

Zygomoligus dentatus* n. sp. (Copepoda, Poecilostomatoida, Lichomolgidae) from Korea, with Synonymization of the Genus *Lichomolgides* with *Zygomoligus

Il-Hoi Kim

Department of Biology, College of Natural Sciences, Kangnung National University, Kangnung 210-702, Korea

Abstract: *Zygomoligus dentatus* n. sp. is described based on specimens from washings of compound ascidians from intertidal shores of Korea. It possesses the long caudal rami which are 5.6 times as long as their width, four scales on the convex side of mandible, and three setal elements and a large process on maxillule. *Lichomolgides cuanensis* Gotto, the only representative of the genus *Lichomolgides*, is transferred to the genus *Zygomoligus*.

Key words: *Zygomoligus dentatus*, new species, Korea, Lichomolgidae, *Lichomolgides*

INTRODUCTION

Zygomoligus is a copepod genus proposed by Humes and Stock (1972) to incorporate some of species belonged to the genus *Lichomoligus* Thorell, 1879. Humes and Stock (1973) included four species in this genus, *Z. curtiramus* (Bocquet and Stock, 1962), *Z. didemni* (Gotto, 1956), *Z. poucheti* (Canu, 1891), and *Z. tenuifurcatus* (G. O. Sars, 1917), all of which have been reported infrequently from the European seas.

Kim (1997) recorded *Z. tenuifurcatus* from Korean waters. But a careful re-examination of these Korean specimens revealed that they are not *Z. tenuifurcatus*, but a new species. This new species is described in this paper.

Copepod specimens were measured and dissected after soaking in lactic acid. Dissection was done using the reversed slide method. In the following description, Roman and Arabic numerals in the armature formula represent spines and setae, respectively. All figures were drawn with the aid of a camera lucida.

Tel: 82-33-640-2312, Fax: 82-33-641-6124
E-mail: ihkim@kangnung.ac.kr

DESCRIPTION

Order Poecilostomatoida

Family Lichomolgidae

Zygomoligus dentatus n. sp. (Figs. 1 & 2)

Zygomoligus tenuifurcatus: Kim, 1997, p. 453, figs. 191, 192.

Material examined: 17 ♀♀ collected from washings of compound ascidians living on the mussel *Mytilus edulis* (L.), in Port Imwon (37°13'35"N, 129°20'45"E), 4 August 1992. Holotype (♀, USNM 1087309) and paratypes (14 ♀♀, USNM 1087310) have been deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D. C., United States. Dissected paratypes (2 ♀♀) are kept in the collection of the author.

Other material examined: Four ♀♀ collected from washings of compound ascidians living on intertidal rocks in Port Seogwipo (33°14'11"N, 126°33'44"E), 30 March 2006.

Female: Body (Fig. 1A) cycloform. Body length variable, ranging from 1.36 mm to 1.93 mm, based on 10 specimens. Prosoma greatly swollen dorsally. Prosoma of dissected largest specimen (1.93 mm long) 1.21 mm long. Greatest width of prosoma 771 µm. Cephalothorax globular, as long as dorsoventral depth. Urosome (Fig. 1B) much slender than prosoma, 5-segmented. Fifth pedigerous somite 194 µm wide. Genital double-somite 223 × 204 µm, anteriorly expanded, with rudimentary lines on dorsal surface between broad anterior part and narrower posterior part. Genital areas located dorsolaterally near midlength of somite. Three abdominal somites 60 × 110, 46 × 100, and 105 × 100 µm, respectively. Anal somite with pair of

