). In spite of repeated attempts to collect additional specimens, all subsequent trials had failed to yield more specimens of this form of lichomolgoids. However, since we succeeded in making a complete morphological study of these rare and interesting copepods, we decided to give a report of its discovery with a full description of the species and a discussion on its systematic attribute.

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Materials and Methods

The two copepods to be described below, one female and one male, were obtained on 29 September by filtering the water from a tide pool on the mud flat at Jakyakdo Island located off Inchon, Korea in the Yellow Sea. The copepods were preserved in 70% alcohol and cleared in lactic acid for morphological studies. All drawings were made with the aid of a camera lucida. A full description is given below for the female and only those features showing sexual dimorphism are mentioned for the male. The terminology used in Humes and Boxshall's (1996) work is adopted in this report.

Results

Polyankyliidae, new family

Diagnosis: Poecilostomatoida. Body cyclopiform. Prosome comprising cephalosome and four distinct pedigerous somites. Urosome 5-segmented in female and 6-segmented in male. Genital apertures paired, located laterally on double-somite in female and ventrally on genital somite in male. Caudal ramus with six setae.

Antennule 6-segmented, with additional aesthetascs in male. Antenna 4-segmented, with hook on mediodistal corner of first segment (coxobasis). Labrum deeply incised. Mandible forming short, strongly tapering blade without proximal notch; inner margin with denticulate process; and outer scales forming two unequal teeth. Maxillule a single lobe with four setae. Maxilla 2-segmented; syncoxa armed with strongly

