

Redescriptions of Two Species of Copepoda (Poecilostomatoida, Lichomolgidae) Associated with the Bivalve *Dosinorbis japonicus* from the Korea Strait

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ABSTRACT

Two lichomolgoid copepods, *Lichomolgus inflatus* Tanaka and *Philoconcha paphiae* Yamaguti, both known very rarely since the original descriptions, are redescribed based on the specimens discovered as associates with the bivalve *Dosinorbis japonicus* from the Korea Strait. *Lichomolgus inflatus* is very closely related to *L. chamarum* Humes, but can be differentiated by the features of the rostrum and genital double-somite. *Philoconcha paphiae* is found to have an extremely variable leg armature. This is the first discovery of the two species of copepods outside the Japanese waters.

Key words: *Lichomolgus inflatus*, *Philoconcha paphiae*, redescription, bivalves, association, Korea Strait

INTRODUCTION

Copepoda associated with the bivalves is a relatively well-known group of animal in Korea. Since Kim (1998) included in his monograph 24 species of copepods known until that time as the associates of the bivalves in Korean seas, he (Kim, 2000) added another species, *Lichomolgus bullatus* discovered in the mantle cavity of a small clam, *Striarca tenebrica* (Reeve), from the Yellow sea. These twenty-five species do not represent a whole copepod fauna associated with Korean bivalves, because far more species of bivalve, chiefly those dwelling in the subtidal and

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deeper water, have not been examined yet for copepods.

In Korea, the bivalves are of great economic importance. Many species are used as food resources and being cultivated along the shores of this country. Recently, I had a chance to examine the clam *Dosinorbis japonicus* dug out from an intertidal mudflat of Namhae Island located in the Korea Strait. Two species of copepods, *Lichomolgus inflatus* Tanaka and *Philoconcha paphiae* Yamaguti, were discovered from this clam, the former from the mantle cavity, and the latter from the pericardium. Both species are redescribed in the present paper because they have not been recorded or very rarely recorded since the original descriptions.

DESCRIPTIONS

Family Lichomolgidae Kossmann, 1877

***Lichomolgus inflatus* Tanaka, 1961 (Figs. 1, 2)**

Syn.: *Lichomolgus inflatus* Tanaka, 1961, p. 263, pls. 30, 31, pl. 32, figs. 1-5; Ko, Murakami and Daiku, 1962, p. 114; Humes and Stock, 1973, pp. 190, 193 (in key and list).

Material examined. A single female collected from the mantle cavity of 22 *Dosinorbis japonicus* (Reeve) dug out from a mud flat in Namhae Island in the Korea Strait, on 22 July 2001.

Female. Body (Fig. 1A) relatively narrow, 1.24 mm long. Greatest width 480 μ m. Prosome 710 μ m long and 5-segmented. Urosome (Fig. 1B) 5-segmented. Fifth pedigerous somite 124 μ m wide. Genital double-somite 181 \times 162 μ m (1.12 : 1), nearly quadrangular, with broad anterior expansion and narrower posterior part. Genital area large, located dorsolaterally in posterior part of anterior expansion. Three abdominal somites 58 \times 71, 53 \times 62, and 65 \times 63 μ m, respectively. Anal somite unarmed, no spinules on ventral surface. Caudal ramus 135 \times 30 μ m (4.50 : 1), with 6 setae; outer lateral seta short, shorter than width of caudal ramus and located midway outer margin of ramus; terminal 4 setae plumose, largest one of them 254 μ m, less than twice length of ramus.

Rostrum tapering, longer than wide, but rounded posteriorly. Antennule (Fig. 1C) 7-segmented; armature formula 4, 13, 6, 3, 4+1 aesthetasc, 2+1 aesthetasc, and 7+1 aesthetasc; all setae naked; one of four setae on first segment distinctly larger than other three. Antenna (Fig. 1D) robust and 3-segmented; armature formula 1, 1, and 9+1 claw; inner two setae on terminal segment spine-like; terminal claw strong, longer than terminal segment.