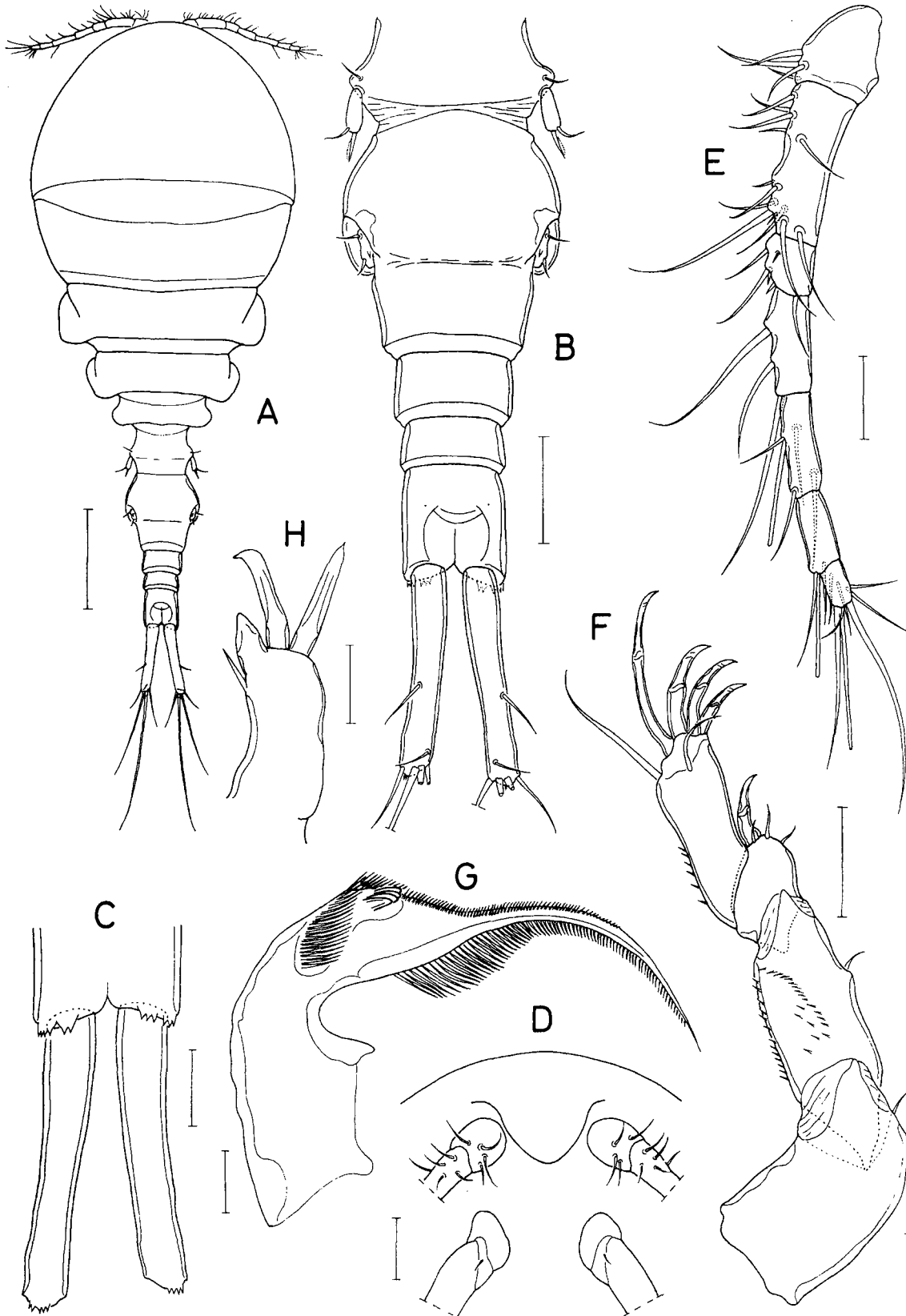


Fig. 1. *Zygomolgus dentatus* n. sp., female. A. habitus, dorsal; B. urosome, dorsal; C. caudal rami, ventral; D. rostral area, ventral; E. antennule; F. antenna; G. mandible; H. maxillule. Scale bars: A, 0.5 mm; B, 0.1 mm; C-F, 0.05 mm; G, H, 0.02 mm.

