Copepods (Crustacea, Copepoda, Cyclopoida) Associated with Marine Invertebrates from Thailand

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ABSTRACT

Fifteen species of poecilostome copepods associated with marine invertebrates, including ten new species, are recorded from intertidal zone in Thailand. New species are Hemicyclops cornutus n. sp. and Hemicyclops parapiculus n. sp. in the family Clausidiidae, Presynaptiphilus trifurcatus n. sp. in the Synaptiphilidae, Anchimolgus kantariensis n. sp. and Anchimolgus palmatus n. sp. in the Anchimolgidae, Kelleria vasfera n. sp. in the Kelleridae, Pseudanthessius stenosus n. sp. and Pseudanthessius phuketensis n. sp. in the Pseudanthessiidae, Doricidola pattayensis n. sp., and Lambanetes mollis n. sp. in the Rhynchomolgidae. Five species are new records of Thailand: Critomolgus gemmatus (Humes, 1964), Doridicola cuspis (Humes, 1964), Doridicola inaequalis (Humes and Ho, 1966), Indomolgus brevisetosus (Humes and Ho, 1966), and Lambanetes stichodactylae Humes, 1982. The female of Lambanetes stichodactylae is described for the first time in the world.

Keywords: Copepoda, poecilostome Cyclopoida, new species, association, Thailand

INTRODUCTION

Copepods associated with marine invertebrates have been very poorly investigated in Thailand. Ho and Kim (1990) reported six species of the family Synapticolidae associated with holothurians from Phuket: Scambicornus brachysetosus Reddiah, 1968, S. affinis Ho, 1982, S. nicobaricus (Sewell, 1949), S. tuberatus (Humes and Cressey, 1961), S. pectinis, and Synapticolica tripocula, the latter two as new species. Ho and Yoosukh (1994) described Ostrincola humesi as new species parasitic in the oyster Saccostrea cucullata (Born) in the Gulf of Thailand. Ho and Kim (1995) reported Conchylurus bombasticus Reddiah, 1961, Ostrincola portonoviensis Reddiah, 1962, and Lichomolgus similis Ho and Kim, 1991 as parasites of the clam Meretrix meretrix (L.) from Phuket. Finally, Ho and Kim (2001) recorded Doricicola similis as a new species of the family Rhynchomolgidae associated with the squid Sepiotheuthis lessoniana Lesson from the Gulf of Thailand.

During a couple of international scientific conferences held in the past in Thailand, the authors could make short field works to collect copepods at vicinities of conference places. One of them is the 10th International Conference on Copepoda at Pattaya in July 2008, and the other being the First Asian Marine Biology Symposium at Phuket in December 2012. A total of 15 species of poecilostome copepods were collected, including ten new species, as described below.

MATERIALS AND METHODS

The copepods examined in the present study were recovered by washing, sweeping, and sucking. On the tidal flat the host animals were dug out with a stick and collected in plastic bags, with different species being placed in different bags and later being fixed in alcohol. On the coral reef and rocky shore, the copepods on the hosts (mainly hard corals) living in the shallow water were swept into a hand net using a small brush. Some copepods were sucked up directly from the host’s burrows with a large pipette. The sucked material were filtered using a small hand net and later in the laboratory the copepods were sorted out from the filtrates.
Before dissection for microscopic observation, copepod specimens were immersed in lactic acid. Dissections were done using the reversed slide method (Humes and Gooding, 1964). Dissected specimens were mounted on glass slides with Hoyer’s mounting medium. Type specimens have been deposited in the Marine Biodiversity Institute of Korea (MABIK), Seocheon, Korea.

SYSTEMATIC ACCOUNTS

Order Cyclopoida Burmeister, 1834
Family Clausidiidae Embleton, 1901
Genus Hemicyclops Boeck, 1873

Hemicyclops cornutus n. sp. (Figs. 1–3)

Material examined. 1 ♀ (holotype) from invertebrate burrows on a tidal flat (Ban Pa Khok seagrass bed) on the northeastern coast of Phuket Province, Thailand, 16 Dec 2012. Holotype (CR00233151, dissected and mounted on a glass slide) has been deposited in the MABIK, Seocheon, Korea.

Female. Body (Fig. 1A) moderately broad, 1.77 mm long. Prosome fusiform, 931 μm long, and consisting of cephalothorax and 3 pedigerous somites. Greatest width of prosome 638 μm across second pedigerous somite. Cephalothorax 500 × 608 μm. Second and third pedigerous somites with angular posterolateral corners; their posterior margin fringed with narrow membrane. Third pedigerous somite with blunt posterolateral corners. Urosome (Fig. 1B) 5-segmented. Fifth pedigerous somite (first urosomite) 230 μm wide, with gently curved, horn-like spine (indicated by arrow in Fig. 2G) at each posterolateral corner of dorsal side; this spine spinulose at proximal outer margin, but smooth in remaining part. Genital double-somite 308 × 258 μm (length to width ratio 1.19 : 1), with anterolateral expansion; lateral margins of this expanded region complicated, with 3 curvatures (Fig. 3E); genital aperture locating laterally at this expanded region; posterior part of somite weakly narrowing posteriorly, with width of 140 μm across posterior region. Three free abdominal somites 126, 92 × 123, and 71 × 114 μm, respectively. Anal somite (Fig. 1C) with row of spines along all posterior margins. Caudal rami (Fig. 1C) slightly divergent; each ramus rectangular, 85 × 40 μm (ratio 2.13 : 1), covered with fine setules on dorsal and ventral surfaces, and armed with 6 setae; outer seta (seta II) and outermost distal seta (seta VI) spiniform, not flexible, naked, and tipped by setule; other 4 setae pinnate; inner margin of ramus with long setules along distal third. Egg sac fusiform, 577 × 207 μm, distinctly shorter than urosome.