Labrum (Fig. 1E) with 2 semi-circular lobes and deep median furrow. Mandible (Fig. 1F) slender, tapering, terminated in long lash, with spinulated margins; proximal notch shallow. Paragnath (Fig. 1G) as spinulated lobe. Maxillule (Fig. 1H) with 2 terminal setae of different lengths. Maxilla (Fig. 2A) 2-segmented; first segment broad and unarmed, with broad hyaline membrane on outer margin; second segment terminated in long lash bearing one smaller naked seta and one larger, spinulated seta. Maxilliped (Fig. 2B) 3-segmented; first segment unarmed; second segment with 2 small setae; terminal segment tapering, terminally curved and sharply pointed, with 1 small seta.

Leg 1 (Fig. 2C), leg 2 (Fig. 2D) and leg 3 with 3-segmented rami. Leg 4 (Fig. 2F) with 3-segmented exopod and 2-segmented endopod. Outer seta on basis of legs 1-4 small and naked. Outer margin of second endopodal segment of leg 4 with small spiniform process; 2 terminal

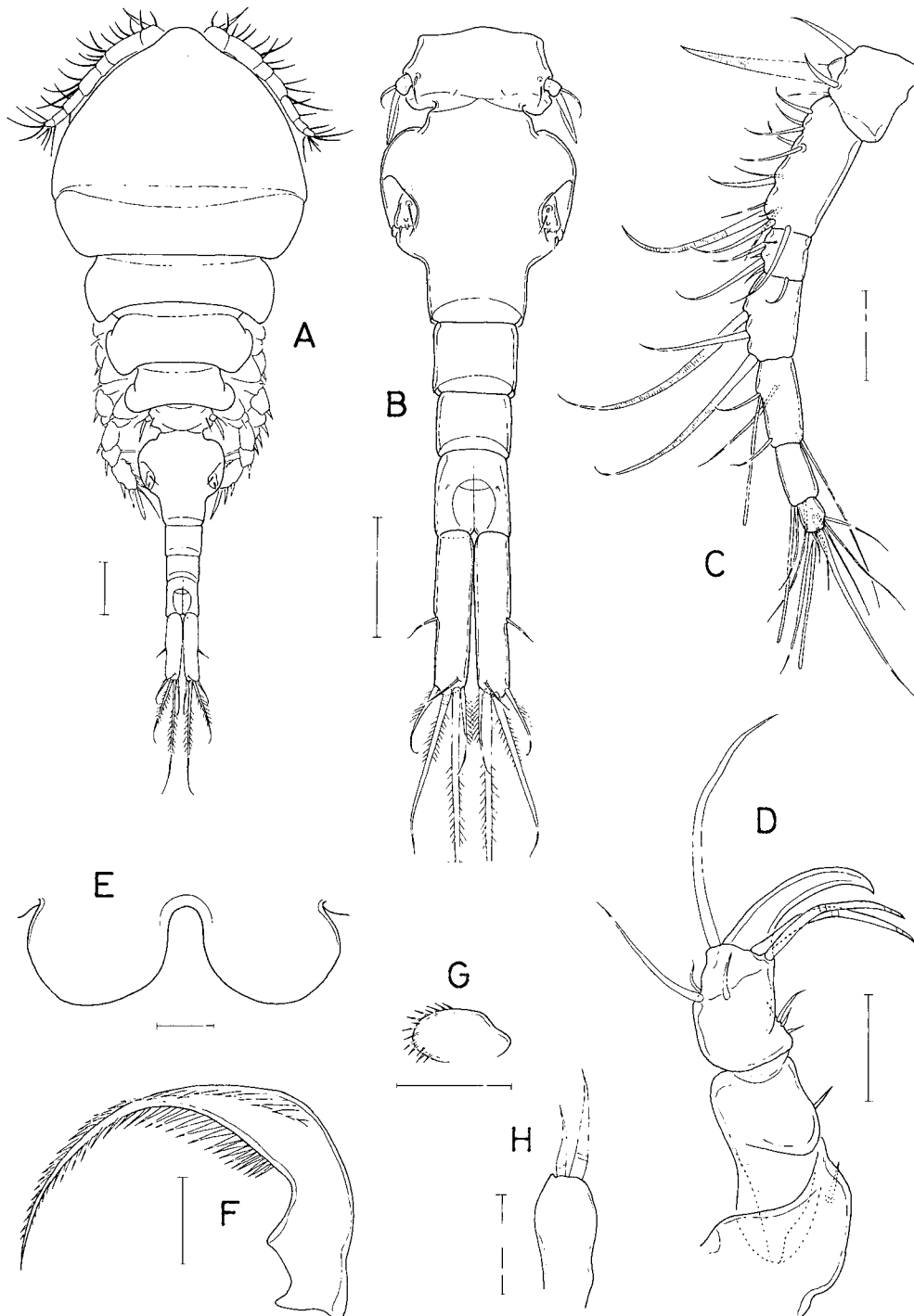


Fig. 1. *Lichomolgus inflatus* Tanaka, female. A, habitus, dorsal; B, urosome, dorsal; C, antennule; D, antenna; E, labrum; F, mandible; G, paragnath; H, maxillule. Scales: A, B = 0.1 mm; C, D = 0.05 mm; E-H = 0.02 mm.