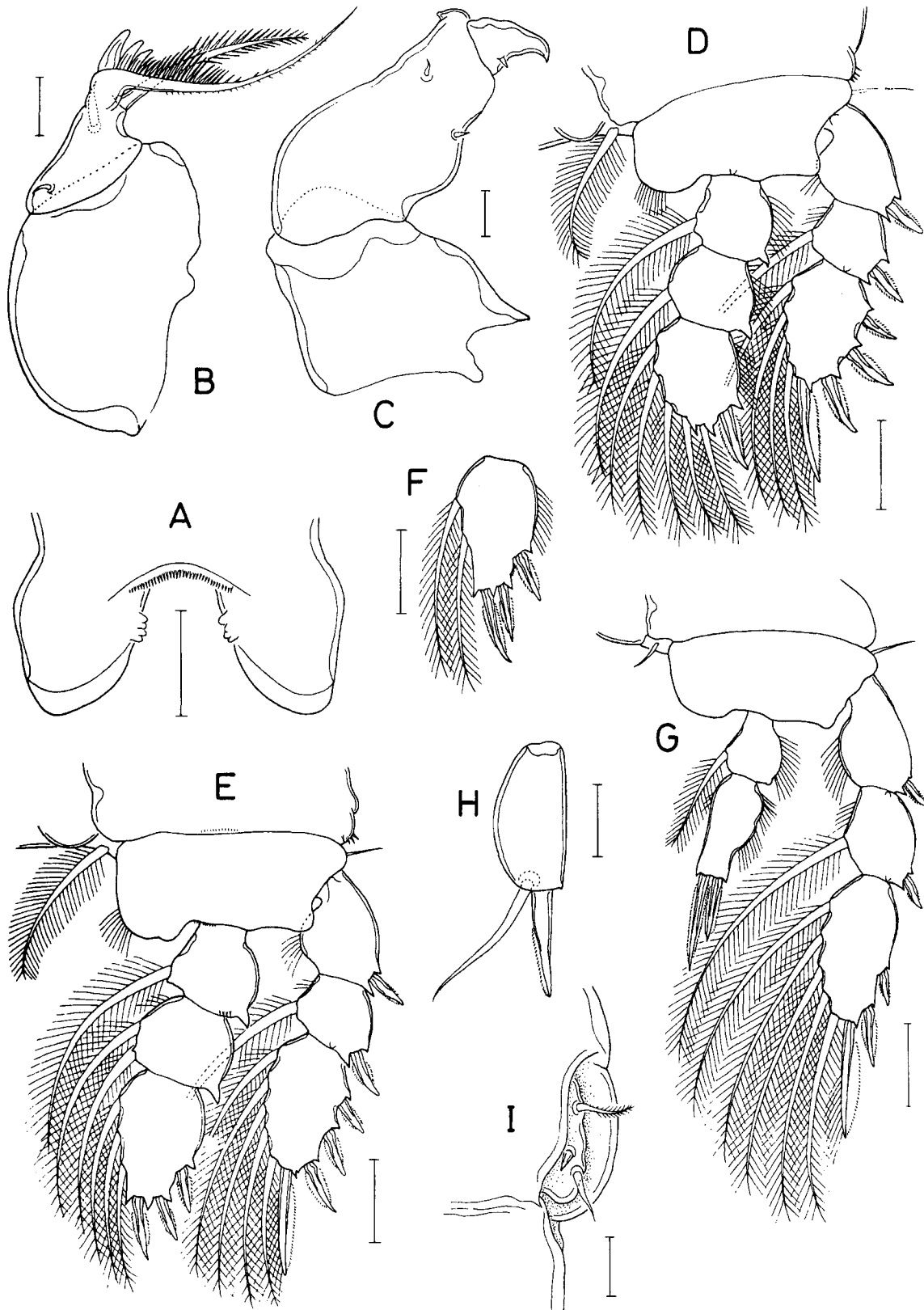


Fig. 2. *Zygomolgus dentatus* n. sp., female. A. labrum; B. maxilla; C. maxilliped; D. leg 1; E. leg 2; F. third endopodal segment of leg 3; G. leg 4; H. free segment of leg 5; I. right genital area. Scale bars: A, D-G, 0.05 mm; B, C, H, I, 0.02 mm.