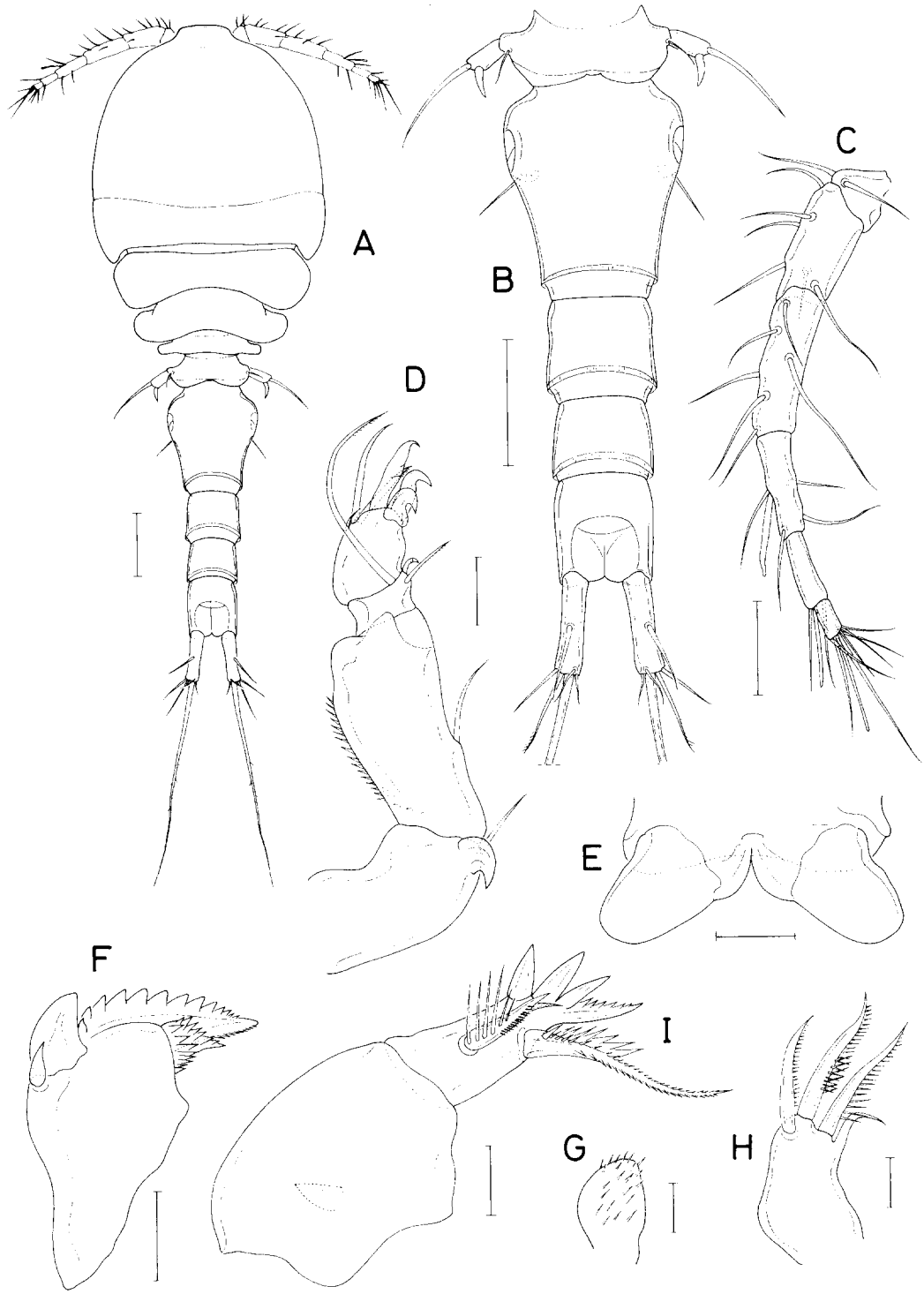

Fig. 1. *Polyankylis orientalis*, new genus, new species, female. A, habitus, dorsal; B, urosome, dorsal; C, antennule; D, antenna; E, labrum; F, mandible; G, paragnath; H, maxillule; I, maxilla, dorsal. Scale bars=0.01 mm (G, H), 0.02 mm (D-F, I), 0.05 mm (C), and 0.01 mm (A, B).

pointed ventral process; basis drawn out into short tapering blade; seta III missing. Maxilliped 3-segmented in female; syncoxa unarmed, basis bearing two large setae; endopod drawn out into long blade with two setae at base. Male maxilliped 4-segmented, typical lichomolgoid type.

Legs 1-3 with 3-segmented exopod and 2-segmented endopod. Leg 4 uniramous, with 1-segmented exopod.