Rostrum not examined. Antennule (Fig. 1D) 359 μm long and 7-segmented, with armature formula 4, 15, 6, 3, 4+aesthetasc, 2+aesthetasc, and 7+aesthetasc; setae generally long and naked, except for following pinnate setae: 1 on second, fourth, and sixth segments each, 2 on fifth, and 3 on last. Antenna (Fig. 1E) 4-segmented; first segment longest, with scattered spinules and 1 pinnate seta at inner distal corner; second segment with spinulose inner margin and 1 pinnate seta on inner margin; third segment with dense spinules on inner margin, 4 setae at distinctly projected inner distal corner; terminal segment as long as wide, 25 × 25 μm, and armed with 7 setae, of which 2 outer ones weakly pinnate and one of remaining spinulose.

Labrum (Fig. 2A) as in general of the genus, with broad proximal part, narrower, spinulose distal part, and straight posterior margin. Mandible (Fig. 1F) with 4 elements distally: 1 claw-like thick element bearing 2 rows of fine spinules, 1 plate-like, densely spinulose element, and 2 pinnate setae. Paragnath (Fig. 2B) as small, unarticulated lobe bearing setules in distal region. Maxillule (Fig. 2C) distally bilobed, with patch of fine spinules on inner margin, and armed with 3 setae on inner lobe and 5 setae on outer lobe; most of setae on these lobes pinnate or spinulose. Maxilla (Fig. 2D) 2-segmented; basal segment with 2 thick setae on inner side, one of these setae with subsidiary setule at base; distal segment terminating in large, bifurcate process (with smooth outer branch and 3 cusps-bearing inner branch) and armed with 1 unilaterally pinnate seta and 2 spines: outer spine pinnate on inner margin and finely spinulose on outer margin; inner spine with patch of spinules near middle of outer margin. Maxilliped (Fig. 2E) 4-segmented; first segment broadest, with 2 large setae on inner margin; second segment longest, with 2 large setae on protrusion of inner margin; short third segment unarmed; terminal segment with 3 naked setae and 2 spines (terminal and inner ones); long inner spine with several long spinules near proximal third; terminal spine with several spinules on outer margin and 1 naked proximal seta; latter seta not articulated at base.

Legs 1–4 (Figs. 2F, 3A–C) with 3-segmented rami; endopods distinctly longer than exopods; coxa with setules on outer margin and patch of spinules at outer distal corner. Inner distal spine on basis of leg 1 large, spinulose, 78 μm long, and extending to distal border of second endopodal segment. Intercoxal plate with setules on posterior margin in leg 1, but with spinules in legs 2–4. Basis with row of spinules along distal margin between bases of rami and on inner side of anterior surface; inner side of distal margin with spinules in leg 1, but with setules in legs 2–4. Outer spines on leg 1 exopod tipped with setule. Outer distal corner of first and second endopodal segments of legs 1–4 projected, spiniform. Two inner spines on third endopodal segment of leg 4 elongate and pinnate in proximal 2/5 but spinulose in distal 3/5. Armature formula of legs 1–4 as follows:
Fig. 1. *Hemicyclops cornutus* n. sp., female. A, Habitus, dorsal; B, Urosome, dorsal; C, Anal somite and caudal rami, ventral; D, Antennule; E, Antenna; F, Mandible. Scale bars: A=0.2 mm, B=0.1 mm, C-E=0.05 mm, F=0.02 mm.
Fig. 2. *Hemicyclops cornutus* n. sp., female. A, Labrum; B, Paragnath; C, Maxillule; D, Maxilla; E, Maxilliped; F, Leg 1; G, Left side of fifth pedigerous somite and genital area, dorsal. Scale bars: A, C-G=0.05 mm, B=0.02 mm.
Fig. 3. *Hemicyclops cornutus* n. sp., female. A, Leg 2; B, Leg 3; C, Leg 4; D, Leg 5 exopod; E, Right genital aperture, dorsal. Scale bars: A–E=0.05 mm.
Leg 5 (Fig. 2G) 2-segmented; basal segment with 1 unilaterally pinnate, dorsodistal seta and patch of spinules at outer distal corner; exopod (distal segment, Fig. 3D) narrow proximally but gradually broadened distally, 142 × 63 μm (ratio 2.25 : 1), ornamented with dense spinules on both lateral margins and armed with 3 spines and 1 seta on distal margin; lengths of spines 63, 56, and 69 μm, respectively, from outer to inner. Leg 6 not discernible.

**Male.** Unknown.

**Etymology.** The specific name cornutus is derived from the Latin “cornu” (=horn) and alludes to the presence of a pair of dorsal, horn-like spines on the fifth pedigerous somite.

**Remarks.** Although only a single specimen is available to present the description of *Hemicylops cornutus* n. sp., its outstanding feature, the presence of a pair of horn-like spines on the fifth pedigerous somite may clearly typify the new species. Only two species have previously been described to have a pair of similar elements each on postero-dorsal corner of the fifth pedigerous somite, as in the new species. They are *H. biflagellatus* and *H. acanthosquillae*, both described by Humes (1965) from Madagascar. Of these two species, *H. acanthosquillae* clearly differs from *H. cornutus* n. sp., because the former species has, most of all, an extraordinary form of the antenna in which the inner distal corner of the third segment is strongly projected. *Hemicylops biflagellatus* is closely similar to *H. cornutus* n. sp. in sharing nearly all of significant characters, including the similar form of the hairy caudal rami. However, they are not of a same species. The most significant difference is displayed in the shape of the genital double-somite, in which the lateral margins of the anterolateral expansion are simple, rounded in *H. biflagellatus*, as Humes (1965) figured, but truncated, with 3 curvatures in *H. cornutus* n. sp. Other minor differences are as follows: (1) the posterolateral corners of the fourth pedigerous somite are sharply pointed in *H. biflagellatus*, but only angular in *H. cornutus*; (2) the caudal ramus is 100 × 41 μm, 2.44 times as long as wide in *H. biflagellatus*, compared to 85 × 40 μm, 2.13 times as long as wide in *H. cornutus*; (3) the dorsolateral element on the fifth pedigerous somite is a pinnate seta in *H. biflagellatus*, but a non-flexible, naked spine bearing a tuft of spinules proximally in *H. cornutus*; and (4) one (second inner element) of five elements on the third endopodal segment of leg 4 is a pinnate seta in *H. biflagellatus*, but all of these five elements are spines in *H. cornutus*.