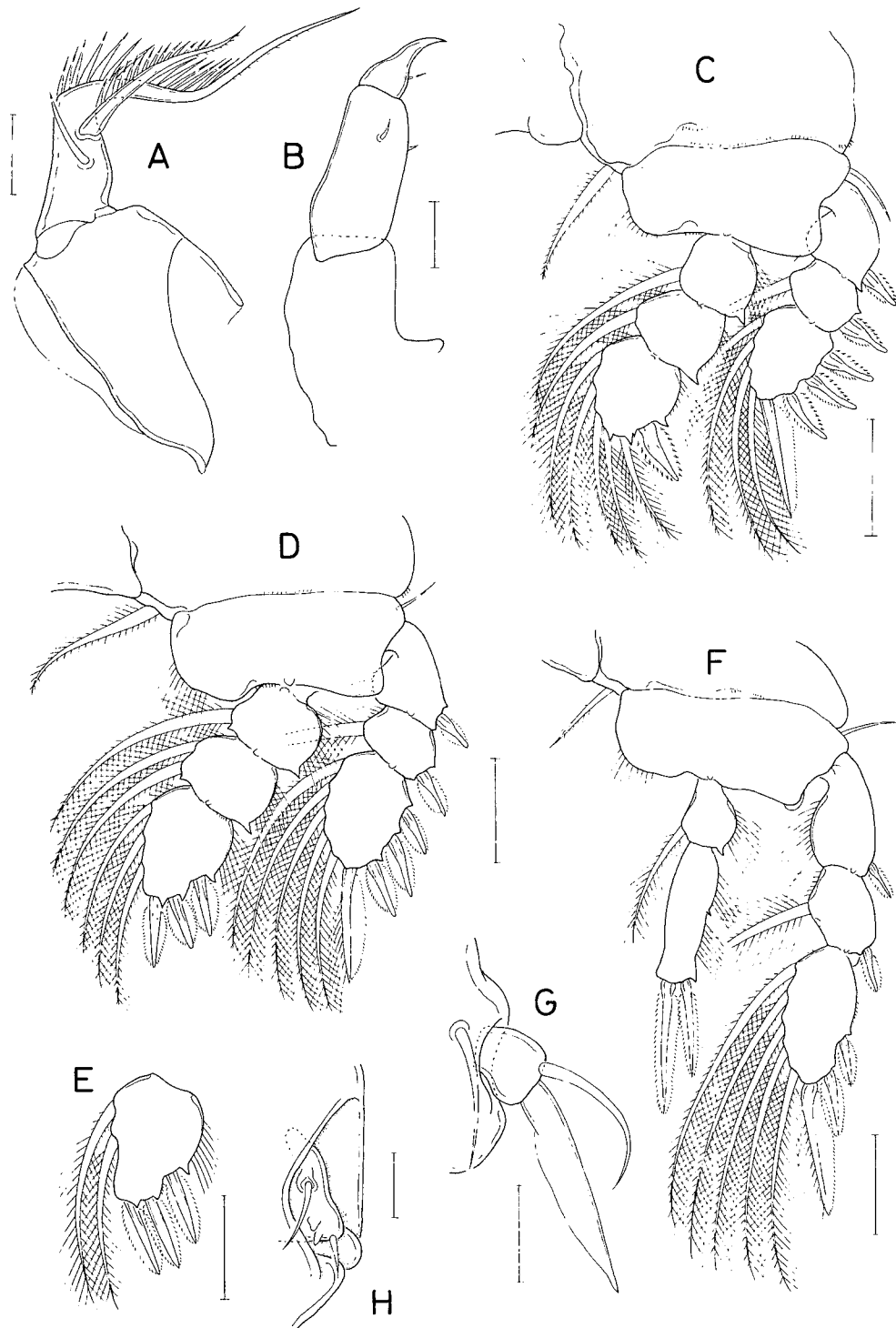


Fig. 2. *Lichomolgus inflatus* Tanaka, female. A, maxilla; B, maxilliped; C, leg 1; D, leg 2; E, third segment of leg 3 endopod; F, leg 4; G, leg 5; H, genital field. Scales: A, B, G, H = 0.02 mm; C-F = 0.05 mm.