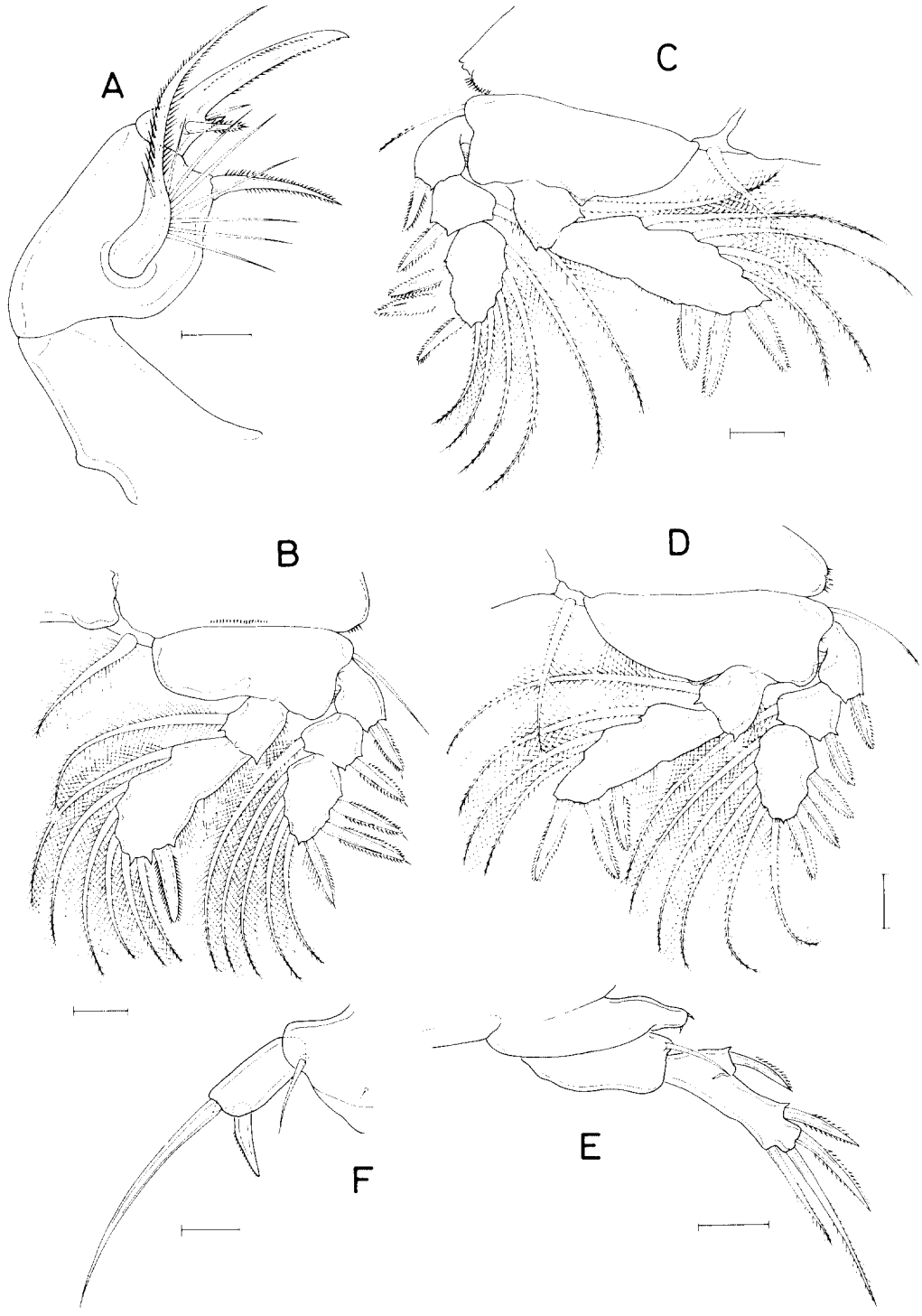

Fig. 2. *Polyankylis orientalis*, new genus, new species, female. A, maxilliped; B, leg 1; C, leg 2; D, leg 3; E, leg 4; F, leg 5. Scale bars=0.02 mm.

Leg 5 with free segment carrying two terminal elements. Leg 6 single seta at genital aperature.

Type-genus: *Polyankylis*, new genus.