### **Hemicylops parapiculus** n. sp. (Figs. 4–6)

**Material examined.** 1 ♀ (holotype) from invertebrate burrows on the Ban Pa Khok seagrass bed, northeastern coast of Phuket Province, Thailand, 16 Dec 2012. Holotype (CR00 233152, dissected and mounted on a glass slide) has been deposited in the MABIK, Seocheon, Korea.

**Female.** Body (Fig. 4A) moderately narrow and 1.19 mm long. Prosome 655 × 465 μm and consisting of cephalothorax and second to fourth pedigerous somites. Posterolateral corners of prosomal somites not pointed. Cephalothorax 385 μm long. Second and third pedigerous somites fringed with membrane along posterior margin. Urosome (Fig. 4B) 5-segmented. First urosomal somite (fifth pedigerous somite) 185 μm wide, with smooth lateral and posterior margins. Genital double-somite (Figs. 4B, 6E) 227 μm long, comprising roundly expanded anterior 63% and narrower distal 37%; greatest width of double-somite 185 μm, and width of narrower distal part 115 μm; expanded anterior part with sharp point at subdistal region of its lateral margins; genital aperture locating at midlength of expanded anterior part. Three free abdominal somites 78 × 108, 60 × 100, and 50 × 103 μm, respectively. Anal somite with short, transverse row of fine spinules along lateral side of posterodorsal margin (Fig. 4C). Caudal rami (Fig. 4C) quadrate, 55 × 48 μm (ratio 1.15 : 1) measured in ventral view, with setules on inner margin, tapered, tube-like ventrodistal element bearing pore at tip (Fig. 4D), and finely spinulose posteroventral margin; outer lateral seta small, 35 μm long and pinnate along inner margin; outermost distal seta (seta III) spiniform proximally and tipped with pinnate seta.

Rostrum short, with round posterior apex. Antennule (Fig. 4E) 321 μm long; armature formula 4, 15, 6, 4, 4++aesthetasc, 2++aesthetasc, and 7++aesthetasc; pinnate setae: 1 on fourth, fifth, and sixth segments each, and 3 on terminal segment. Antenna (Fig. 4F) 4-segmented; first segment longest, with scattered setules and spinules and 1 long inner distal seta; second segment slightly shorter than first, with setules on outer margin, spinules on proximal part of inner margin and 1 seta (this seta spinulose on inner margin) at middle of inner margin; third segment with inflated inner distal corner, spinules on inner margin and 4 setae at inner distal region, 2 of these setae naked and remaining 2 spinulose; terminal segment 22 × 27 μm, slightly wider than long, and armed with 7 setae, 4 of them large and weakly geniculate.

Labrum (Fig. 5A) nearly hemicircular, with various spinules on distal and subdistal regions; posterior and lateral margins not defined. Mandible (Fig. 5B) with 2 massive elements and 2 setae distally. Paragnath (Fig. 5C) not articulated, slightly curved, with spinules and setules. Maxillule (Fig. 5D) distally bilobed, with 3 shorter setae (one of them broad) on
Fig. 4. *Hemicyclops parapiculus* n. sp., female. A, Habitus, dorsal; B, Urosome, dorsal; C, Anal somite and caudal rami, dorsal; D, Right side of anal somite and right caudal ramus, ventral; E, Antennule; F, Antenna. Scale bars: A=0.2 mm, B=0.1 mm, C, E, F= 0.05 mm, D=0.02 mm.
Fig. 5. *Hemicyclops parapiculus* n. sp., female. A, Labrum; B, Mandible; C, Paragnath; D, Maxillule; E, Maxilla; F, Maxilliped; G, leg 1. Scale bars: A–E=0.02 mm, F, G=0.05 mm.
Fig. 6. *Hemicyclops parapiculus* n. sp., female. A, Leg 2; B, Leg 3; C, Leg 4; D, Leg 5 exopod; E, Left genital area, dorsal. Scale bars: A–E=0.05 mm.
narrower lobe and 5 longer setae on broader lobe. Maxilla (Fig. 5E) similar to that of preceding species; basal segment with 2 large setae and 1 small, weakly pinnate seta inserted to base of one of 2 larger setae. Maxilliped (Fig. 5F) with 2 large setae on inner margin and patch of spinules on outer side of first segment; second segment slightly inflated in middle, with 2 spinulose setae on inner margin and ornamented with row of large spinules on distal part of inner margin and row of several setules near inner distal corner; third segment small and unarmed; terminal segment terminating in long, smooth claw and proximally with 2 naked seta, 1 bifurcate seta, and 1 spinulose spine.

Leg 1 (Fig. 5G) with small tubercle on outer margin of coxa; inner distal spine on basis 54 μm long; distal process on third endopodal segment pronounced, with fine spinules on its outer margin; outermost terminal seta on third endopodal segment naked and smaller than nearby setae; all of outer spines on exopod tipped with setule. Posterior margin of coxa of leg 1 with setules (Fig. 5G), but those of legs 2–4 with sparse spinules (Fig. 6A–C). Inner proximal spine on third endopodal segment of leg 4 pinnate proximally. Armature formula of legs 1–4 as follows:

| Coxa | Basis | Exopod | Endopod |
|------|-------|--------|---------|
| Leg 1: | 0-1   | 1-1    | I-0; I-1; III, I, 4 | 0-1; 0-1; I, 2, 3 |
| Leg 2: | 0-1   | 1-0    | I-0; I-1; III, I, 5 | 0-1; 0-2; I, II, 3 |
| Leg 3: | 0-1   | 1-0    | I-0; I-1; III, I, 5 | 0-1; 0-2; II, II, 2 |
| Leg 4: | 0-1   | 1-0    | I-0; I-1; II, I, 5  | 0-1; 0-2; I, II, II |

Leg 5 two-segmented (Fig. 4B); basal segment (protopod) with angular outer distal corner, setule outer margin and armed with 1 dorsal, naked seta; exopod (Fig. 6D) 83 × 46 μm (ratio 1.80 : 1), with densely spinulose lateral margins, and armed with 3 spines and 1 pinnate seta; lengths of distal spines on exopod 35, 38, and 53 μm, respectively, from outer to inner. Leg 6 not discernible.