serrated crests on both sides of posteroventral margin; each crest with 1-4 denticles. Caudal rami (Fig. 1C) slightly divergent; each ramus $196 \times 35 \mu\text{m}$, 5.6 times as long as wide, with 4 or 5 denticles on posteroventral margin. Caudal ramus of some specimens narrowed near 2/3 length. All 6 caudal setae naked. Outer lateral seta positioned 3/5 length of ramus. Egg sac not seen.

Rostrum prominent, wider than long, with round posterior apex (Fig. 1D). Antennule $367 \mu\text{m}$ long, 7-segmented, with armature formula 4, 13, 6, 3, 4 + aesthetasc, 2 + aesthetasc, and 7 + aesthetasc. All setae naked, and most of them small. Antenna (Fig. 1F) 4-segmented. First segment with 1 small inner distal seta. Second segment as long as first segment, with many spinules on surface and 1 seta on inner margin. Short third segment armed with 1 distinct claw and 3 small setae, one of latter located near base of claw and minute. Fourth segment approximately $69 \times 32 \mu\text{m}$, slightly more than twice as long as wide, with spinules on outer margin, 2 subdistal setae and 4 terminal claws, outermost one of them distinctly slender and longer than 3 inner ones.

Labrum (Fig. 2A) prominently bilobed, with deep and broad median incision, and spinulated posteromedian margin. Mandible (Fig. 1G) slender, with long distal lash; inner margin not delimited from distal lash, with long and dense spinules. Outer margin slightly convex, with dense spinules and 4 tooth-like processes. Maxillule (Fig. 1H) armed with 2 distal, broad setae, 1 inner tapering process (this process somewhat variable in width), and 1 inner, subdistal setiform element. Maxilla (Fig. 2B) 2-segmented. First segment unarmed. Second segment with small proximal seta, simple anterior seta, and enlarged spiniferous inner seta. Distal lash thin and elongate, with 3 proximal, tooth-like spines followed by dense spinules. Maxilliped (Fig. 2C) 3-segmented. First segment broad and unarmed. Second segment with 2 small setae and 1 small outer distal process pointed backward. Third segment strongly tapering, forming claw, with 1 small, proximal seta.

Legs 1-3 with 3-segmented exopod and endopod (Fig. 2D, E). Leg 4 (Fig. 2G) with 3-segmented exopod and 2-segmented endopod. Outer seta on basis of legs 1-4 small and naked. Inner coxal seta of legs 1-3 prominent and plumose, but that of leg 4 small and naked. Second endopodal segment of leg 4 $65 \times 32 \mu\text{m}$, its outer margin slightly undulated; two terminal spine 60 (inner one) and 38 (outer one) μm , respectively. Armature formula of legs 1-4 as follows:

Leg 1: coxa 0-1; basis 1-0; exp. I-0; I-1; III, I, 4;
enp. 0-1; 0-1; I, 5

Leg 2: coxa 0-1; basis 1-0; exp. I-0; I-1; III, I, 5;
enp. 0-1; 0-2; I, II, 3

Leg 3: coxa 0-1; basis 1-0; exp. I-0; I-1; III, I, 5;
enp. 0-1; 0-2; I, II, 2

Leg 4: coxa 0-1; basis 1-0; exp. I-0; I-1; II, I, 5;
enp. 0-1; II

Leg 5 consisting of 1 lateral seta on genital double-somite and free segment. Free segment (Fig. 2H) $41 \times 20 \mu\text{m}$, with convex ventral margin in lateral view (both margins parallel in dorsal and ventral views), and armed distally with 1 spine (29 μm long) and 1 naked setae (42 μm long). Leg 6 represented by 1 plumose seta, 1 naked seta, and 1 small spine in genital area (Fig. 2I).