spines of this segment unequal. 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; III, 3

Leg 3: Coxa 0-1; Basis 1-0; Exp I-0; I-1; III, I, 5; Enp 0-1; 0-2; III, 2

Leg 4: Coxa 0-1; Basis 1-0; Exp I-0; I-1; II, I, 5; Enp 0-1; II

Leg 5 (Fig. 2G) consisting of 1 plumose seta on fifth pedigerous somite and free segment. Free segment small, $14 \times 13 \mu\text{m}$, distally broadened and terminally with scalpel-like spine ($45 \mu\text{m}$) and 1 naked seta. Leg 6 represented by 2 naked setae and 1 spinule in genital area (Fig. 2H).

Male. Not found.

Remarks. Tanaka (1961) described this species on the basis of one pair of specimens discovered from the mantle cavity of *Paphia*. Ko et al. (1962) recorded their discovery of this species from *Ruditapes philippinarum* (Adams and Reeve) (recorded as *Tapes japonica*), *Saxidomus purpuratus* (Sowerby) and *Pinctada martensii* (Dunker), and commented as “resembles *Modiolicoa bifida*, but its uniramous and prehensile second antenna has a large strong claw and three spines terminally. The fifth pair of swimming legs is small with two curved spines”. But this comment hardly corresponds to the features of *L. inflatus*. Because *Herrmannella hoonsooi* Kim, 1992 is known to infest to both *Ruditapes philippinarum* and *Saxidomus purpureus* and their comment is approximately applicable to *H. hoonsooi*, the species they called as *L. inflatus* might in fact be *H. hoonsooi*.

Tanaka (1961) recorded that the caudal ramus of his female specimen is more than five times as long as wide, and the antennule has many plumous setae. In contrast, in the Korean specimen the caudal ramus is 4.5 times as long as wide, and all setae on the antennule are naked. These differences are thought to be of artificial. In the other major respects, the Korean specimen is in well accordance with the Japanese one.

Lichomolgus inflatus may be easily distinguished from its congeners, except for *L. chamarum* Humes, 1968, by the following combination of female characters: caudal ramus 4.5 times as long as wide; antenna with one terminal claw; second segment of leg 4 endopod with a pointed process on the outer margin; free segment of leg 5 as long as wide and armed distally with one spine and one seta. *Lichomolgus inflatus* is very closely related in the above and other features to *L. chamarum* reported from a Madagascan bivalve (Humes, 1968). Differences of the two species lie in the rostrum and genital double-somite. Unlike the Far Eastern species, *L. chamarum* has a rostrum which is characteristically tapering and long, extending to the base of antenna, and has the genital double-somite in which the anterior lateral expansion is rounded (nearly quadrangular in *L. inflatus*).

***Philoconcha paphiae* Yamaguti, 1936 (Figs. 3-5)**

Syn.: *Philoconcha paphiae* Yamaguti, 1936, p. 119, pl. 11, figs. 52-62; Humes and Stock, 1973, pp. 279, 280 (in key and list).

Material examined. Six females and 3 males collected (along with *Lichomolgus inflatus*) from the pericardium of 22 *Dosinorbis japonicus* (Reeve) dug out from a mud flat of Namhae Island in the Korea Strait, on 22 July 2001.