Polyankylis, new genus

Type-species: *Polyankylis orientalis*, new species

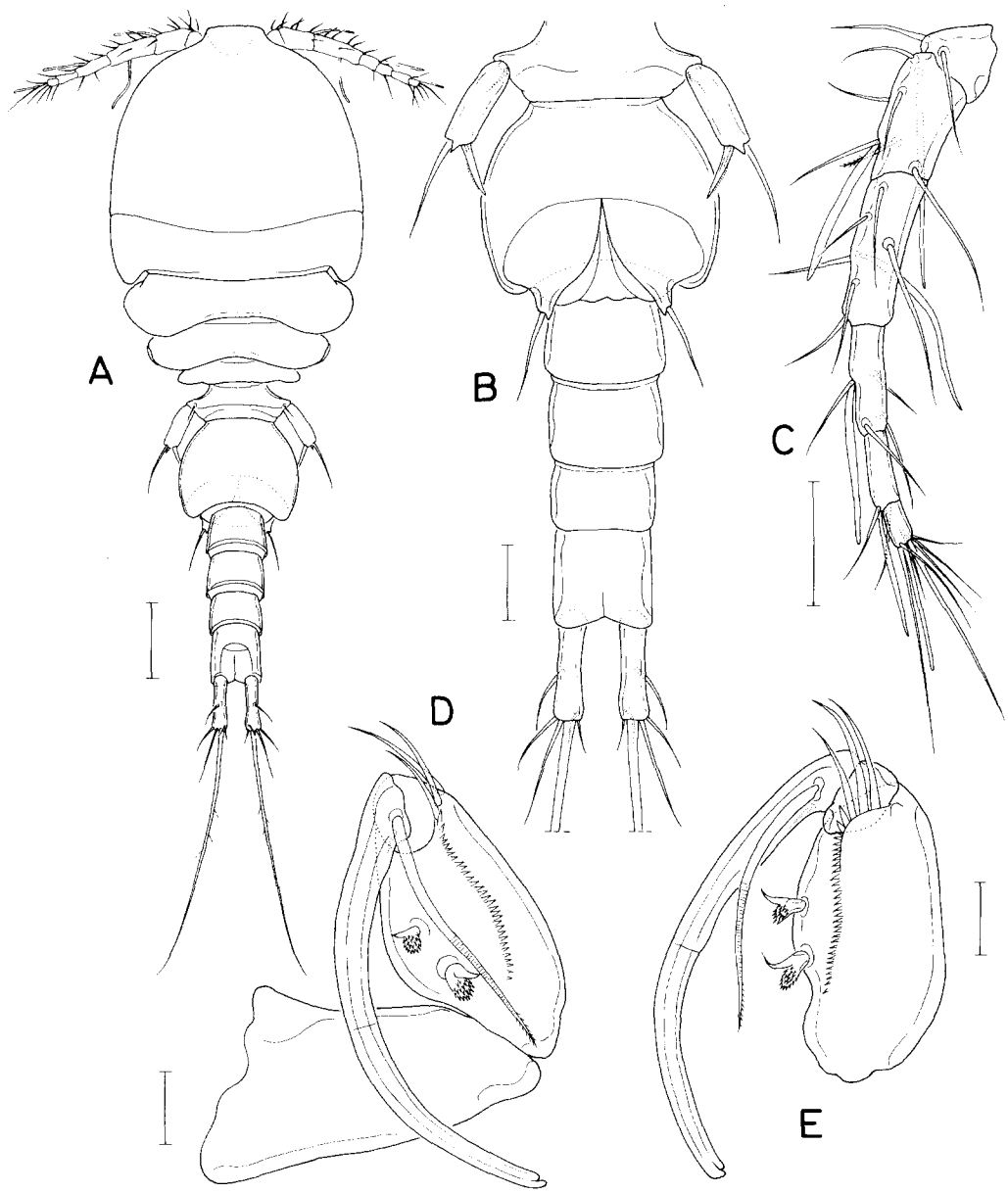

Fig. 3. *Polyankylis orientalis*, new genus, new species, male. A, habitus, dorsal; B, urosome, ventral; C, antennule; D, maxilliped; E, distal three segments of maxilliped. Scale bars=0.02 mm (D, E), 0.05 mm (B, C), and 0.1 mm (A).

Gender: Feminine

Etymology: The generic name is from the Greek *polys* (many) and *ankylis* (hook or barb), alluding to the antenna being equipped with one claw each on the first and third segments in addition to the three terminal claws on the fourth segment.

Polyankylis orientalis, new species
(Figs. 1-3)

Type material: Holotype female (slide containing a complete set of appendages) and allotype male (with left antennule and left maxilliped removed) have been deposited in the U.S. National Museum of Natural History, Smithsonian Institution in Washington, D.C.

Female: Body (Fig. 1A) well-sclerotized, 1.04 mm long, with truncated rostral area. Rostrum broadly rounded posteroventrally. Prosome 0.53 mm long and 0.36 mm wide, fifth pediger 136 μm wide, and genital double-somite 169 μm long and 142 μm wide. Caudal ramus (Fig. 1B) 75 μm long and 22 μm wide, ratio 3.4 : 1

and with 6 setae. Proximalmost seta located dorsally at midlength of ramus; inner median terminal seta greatly elongated, 338 μm long; all short setae rather stiff.