Male. Unknown.

Etymology. The specific name parapiculus refers to the close similarity of the new species to Hemicyclops apiculus Humes, 1995. The prefix par means “equal” in Latin.

Remarks. Hemicyclops parapiculus n. sp. is very closely related to H. apiculus Humes, 1995 described from Madagascar (Humes, 1995). These two species have in common almost all important characteristics, such as similar length: width ratio of caudal ramus, similar form of antenna and maxilliped, and similar armature on legs. The most significant difference between the two, which prevents them from being treated as conspecific, is in the shape of the genital double-somite. The narrower posterior part of the genital double-somite of H. parapiculus is relatively short, about 0.4 times as long as entire somite length, while the same part of H. apiculus is longer, two-thirds as long as somite length (Humes, 1995). The anterior expansion of the genital double-somite of H. parapiculus bears a pointed, tooth-like process on both sides, whereas the same place of H. apiculus is bluntly angular, without a process.

As minor differences, the body length of the new species is 1.19 mm, which is compared to 1.36–1.50 mm in H. apiculus. The posterolateral corners of the second pedigerous somite is blunt in H. parapiculus, but tapered and pointed in H. apiculus, as figured by Humes (1995) for the latter species. The exopod of leg 5 is 83 × 46 (ratio 1.80) in H. parapiculus, but 94 × 60 (ratio 1.57) in H. apiculus. H. parapiculus n. sp. was found from invertebrate burrows on a tidal flat, but H. apiculus was discovered from washings of scleractinian corals. This habitat difference may be a suggestion that they are not conspecific.

It should be pointed out that H. australis Nicholls, 1944 appears close to H. parapiculus n. sp. In viewing of illustrations of Nicholls (1944) for H. australis, the genital double-somite and its short caudal rami are very similar in form to those of H. parapiculus. The shape of the antenna, in which the medio-distal corner of the third segment is unusually blunt, is also shared by the two species. However, a further comparison is impossible due to the incomplete original description for H. australis. In the illustrations of Nicholls (1944) the labrum of H. australis has a straight (vs. convex in H. parapiculus) posterior margin and the maxilliped of the female does not have a bifurcate seta on the terminal segment. These points may suggest that this species from South Australia differs from H. parapiculus in species level.

Family Synaptiphilidae Bocquet and Stock, 1957
Genus Presynaptiphilus Bocquet and Stock, 1960

Presynaptiphilus trifurcatus n. sp (Figs. 7–9)

Material examined. 1 ♂, 1 ♀ from a brittle star (genus Amphiura) dug out from the tidal flat, Ban Pa Khok seagrass bed, northeastern coast of Phuket Province, Thailand, 16 Dec 2012. Hototype (♀, CR00233153) and allotype (♂, CR00233154), both dissected and mounted each on a glass slide, have been deposited in the MABIK, Seocheon, Korea.

Female. Body (Fig. 7A) small, 692 μm long. Prosome 425 × 283 μm, consisting of cephalothorax and second to fourth pedigerous somites. Cephalothorax 238 μm long, wider than long, with blunt posterolateral corners. Second and third pedigerous somites with convex lateral margins, without corners. Fourth pedigerous somite reduced, much narrower than preceding somite. Urosome (Fig. 7B) 5-segmented. Fifth pedigerous somite (first urosomal somite) 90 μm wide, with smooth lateral and posterior margins. Genital double-somite...
Fig. 7. *Presynaptiphilus trifurcatus* n. sp., female. A, Habitus, dorsal; B, Urosome, dorsal; C, Genital double-somite and abdomen, ventral; D, Anal somite and caudal rami, dorsal; E, Rostral region, ventral; F, Antennule; G, Antenna; H, Mandible; I, Maxillule. Scale bars: A=0.1 mm, B, C=E=0.05 mm, D, F, G, I=0.02 mm, H=0.01 mm.
Fig. 8. *Presynaptiphilus trifurcatus* n. sp., female. A, Labrum; B, Maxilla; C, Maxilliped; D, Leg 1; E, Leg 2; F, Leg 3; G, Leg 5. Scale bars: A-C=0.02 mm, D-G=0.05 mm.
Fig. 9. *Presynaptiphilus trifurcatus* n. sp. Female: A, Leg 4; B, Right genital area. Male: C, Habitus, dorsal; D, Urosome, ventral; E, Caudal rami, ventral; F, Maxilliped; G, Leg 1; H, Leg 5. Scale bars: A, D=0.05 mm, B, E–H=0.02 mm, C=0.1 mm.
being spiniform) of distal and 1 pair of inner, subdistal setae almost rectangular and plate-like, with 1 pair (one of them saw-like spine bearing serrate distal margin; distal segment seta. Maxilliped (Fig. 8C) peculiar and 2-segmented; basal lose spine, 2 slender seta and 1 small, setule-like, subdistal with elongate inner distal spine bearing minute spinules on inner lobe. Maxilla (Fig. 8B) 2-segmented; basal segment armed with 3 pinnate seta on outer lobe and 1 naked seta on discernible. Maxillule (Fig. 7I) weakly bilobed distally and 2 elements consisting of 1 subdistal seta and 1 distal spine.

Mandible (Fig. 7H) armed with ing lateral margins and 1 pair of membranous lobes on poste-

Rostrum (Fig. 7E) nearly rectangular, much wider than long, with well-sclerotized posterior margin. Antennule (Fig. 7F) 265 μm long and 6-segmented; armature formula 4, 15, 9, 4+aesthetasc, 2+aesthetasc, and 7+aesthetasc; all setae naked and all aesthetascs thin; first segment with additional patch of several setules at proximal region. Antenna(Fig. 7G) 4-segmented; first segment with 1 pinnate seta at inner distal corner and several rows of setules on distal half of surface; second segment nearly as long as first segment, with 1 naked seta on inner side; short third segment with produced inner distal inner corner and armed with 1 powerful claw and 3 setae, proximalmost one of latters small, setule-like; terminal segment wider than long and armed with 4 large, geniculate spiniform setae, 1 simple naked seta, and 2 pinnate setae.