Male: Unknown.

Etymology: The specific epithet *dentatus* is derived from the four tooth-like processes on the outer side of the mandible in the new species.

DISCUSSION

As a genus of the family Lichomolgidae, *Zygomoligus* Humes and Stock, 1972, is typified by the characteristic antenna in which the third segment is armed with a claw and the fourth segment with four claws in addition to setae on the segments.

In the description of *Lichomolgides cuanensis*, Gotto (1954) proposed the new genus *Lichomolgides*. This genus has been remained as a monotypic genus for more than a half century. It is differentiated by the features in the female that the antennary region is sunken ventrally, thus delimited from the rest of cephalothorax and the post-oral area protrudes ventrally. I consider that these features may not be the important features justifying a genus within the Lichomolgidae. Genera of lichomolgoid families are recognized generally by the morphological features of legs and mouth appendages, not by the shapes of cephalothorax and the presence of a post-oral protuberance. Other morphological features of *Lichomolgides cuanensis*, including all the morphological characteristics of the male, are not different from those of *Zygomoligus*. It was discovered as an associate of *Trididemnum tenerum* (Verrill), a species of the compound ascidians which are generally known as hosts for species of *Zygomoligus*. *Lichomolgides cuanensis* is herewith transferred to the genus *Zygomoligus*.

Five species are known in *Zygomoligus*, now including *Z. cuanensis* (Gotto, 1954). *Zygomoligus dentatus* n. sp. possesses the long caudal ramus that is more than five times as long as wide. In this respect, it is closer to *Z. tenuifurcatus* (Sars, 1917) than to other four species where the length of the caudal ramus does not exceed three times as its width. However, in other morphological details, *Z. dentatus* differs from *Z. tenuifurcatus*. The cephalothorax of *Z. dentatus* is almost globular, whereas it is slightly tapering anteriorly in *Z. tenuifurcatus*. The maxillule of *Z. dentatus* is armed with two broad terminal setae, one plate-like inner distal process and one subdistal slender, setiform

element, unlike that of *Z. tenuifurcatus* that has only two simple terminal setae. The mandible of *Z. dentatus* is unique in the genus in having four tooth-like processes on the convex outer side. No species of *Zygomoligus* has been recorded to have such processes on the mandible, although it might be overlooked by previous researchers. The mandible is illustrated to have one process in *Z. tenuifurcatus* (see Plate 89 of Sars, 1917) and two processes in *Z. poucheti* (see Fig. 3b of Bocquet and Stock, 1962), but these processes arise from the outer margin of the mandible and are of different nature from those of *Z. dentatus*. Other congeners of *Z. dentatus* display the following features that are not observable in *Z. dentatus*.

In *Z. cuanensis*, the maxillule has two distal setae and the cephalothorax has the delimited antennary region and post-oral outgrowth, as mentioned above.

In *Z. curtiramus*, the maxillule has four setae and the third exopodal segment of leg 3 is armed with three spines and five setae.

In *Z. didemni*, the prosome is greatly expanded, with a incomplete segmentation between the cephalothorax and the second pedigerous somite; and the first and second endopodal segments of leg 4 are similar in length (Gotto, 1956, 1993).

Although *Z. poucheti* can be easily distinguished from *Z. dentatus* by the form of the caudal ramus and mandible, this European species is similar to *Z. dentatus* in the respects that the maxillule bears three setae and one conical process, the anal somite bears serrated crests (a simple serration in *Z. curtiramus*) on posteroventral margin, and the posteroventral margin of caudal ramus is serrated (this last feature is shared by *Z. curtiramus*). It is notable that the figures given by Canu (1892) and Sars (1917) for leg 4 show an important discrepancy, because Canu illustrated this leg to bear three spines and four setae on the third exopodal segment, but Sars to bear three spines and five setae on the same segment. Therefore, it is questionable whether their specimens are conspecific, although they are very similar to each other in other points.