Antennule (Fig. 1C) 6-segmented and 250 μm long; armature formula 2, 6, 6, 4+1 aesthetasc, 2+1 aesthetasc, and 7+1 aesthetasc. Antenna (Fig. 1D) 4-segmented, with coxa and basis fused to form first segment and carrying 3-segmented endopod; coxobasis bearing 1 seta and a recurved hook at mediodistal corner; endopodal segment 1 with medial seta and a row of outer spinules, segment 2 with a setiform claw and 2 unequal setae, and segment 3 tipped with 3 claws and 3 setae. Labrum (Fig. 1E) deeply incised. Mandible (Fig. 1F) forming short and strongly tapering blade with row of strong teeth on convex edge and much finer teeth on concave edge; proximal notch at base not defined; inner margin with heavily denticulate process; and outer scales forming 2 large but unequal tooth-like protuberances. Paragnath (Fig. 1G) a small spinulose lobe. Maxillule (Fig. 1H) a single lobe armed terminally with 1 setiform process and 3 barbed setae. Maxilla (Fig. 1I) 2-segmented; basal segment (syncoxa) large and armed with strongly sclerotized, pointed process on ventral surface; basis drawn out into tapering blade, armed with 3 large teeth followed by a row of 6 small teeth; seta III missing, but both setae I and II well- developed and heavily armed. Maxilliped (Fig. 2A) 3-segmented; first segment (syncoxa) small and unarmed; second segment (basis) large, bearing two large, spiniform, and heavily armed setae; endopod drawn out into long tapering blade with small, pointed, basal protrusion; basal part of endopod carrying 1 naked and 1 barbed seta.

Legs 1-3 (Figs. 2B-D) with 3-segmented exopod and 2-segmented endopod. Leg 4 (Fig. 2E) with one segmented exopod, endopod absent. Spine and seta formula on these legs as follows:

	coxa	basis	exopod	endopod
Leg 1	0-1	1-0	I-0; I-1; II, I, 4	0-1; I, 6
Leg 2	0-1	1-0	I-0; I-1; II, I, 5	0-1; III, 4
Leg 3	0-1	1-0	I-0; I-1; II, I, 5	0-1; III, 3
Leg 4	0-0	1-0	I, II, 2	(missing)

Leg 5 (Fig. 2F) consisting of 1 seta on fifth pediger and a small free segment measuring 37 × 16 μm, carrying terminally 1 large naked seta (87 μm) and 1 short spine (26 μm). Leg 6 a long seta located in genital aperture (Fig. 1B).

Male: Body (Fig. 3A) 0.92 mm long, generally as in female, except for 6-segmented urosome. Prosome 477 μm long and 331 μm wide, fifth pediger 135 μm wide, and genital somite 135 μm long and 156 μm wide. Caudal ramus (Fig. 3B) 67 μm long and 20 μm wide; armature as in female.

Antennule (Fig. 3C) segmented and armed as in female except for addition of 2 aesthetascs on second segment and 1 aesthetasc on third segment. Antenna, mandible, maxillule and maxilla as in female. Maxilliped (Figs. 3D, E) 4-segmented; first segment (syncoxa) longest but unarmed; second segment (basis) armed on medial margin with 2 modified setae bearing spinulose knob and on outer surface a row of spinules ending with 3 long setae distally; third (first endopodal) segment smallest and unarmed; and fourth (second endopodal) segment forming a long, curved claw carrying proximally 1 short and 1 long setae. All leg armatures as in female. Leg 5 free segment 62 μm long and 20 μm wide.

Discussion

The most outstanding characteristics of the new species described above are the structures of the antennule, antenna, and mandible. While the general morphology of the mandible indicates that it is a poecilostome copepod of the lichomolgoid complex, its antennule and antenna show certain features that are uncommon to this complex of families.