Labrum (Fig. 8A) rhomboidal, wider than long, with tapering lateral margins and 1 pair of membranous lobes on posterior region of dorsal surface. Mandible (Fig. 7H) armed with 2 elements consisting of 1 subdistal seta and 1 distal spine bearing 1 subterminal cusp and 4 spinules. Paragnath not discernible. Maxillule (Fig. 7I) weakly bilobed distally and armed with 3 pinnate seta on outer lobe and 1 naked seta on inner lobe. Maxilla (Fig. 8B) 2-segmented; basal segment with elongate inner distal spine bearing minute spinules on distal part of outer margin; distal segment with with 1 spinu-

Legs 1–3 (Fig. 8D–F) with 3-segmented rami. Leg 4 (Fig. 9A) with 2-segmented rami. Posterior margin of coxa with large setules in leg 1, but with spinules in legs 2 and 3, and naked in leg 4. Inner element of coxa being setulose spine in leg 1, pinnate seta in leg 2, but absent in legs 3 and 4. Outer seta of legs 1–4 naked. Inner spine on basis of leg 1 setiform and spinulose. Third endopodal segment of leg 1 with pointed process at distal apex. Distal endopodal segment of leg 4 55 × 14 μm (ratio 3.93 : 1). Armature formula of legs 1–4 as follows:

| Coxa | Basis | Exopod | Endopod |
|------|-------|--------|---------|
| Leg 1: 0-1 | 1-1 | I-0; I-1; III, I, 4 | 0-1; 0-0; I, 2, 3 |
| Leg 2: 0-0 | 1-0 | I-0; I-1; III, I, 5 | 0-1; 0-2; II, I, 3 |
| Leg 3: 0-0 | 0-0 | I-0; I-1; III, I, 5 | 0-1; 0-2; II, I, 3 |
| Leg 4: 0-0 | 0-0 | 1-0 | 2, 1 5 |

Leg 5 (Fig. 8G) 2-segmented; basal segment (protopod) with 1 large seta and several spinules on outer margin; distal segment (exopod) 46 × 21 μm (ratio 2.19 : 1), with 2 spines (outer and outer subdistal) and 2 distal setae, all of these 4 elements naked. Spines and inner distal seta accompanied with 2 spinules near base of these elements; inner one of terminal setae longest, 107 μm long. Leg 6 (Fig. 9B) represented by 1 small, naked seta on genital operculum.

**Male.** Body (Fig. 9C) very similar to that of female, but smaller, 518 μm long. Greatest width 260 μm. Cephalothorax 190 μm long and distinctly wider than long. Urosome (Fig. 9D) 6-segmented. Fifth pedigerous somite 90 μm wide. Genital somite (Fig. 9B) rectangular, 38 × 87 μm, much wider than long, with indistinct genital opercula. Four abdominal somites 35 × 81, 31 × 69, 41 × 59, and 15 × 36 μm, respectively. First 3 abdominal somites with spinules along both sides of posteroventral margin. Anal somite ornamented as in female (Fig. 9E). Caudal ramus (Fig. 9E) 25 × 15 μm (ratio 1.67 : 1) and armed with 6 setae; seta I absent; outer one (seta IV) of 2 median terminal setae trifurcate at tip (Fig. 9E).

Rostrum, antennule and antenna as in female. Mouthparts, except for maxilliped, also as in female. Maxilliped (Fig. 9F) consisting of 3 segments and terminal claw; first segment unarmed; second segment greatly expanded proximally and strongly tapering distally, with inner hollow at proximal expansion receiving tip of terminal claw, 2 small setae and 4 broad, foliaceous spinules at hollow, and longitudinal row of spinules along inner margin distal to hollow; small third segment unarmed; terminal claw weakly curved and armed with 2 small setae proximally.

Leg 1 (Fig. 9G) with spinules (instead of setules as in female) on posterior margin of coxa; inner spine on coxa weakly pinnate distally; inner element on basis as spinulose seta. Leg 1 endopod 2-segmented; inner seta on proximal segment swollen proximally; distal segment armed with 1 outer spine and 4 inner setae (armature formula I, 4); distal
process more pronounced than that of female.

Leg 5 (Fig. 9H) stout; exopod 31 × 22 μm (ratio 1.41 : 1), tapering, armed with 3 spines (distal element being a strong spine rather than a long seta as in female) and 1 naked seta, and ornamented with more number of spinules than in female. Leg 6 absent (Fig. 9D).

Etyymology. The specific name trifurcatus is derived from the trifurcate seta IV (outer one of two median terminal setae) on the caudal ramus in the male.

Remarks. All of four known species of the genus Presynaptiphilus Bocquet and Stock, 1960 are associates of the amphipodid brittle stars. By having one spine and four setae on the distal segment of 2-segmented endopod of male leg 1, Presynaptiphilus trifurcatus n. sp. is easily differentiated from other four known species of Presynaptiphilus, because in its congeners leg 1 has a 3-segmented endopod (in P. acrinidae Bocquet and Stock, 1960) or the distal segment of 2-segmented endopod bears 1 spine and 5 setae (in P. amphiopli Humes and Hendler, 1972) or one spine and three setae (in P. paraminutus Kim, 2000 and P. paraminutus Shin and Kim, 2003).