Six known species of the genus can be distinguished by the following key.

Key to species of *Zygomoligus*

1. Caudal ramus as long as anal somite; second endopodal segment of leg 4 as long as first segment ---- *Z. didemni*
- Caudal ramus longer than anal somite; second endopodal segment of leg 4 longer than first segment ----- 2
2. Antennary region produced anteriorly and delimited from remaining part of cephalothorax ---- *Z. cuanensis*
- Antennary region as usual and not delimited from cephalothorax ----- 3
3. Third exopodal segment of leg 3 armed with 3 spines

- and 5 setae (armature formula II, I, 5) ---- *Z. curtiramus*
- Third exopodal segment of leg 3 armed with 4 spines and 5 setae (armature formula III, I, 5) ----- 4
4. Caudal ramus about 3 times as long as wide and slightly longer than anal somite ----- *Z. poucheti*
- Caudal ramus 5 or more times as long as wide and distinctly longer than anal somite ----- 5
 5. Mandible with 1 spiniform process on outer margin; maxillule with 2 simple terminal seta -- *Z. tenuifurcatus*
- Mandible with 4 tooth-like processes on outer side; maxillule with 2 broad terminal setae, 1 thick inner distal process, and 1 setiform inner element subdistally -
----- *Z. dentatus*

ACKNOWLEDGMENTS

The field work for this study was supported by the Ministry of Environment, Korea.

REFERENCES

- Bocquet C and Stock JH (1962) Copépodes parasites d'invertébrés des côtes de France. XIV. Description d'un nouveau copépoïde cyclopoïde, *Lichomoligus curtiramus* n. sp. *Proc K Ned Akad Wet* 65(3): 244-249.
- Canu E (1892) Les copépodes du Boulonnais. Morphologie, embryologie, taxonomie. *Trav Inst Zool Lille Trav Stn Zool Maritime Wimereux* 6: 1-354, pls. 1-30.
- Gotto RV (1954) *Lichomolgides cuanensis* n. g., n. sp., an ascidicolous copepod occurring in *Trididemnum tenerum* (Verrill). *Parasitology* 44(3,4): 379-386.
- Gotto, RV (1956) A new ascidicolous copepod: *Lichomoligus didemni*, sp. nov. *J Linn Soc London* 42(288): 600-602.
- Gotto RV (1993) Commensal and Parasitic Copepods Associated with Marine Invertebrates (and Whales). Kermack, Barnes and Crothers eds., Synopses of the British Fauna (New Series), No. 46, *The Linnean Society of London & The Estuarine and Coastal Sciences Association* 264 pp.
- Humes AG and Stock JH (1972) Preliminary notes on a revision of the Lichomolgidae, cyclopoïd copepods mainly associated with marine invertebrates. *Bull Zool Mus Univ Amsterdam* 2(12): 121-133.
- Humes AG and Stock JH (1973) A revision of the family Lichomolgidae Kossmann, 1877, cyclopoïd copepods mainly associated with marine invertebrates. *Smithson Contr Zool* 127: 1-368.
- Kim I-H (1997) Illustrated Encyclopedia of Fauna & Flora of Korea. Vol. 38. Cirripedia, Symbiotic Copepoda, and Pycnogonida. *Ministry of Education, Korea*, 1038 pp.
- Sars GO (1917) An Account of the Crustacea of Norway with Short Descriptions and Figures of All the Species. VI, Copepoda, Cyclopoïda, Parts XI, XII, Clausidiidae, Lichomolgidae (part), pp. 141-172, pls. 81-96.

[Received May 22, 2006; accepted July 28, 2006]