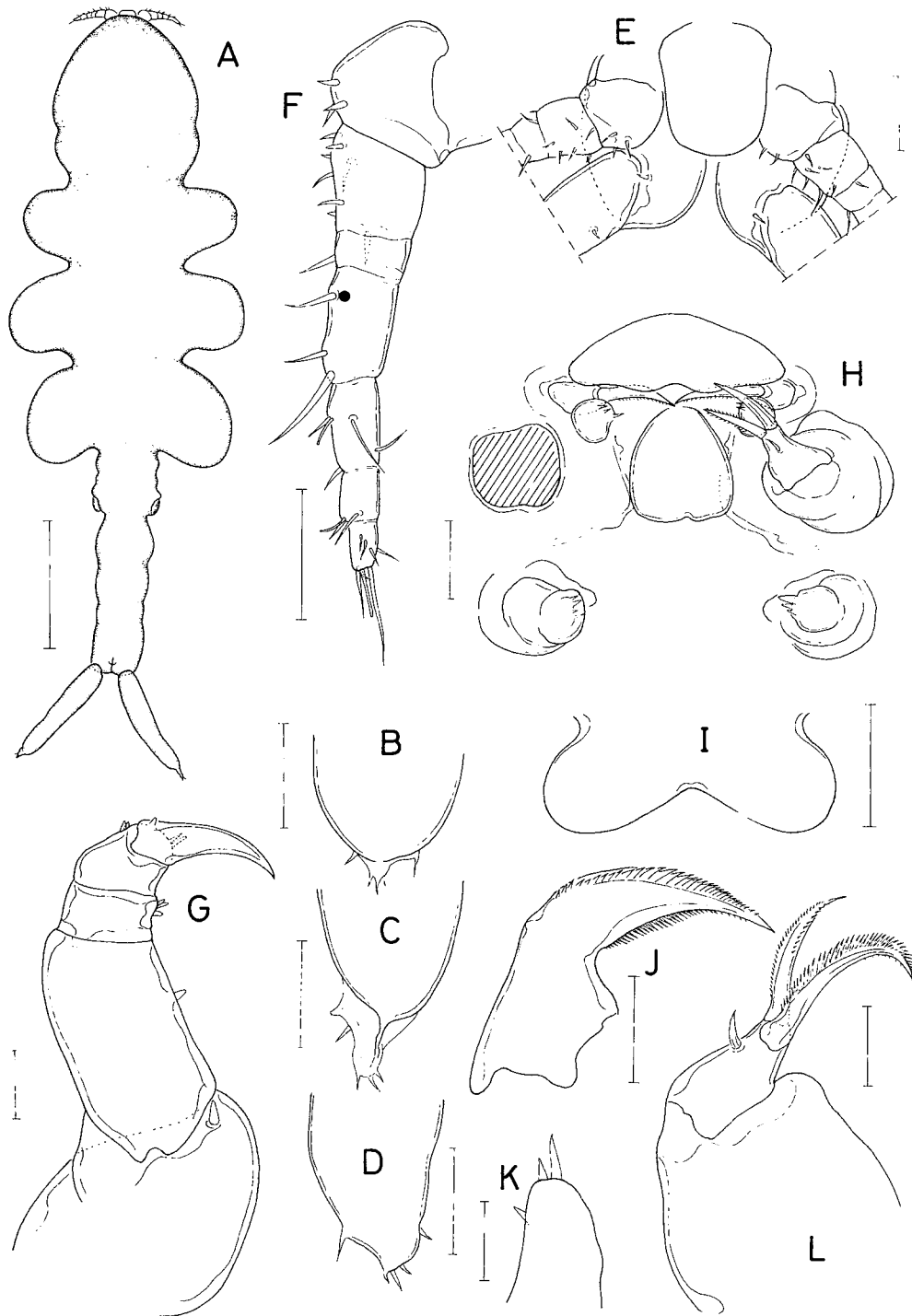


Fig. 3. *Philoconcha paphiae* Yamaguti, female. A, habitus, dorsal; B-D, distal part of caudal ramus; E, rostral area, ventral; F, antennule (black dot representing insertion of asetethasc in male); G, antenna; H, oral area; I, labrum; J, mandible; K, maxillule; L, maxilla. Scales: A = 1 mm; B-F, H, I = 0.1 mm; G, J-L = 0.05 mm