The new species can be differentiated from its congeners on the basis of the female morphology. The endopod of female leg 1 is 3-segmented in all known species of the genus. The endopod of female leg 1 of the new species has 1, 0, and 6 elements, respectively, on the first to third segments (formula 0-1; 0-0; 1, 5). This armature state is shared only with P. amphiopli, and in other congeners the formula is 0-0; 0-0; 1, 5 (in P. acrinidae) or 0-1; 0-0; 1, 3 (in P. minutes and P. paraminutus). Therefore, the new species can be compared only with P. amphiopli which is known from the Atlantic coast of North America (Humes and Hendler, 1972). In addition to the difference in the armature of male leg 1, these two species show further differences in the female as follows: (1) the second free abdominal somite is wider than long in P. amphiopli, but longer than wide in the new species; (2) the posterior margin of the third pedigerous somite is deeply notched in P. amphiopli, but not notched, only weakly concave in the new species; (3) the posterior margin of the fourth pedigerous somite bears a complex ornamentation, with acute processes, spines, and setules in P. amphiopli, but smooth in the new species; and (4) the first segment of the antenna bears a patch of numerous spinules in P. amphiopli, but only few spinules in the new species.

Family Anchimolgidae Humes and Boxshall, 1996
Genus Anchimolgus Humes and Stock, 1972

Anchimolgus kantariensis n. sp. (Figs. 10–12)

Material examined. 5 ♀ ♀, 8 ♂ ♂ from a scleractinian coral, on coral reef in Kantary Bay, southern coast of Phuket Province, Thailand, 7° 48′ 14″N, 98° 24′ 20″E, 15 Dec 2012. Holotype (♀, CR00233155), allotype (♂, CR00233156), and paratypes (3 ♀ ♀, 6 ♂ ♂, CR00233157) have been deposited in the MABIK, Seocheon, Korea. Dissected paratypes (1 ♀, 1 ♂) are retained in the collection of the senior author.

Female. Body (Fig. 10A) moderately broad, 1.35 mm long. Prosome 769 × 523 μm, tapering posteriorly. Cephalothorax 548 μm long, with dorsal suture line delimiting cephalosome and first pedigerous somite; posterolateral corners rounded. Fourth pedigerous somite small, only slightly wider than next somite. Urosome (Fig. 10B) 5-segmented. Fifth pedigerous somite 178 μm wide. Genital double-somite (Figs. 10B, 11H) 193 μm long and 178 μm in greatest width (measured at anterior 0.35 region); middle half of double-somite inflated laterally and invertedly trapezoidal; genital aperture large and located in middle of double-somite. Three free abdominal somites 52 × 95, 40 × 80, and 78 × 100 μm, respectively. Anal somite with row of fine spinules along posteroventral margin. Caudal ramus (Fig. 10C) 82 × 43 μm (ratio 1.91 : 1) with 6 setae and with fine spinules on posteroventral margin; outer lateral seta naked and locating at distal third of outer margin; inner dorsal seta (seta VII) naked and articulated at base; 4 distal setae pinnate.

Rostrum (Fig. 10D) with posterior margin confluent with ventral surface of cephalothorax. Antennule (Fig. 10E) slender, 425 μm long, and 7-segmented; armature formula 4, 13, 6, 3, 4+aesthetasc, 2+aesthetasc, and 7+aesthetasc; one of 4 setae on first segment much larger than other 3. Antenna (Fig. 10F) slender and 4-segmented; segments gradually narrowing from proximal to distal; first segment unarmed; second segment 77 μm long, longer than first, with 1 small seta at distal fourth of inner margin; third segment 94 μm long, elongate, 5 times as long as wide, and armed with 2 setae, one of which at proximal third of inner margin and the other at inner distal corner; last segment short, 32 μm long, about 1/3 as long as third segment, and armed with 1 claw (58 μm long) and 1 small seta.

Labrum (Fig. 10G) unornamented, with broad posterior lobes. Mandible (Fig. 10H) with distinct proximal notch; inner margin bilobed and spinulose; distal lach thin and elongate; proximal region of outer margin protruding, with 5 slender digitiform processes. Maxillule (Fig. 10I) with 3 distal and 1 subdistal setae. Maxilla (Fig. 11A) with unarmed basal segment. Distal segment with large distal lach and 3 setae; distal lach perpendicular to axis of segment, with 1 proximal spine followed by row of spinules along distal margin and with smooth inner margin; inner seta spinulose, not longer than anterior seta; anterior seta flame-shaped distally; outer proximal seta minute. Maxillipeds (Fig. 11B) 3-segmented; first segment unarmed; middle segment with 2 small inner
Fig. 10. Anchimolgus kantariensis n. sp., female. A, Habitus, dorsal; B, Urosome, dorsal; C, Caudal rami, dorsal; D, Rostral area, ventral; E, Antennule; F, Antenna; G, Labrum; H, Mandible; I, Maxillule. Scale bars: A=0.2 mm, B=0.1 mm, C, E, F=0.05 mm, G–I=0.02 mm.
**Fig. 11.** Anchimolgus kantariensis n. sp., female. A, Maxilla; B, Maxilliped; C, Leg 1; D, Leg 2; E, Third endopodal segment of leg 3; F, Leg 4; G, Leg 5 exopod; H, Right genital area, dorsal. Scale bars: A, B, H=0.02 mm, C-G=0.05 mm.
setae of similar size; terminal segment with 1 spine and 1 seta, and terminating in sharp process.