Typically, the lichomolgoid antennule is 7-segmented. The 6-segmented condition in *Polyhankylis* is apparently due to the fusion of the third and fourth segments. This is evident from the distribution patterns of the aesthetascs on this appendage. In those seven lichomolgoid families bearing additional aesthetascs on the male antennule (Anchimolgidae, Kelleriidae, Lichomolgidae, Macrochironidae, Pseudanthessidae, Rhynchomolgidae, and Thamnomolgidae), there are two aesthetascs on the second segment and one aesthetasc on the fourth segment (with a forumula of 4+1 aesthetasc). Therefore, having a formula of 6+2 aesthetascs on the second segment, 6+1 aesthetasc on the third segment, and three setae proximal to the attachment point of the aesthetasc on the third segment (see Fig. 3C), the third antennular segment in *Polyankylis* must have been resulted from a fusion of the ancestral third and fourth segments.

The most unusual feature of the antenna of *Polyankylis* is in the possession of a recurved hook on the mediodistal corner of the first segment (coxobasis) (see Fig. 1D). In typical lichomolgoid, this part of the coxobasis carries a seta, which may be modified into a spiniform element as in *Rhynchomolgus*, but does not carry an additional hook-like element as in *Polyankylis*. Thus, clearly, this proximal antennal hook is a derived character of this new form.

In their revision of the lichomolgoid complex, Humes and Boxshall (1996) placed emphasis on the mouthparts, especially the mandible, and discarded Humes and Stock's (1972) idea of family arrangement based primarily on leg segmentation patterns. Thus, in our search for the familial attribution of *Polyankylis*, we

did not take into consideration the uniramous occurrence of the fourth swimming leg but concentrated primarily on the patterns of the mandibular structure.

As shown in Fig. 1F, having the main axis of the gnathobase forming a strongly tapering blade without forming a proximal notch, the mandible of *Polyankylis* resembles those found in the Octopicolidae, Pseudanthessidae, Sabelliphilidae, and Synapticolidae. However, with the retention of both proximal and distal outer scales on the convex margin, the new form can find home only with the Synapticolidae, because in the other three families there is at most only one outer scale on the convex margin and in Synapticolidae there is one genus, *Chauliolobion*, with two setiform outer scales in the same area of the mandible.

Nevertheless, if one takes into consideration the characters selected by Humes and Boxshall (1996) for their analysis of the phylogenetic relationships of the lichomolgoid complex, it becomes clear that *Polyankylis* can not be attributed to the Synapticolidae. The non-conformative features are found on the antennule for characters 2 (male without proximal aesthetasc on 2nd segment) and 4 (male without aesthetasc on 4th segment); and on the antenna for characters 5 (4th segment atrophied), 7 (3rd segment with 4 elements), and 8 (4th segment lacking claw).

Inasmuch as the differences in the armature of the endopodal segments of legs 1, 3 and 4, and terminal segment of leg 4 exopod were considered by Humes and Boxshall (1996) to be some derived characters indicative of phylogenetic relationships among the lichomolgoid families, then, naturally, these features (characters 16-21) should also be checked in search for the affiliation of *Polyankylis*.

The endopods of legs 1-3 in the new form are 2-segmented due to the fusion of the distal two segments. Such fusion is indicated by a slight indentation observed on the outer margin of these three long endopods (see Figs. 2B, C, D). Taking this fusion (or failure of separation in the course of development) into consideration, one finds that only one (character 17, sexual dimorphism in leg 1 endopodal armature) out of the six selected leg armature characters (characters 16-21) is shared between the new form and the Synapticolidae.

In conclusion, it is impossible to place *Polyankylis* in the Synapticolidae as it is defined by Humes and Boxshall (1996). Accordingly, a new family, Polyankyliidae, is proposed with its diagnosis as given above for the type genus *Polyankylis*.

Acknowledgements

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