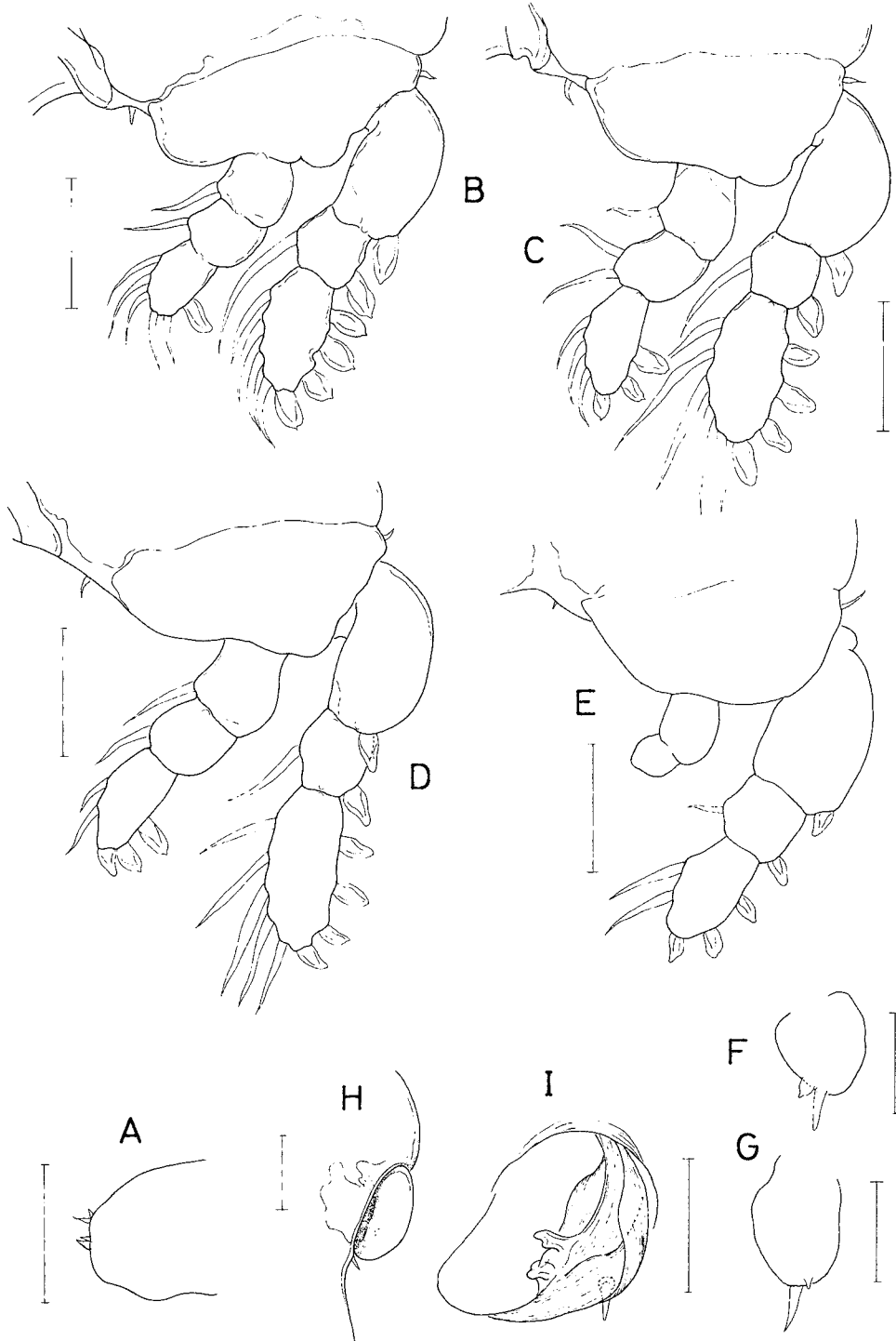


Fig. 4. *Philoconcha paphiae* Yamaguti, female. A, maxilliped; B, leg 1; C, leg 2; D, leg 3; E, leg 4; F, G, leg 5; H, genital field; I, same, enlarged. Scales: A-E, H, I = 0.1 mm; F, G = 0.05 mm.