Legs 1–3 with 3-segmented rami (Fig. 11C, D). Outer spines on leg 1 exopod with serrate margins (Fig. 11C); other spines of legs with smooth or finely serrate margins. Outer seta on basis of legs 1–4 naked. Leg 4 (Fig. 11F) with 3-segmented exopod and 2-segmented endopod; inner coxal seta small and naked; distal endopodal segment $56 \times 22 \mu m$, its 2

**Fig. 12.** Anchimolgus kantariensis n. sp., male. A, Habitus, dorsal; B, Urosome, ventral; C, Antenna; D, Maxilliped; E, Leg 1; F, Leg 5 exopod. Scale bars: A=0.2 mm, B=0.1 mm, C-E=0.05 mm, F=0.02 mm.
distal spines 53 μm (inner) and 34 μm (outer). Armature formula of legs 1–4 as follows:

| Leg  | Coxa | Basis | Exopod | Endopod |
|------|------|-------|--------|---------|
| Leg 1: | 0-1  I-0; I-1; III, I, 5 | 0-1; 0-1; I, 2, 3 |
| Leg 2: | 0-1  I-0; I-1; III, I, 5 | 0-1; 0-2; I, II, 3 |
| Leg 3: | 0-1  I-0; I-1; III, I, 5 | 0-1; 0-2; I, II, 2 |
| Leg 4: | 0-1  I-0; I-1; II, I, 5 | 0-1; II |

Leg 5 consisting of 1 pinnate dorsolateral seta on fifth pedigerous somite and free exopod (Fig. 10B); exopod (Fig. 11G) slender, 126 × 28 μm (ratio 4.50 : 1), with distinct inner proximal swelling, fine spinules on outer margin and 2 naked distal setae; slender distal region of exopod 16 μm wide; outer distal seta 74 μm long and inner one 104 μm long. Leg 6 represented by 2 small setae on genital operculum (Fig. 11H).

**Male.** Body (Fig. 12A) smaller than that of female, 1.05 mm long. Prososome 585 μm long. Cephalothorax 404 × 400 μm. Urosome (Fig. 12B) 6-segmented. Fifth pedigerous somite 131 μm wide. Genital somite (Fig. 12B) large, globular, 212 × 217 μm. Abdomen gradually broadening from proximal to distal. Four abdominal somites small, 31 × 63, 34 × 67, 21 × 67, and 48 × 79 μm, respectively. Caudal rami 67 × 38 μm (ratio 1.76 : 1).

Rostrum as in female. Antennule with 3 additional aesthetasc: 2 on second and 1 on fourth segments as indicated by dark dots in Fig. 10E. Antenna (Fig. 12C) shaped and armed as that of female, but with numerous, minute, additional spinules on inner margin of second and third segments.

Labrum, mandible, maxillule, and maxilla as in female. Maxilliped (Fig. 12D) consisting of 3 segments and terminal claw; first and third segments unarmed; second segment with 2 setae of similar length near middle of inner margin and longitudinal row of spinules along inner margin; terminal claw arched, as long as 3 combined proximal segments, with 1 minute and 1 large setae proximally and membrane along concave margin.

Leg 1 (Fig. 12E) with 2 spines and 4 setae on third endopodal segment. Legs 2–4 as in female. Exopod of leg 5 (Fig. 12F) small, nearly oval, 23 × 12 μm (ratio 1.92 : 1), with few minute spinules subdistally and armed distally with 1 serrate spine (15 μm long) and 1 naked seta; seta about 3 times as long as spine. Leg 6 represented by 1 pinnate seta and 1 minute, naked seta on genital operculum (Fig. 12B).

**Etymology.** The specific name *kantariensis* is derived from “Kantary Bay” in Phuket, the type locality of the new species.

**Remarks.** In the genus *Anchimolgus* Humes and Stock, 1972 proportional lengths of the second to fourth segments of antenna are useful characters to distinguish species. In the antenna of *Anchimolgus kantariensis* n. sp. the third segment is about three times as long the terminal segment and the third segment is not shorter than the second segment. Similar form of the antenna is shared by 4 congeners: *A. gratus* Humes, 1996, *A. pandus* Humes, 1978, *A. orcuttus* Humes, 1978, and *A. punctilis* Humes, 1978. Of these, the first two species are not related to the new species, because they have three outer spines on the third endopodal segment of leg 4 (armature formula III, I, 5, against to II, I, 5 as in the new species). *Anchimolgus orcuttus* also is clearly different from the new species in having a slender prosome, a longer caudal rami of the female measuring 109 × 40 μm, with the ratio of 2.73 : 1, and a weak inner proximal expansion of leg 5 exopod of the female (Humes, 1978). *Anchimolgus punctilis* is very close to the new species and they share various similar morphological characters, except for only two features. First, the digitiform processes on the outer side of mandible are two in number in *A. punctilis*, but five in *A. kantariensis* n. sp. Second, the exopod of male leg 5 is 28 μm long (longer than that of *A. kantariensis* n. sp., although the body is smaller) with parallel lateral margins in *A. punctilis*, compared to 23 μm long, with convex lateral margins in *A. kantariensis* n. sp. The body length of *A. punctilis* is 1.01–1.22 mm in the female and 0.84–0.96 mm in the male (Humes, 1978), while it is 1.35 mm in the female and 1.05 mm in the male in *A. kantariensis*.

**Anchimolgus palmenus** n. sp. (Figs. 13, 14)

**Material examined.** 3♀♀ from a scleractinian coral, on coral reef in Kantary Bay, southern coast of Phuket Province, Thailand, 7°48′14″N, 98°24′20″E, 15 Dec 2012. Holotype (♀, CR00233158) and paratype (1♀, CR00233159) have been deposited in the MABIK, Seochon, Korea. Dissected paratype (1♀) is retained in the collection of the senior author.

**Female.** Body (Fig. 13A, B) narrow, 1.23 mm long. Prosome 635 μm long and consisting of cephalothorax and second to fourth pedigerous somites. Greatest width of prosome 323 μm measured across second pedigerous somite. Cephalothorax 419 × 304 μm, distinctly longer than wide, dorsally elevated, 365 μm in dorsoventral depth, and dorsoventrally deeper than laterally wider, with nearly parallel lateral margins. Second pedigerous somite trapezoidal, with produced posterolateral corners. Urosome (Fig. 13C) 5-segmented. Fifth pedigerous somite 210 μm wide, much wider than next somite, with tapering lateral margins. Genital double-somite 177 × 144 μm, longer than wide, with slightly broadened anterior half and narrower posterior half; genital apertures locating dorsally at about anterior 0.3 of somite length. Three free abdominal somites 77 × 106, 67 × 90, and 48 × 90 μm, respectively; all of these somites smooth without any ornamentation. Caudal rami divergent (Fig. 13C); each ramus elongate, 205 × 33 μm (ratio 6.21 : 1), armed with 6 distal and subdistal, naked setae and ornamented with fine, sparse setules on outer and inner
Fig. 13. *Anchimolgus palmatus* n. sp., female. A, Habitus, dorsal; B, Habitus, lateral; C, Urosome, dorsal; D, Rostrum; E, Antennule; F, Antenna; G, Labrum; H, Mandible; I, Maxillule. Scale bars: A, B=0.2 mm, C=0.1 mm, D=0.05 mm, E–I=0.02 mm.
Fig. 14. Anchimolgus palmatus n. sp., female. A, Maxilla; B, Maxilliped; C, Leg 1; D, Leg 2; E, Third endopodal segment of leg 3; F, Leg 4; G, Leg 5 exopod. Scale bars: A, B=0.02 mm, C-G=0.05 mm.
mented endopod. Outer seta on basis of legs 1–2 naked, distal one of them very small; terminal segment also short, 23 µm long, and armed with 2 minute setae and terminal claw; terminal claw 23 µm long, as long as segment and weakly curved.