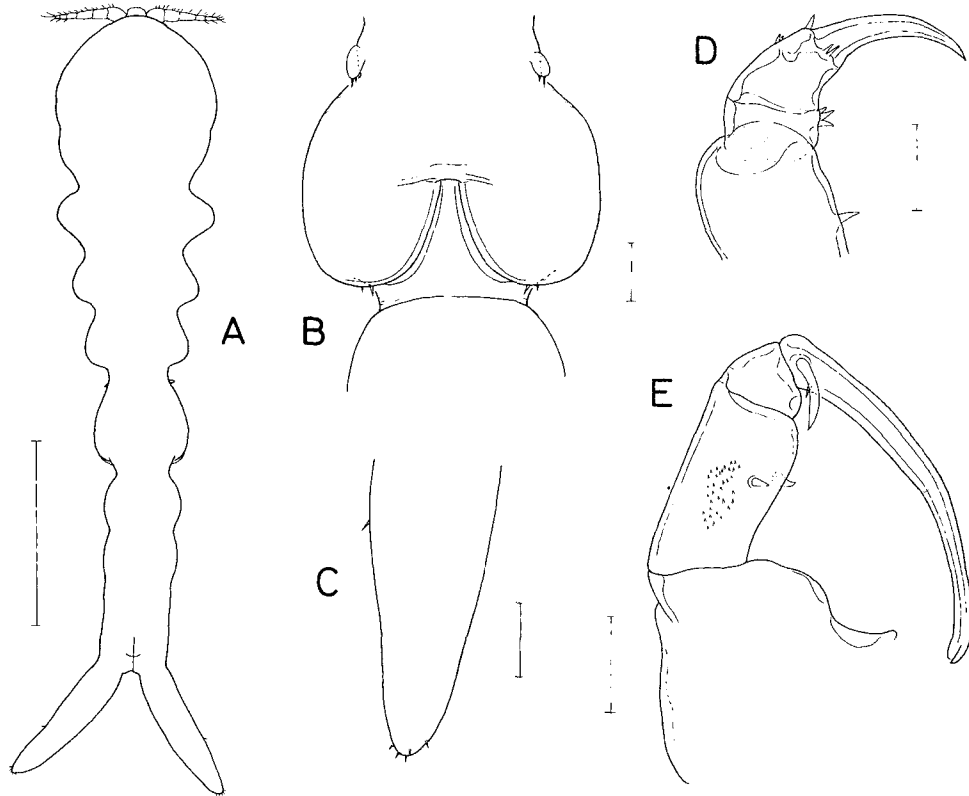


Fig. 5. *Philoconcha paphiae* Yamaguti, male. A, habitus, dorsal; B, genital somite, ventral; C, distal half of caudal ramus; D, distal part of antenna; E, maxilliped. Scales: A = 1 mm; B, C = 0.1 mm; D, E = 0.05 mm.

Female. Body (Fig. 3A) vermiform, without clear segmentation, 6.04 mm long. Prosome about 3.42 mm long. Cephalothorax 1.33×1.13 mm, divided by weak lateral constrictions into cephalosome and first pedigerous somite. Second to fourth pedigerous somites prominently expanded laterally, therefore each somite well distinguished from neighboring somite (s); width of these 3 somites 1.65, 1.81, and 1.58 mm respectively. All urosomal somites fused as well, but each somite distinguishable by weak lateral constrictions. Area of fifth pedigerous somite $490 \mu\text{m}$ wide. Genital field located dorsolaterally. Abdomen columnar, with 4 divisions corresponding respectively to first to fourth abdominal somites. Caudal ramus divergent, $960 \times 205 \mu\text{m}$ (4.68 : 1), its tip tapering or bluntly rounded, always wrapped by globular sticky material, with 5 setae or processes (Fig. 3B-D).

Rostrum shield-like, roughly quadrangular with convex posterior margin (Fig. 3E). Antennule (Fig. 3F) indistinctly 7-segmented, small and tapering, with armature formula: 3, 8, 1. 3. 4+1 aesthetasc, 2+1 aesthetasc, and 7+1 aesthetasc; setae very small, and aesthetascs hardly distinguished from setae. Antenna (Fig. 3G) robust, 4-segmented, with strong terminal claw; terminal 2 segments nearly equal in length, each about 1/4 as long as second segment; armature formula: 1, 1, 3, and 5; all setae small, with blunt tip.

Mandible (Fig. 3J) strongly tapering, with denticulated convex margin and spinulated concave margin. Maxillule (Fig. 3K) lobate, armed with 2 terminal and 1 subterminal setae. Maxilla (Fig. 3L) 2-segmented; first segment unarmed; second segment with 1 small seta and 1 large subterminal, spine-like seta spinulated along convex side; terminal lash spine-like, articulated at base, smaller than subterminal seta. Maxilliped (Fig. 4A) nearly rudimentary, lobate, and armed distally with 3 or 4 small setae.

Legs 1-3 (Fig. 4B-D) with 3-segmented rami. Leg 4 (Fig. 4E) with 3-segmented exopod and 1- or 2-segmented endopod. Leg armature variable as follows:

Leg 1: Coxa 0-1; Basis 1-0; Exp. I-0; I-1; III, I, 4 (or II, 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; 0-1; III, 3

Leg 3: Coxa 0-1; Basis 1-0; Exp. I-0; I-1; III, I, 5 (or II, I, 5);

Enp. 0-1; 0-1; III, 3

Leg 4: Coxa 0-1; Basis 1-0; Exp. I-0; I-1 (or 0-1); II, I, 2 (or II, I, 3 or III, I, 1 or I, I, 2)

Enp. 0-0 (or 0-0; 0-0)

All setae on legs naked. Inner seta on coxa and outer seta on basis small. Inner coxal seta of leg 4 hardly visible. Endopod of leg 4 occasionally with spine at tip. Leg 5 (Fig. 4F, G) lobate, with 2 terminal, process-like setae of different size. Leg 6 represented by 1 seta at genital area (Fig. 4H, I).

Male. Body (Fig. 5A) slender, tapering, and 4.41 mm long. Lateral expansions of prosomal somites not prominent. Caudal ramus $764 \times 176 \mu\text{m}$ (4.34 : 1), with outer lateral and 5 terminal minute setae (Fig. 5C).

Antennule as in female, but added by 1 aesthetasc on fourth segment (dot in Fig. 3F). Terminal claw of antenna more slender than that of female (Fig. 5D). Mouthparts identical to those of female, except for maxilliped. Maxilliped (Fig. 5E) consisted of 3 segments and terminal claw; first segment unarmed; second segment with 2 small setae of equal size and patch of spinules; third segment short and unarmed; terminal claw as long as three segments combined, with 1 seta and 1 minute setule at base.

Segmentation of legs 1-4 as in female. Leg armature variable as in female. Leg 5 as in female. Leg 6 represented by 2 setules on posterior margin of genital flaps.

Remarks. While establishing the genus *Philoconcha*, Yamaguti (1936) included in this genus two new species, *philoconcha amygdalae* and *P. paphiae*, as associates of *Venerupis philippinarum* (= *Ruditapes philippinarum*) and *Paphia euglypta* (Philippi), respectively. He commented that the two species can be differentiated by the body size and the armature of appendages.

The examination of the present Korean material revealed that they are not distinctly different from each other. In the body size the selected female of Korean material (6.04 mm long) is close to *P. amygdalae* (6.6 mm) than to *P. paphiae* (7.5 mm), but, on the contrary, that of the male (4.40 mm) is close to *P. paphiae* (3.75-3.40 mm) than to *P. amygdalae* (2.7-2.8 mm). Because only a single female and several male specimens were available to Yamaguti, he was not able to check the variability of leg armature. Korean material show extremely variable leg armatures, for example, the endopod of leg 4 is 1- or 2-segmented and the third segment of exopod of the same leg has

the armature formulae II, I, 2 or II, I, 3 or III, I, 1 or I, I, 2. This variability suggests that the leg armature is not a good taxonomic trait in this genus. Therefore, it is possible that the two species of *Philoconcha* are conspecific. At present, the only reliable taxonomic character separating the two nominal species of *Philoconcha* seems to be in the caudal ramus. Because the ratio of length to width of the ramus of Korean material, 4.68 : 1, is closer to *P. paphiae* (4.4) than to *P. amygdalae* (about 3 : 1), the Korean species of *Philoconcha* is identified tentatively as *P. paphiae*.

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남해도 갯벌의 떡조개에 공생하는 요각류 2종의 재기재

김 일 회

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요 약

살갓살이과 (Lichomolgidae)에 속하며 원기재 이후 그 기록이 매우 드물었던 요각류 2종 *Lichomoligus inflatus* Tanaka와 *Philoconcha paphiae* Yamaguti가 남해도에서 떡조개 (*Dosinorbis japonicus*)로부터 발견되어 재기재하였다. *Lichomoligus inflatus*는 *L. chamarum* Humes와 매우 유사하나 이마돌기와 생식이중절의 특징으로 서로를 구별할 수 있다. *Philoconcha paphiae*는 매우 변이가 심한 다리 강모식을 가지는 것이 발견되었다. 이 두 종에 대한 본 기록은 일본 외의 지역에서는 처음이다.