Labrum (Fig. 13G) with broad median incision and broad posterior lobes fringed with membrane along posterior margin. Mandible (Fig. 13H) with deep proximal notch, strongly projected and bilobed inner margin (proximal lobe with 2 rows of spinules, and distal lobe with single row), and thin, spinulose distal lobe; outer proximal region of blade strongly produced, with palm-like element bearing 5 or 6 blunt, digitiform processes. Maxillule (Fig. 13I) armed with 4 setae (2 produced, with palm-like element bearing 5 or 6 blunt, digitiform processes). Maxilliped (Fig. 14B) stout, curved and 3-segmented; first segment broadest and unarmed; middle segment with short inner margin and long, curved outer margin, and armed with 1 small and 1 longer, naked setae (longer one about 3 times as long as shorter one); terminal segment armed with 1 spinulose spine and 2 unequal, naked setae.

Legs 1 and 2 (Fig. 14C, D) and leg 3 with 3-segmented rami. Leg 4 (Fig. 14F) with 3-segmented exopod and 2-segmented endopod. Outer seta on basis of legs 1–3 small and naked; that of leg 4 also naked but large. All spines on leg 1 exopod spinulose and tipped with setule. Leg 3 similar to leg 2 but third endopodal segment (Fig. 14E) armed with 3 spines and 2 setae. Distal segment of leg 4 endopod 44 × 18 µm (ratio 2.44:1) and narrowing distally; its 2 terminal spines setiform, spinulose, and 26 µm (outer) and 45 µm long (inner). Armature formula of legs 1–4 as in preceding species.

Leg 5 consisting of 1 dorsolateral seta on fifth pedigerous somite and free exopod (Fig. 13C); exopod 120 × 35 µm (ratio 3.43:1), nearly rectangular, and spinulose on all surfaces, with small inner tubercle proximally and 2 naked distal setae (46 and 72 µm long, respectively). Leg 6 not discernible.

Male. Unknown.

Etymology. The specific name of the new species palnatus alludes to the presence of a palmate element on the convex side of its mandible.

Remarks. About one-third of described species of Anchimolgus have a slender prosome, like A. palnatus n. sp. They share other similarities, such as the elongate caudal ramus and the elongate second segment of antenna. However, only four of them have the digitiform process(es) on the convex side of the mandible, as the new species. They are A. compressus Humes, 1996, A. exsertus Humes, 1991, A. nasutus Humes, 1996, and A. tanaus Humes, 1991. These species can be differentiated from the new species by their features, as follows:

Anchimolgus compressus: caudal ramus tapering; rostrum without posterior apex; maxillule with only 2 setae; and exopod of leg 5 short and 2.61 times as long as wide (Humes, 1996).

Anchimolgus exsertus: genital double-somite with strongly tapering anterior part; terminal segment of antenna distinctly longer than third segment; mandible with 3 digitiform processes on convex side; and leg 5 exopod subcuneate and 1.73 times as long as wide (Humes, 1991).

Anchimolgus nasutus: dorsolateral seta on fifth pedigerous somite large and longer than exopod of leg 5; rostrum elongate, with blunt posterior apex; terminal segment of antenna much longer than third segment; and mandible with 2 digitiform processes on convex side (Humes, 1996).

Anchimolgus tanaus: caudal ramus 10.6 times as long as wide (244 × 23 µm); anterior expansion of genital double-somite distinct, with convex lateral margins; mandible with only 1 digitiform process on convex side; and leg 5 exopod long (Humes, 1991).

Family Kellieriidae Humes and Boxshall, 1996
Genus Kelleria Gurney, 1927

Kelleria vasfera n. sp. (Figs. 15, 16)

Material examined. 2♀♂ from invertebrate burrows on sands of coral reef in Kantary Bay, southern coast of Phuket Province, Thailand, 7°48′14″N, 98°24′20″E, 15 Dec 2012. Holotype (♀, CR00233160) has been deposited in the MABIK, Seocheon, Korea. Dissected paratype (1♀) is retained in the collection of the senior author.

Female. Body (Fig. 15A) narrow, 1.08 mm long. Prosome elliptical and 615 × 385 µm. Cephalothorax 438 µm long, with dorsal suture line delimiting cephalosome and first pedigerous somite. Second pedigerous somite with posterolateral corners tipped with short membranous fringe. Urosome (Fig. 15B) 5-segmented. Fifth pedigerous somite 137 µm wide.
Fig. 15. Kelleria vasfera n. sp., female. A, Habitus, dorsal; B, Uroscope, dorsal; C, Caudal rami, dorsal; D, Rostrum; E, Antennule; F, Antenna; G, Mandible; H, Paragnath; I, Maxillule. Scale bars: A=0.2 mm, B=0.1 mm, C–F=0.05 mm, G–I=0.02 mm.
Fig. 16. Kelleria vasfera n. sp., female. A, Labrum; B, Maxilla; C, Maxilliped; D, Leg 1; E, Leg 2; F, Leg 4; G, Leg 5 exopod; H, Right genital area, dorsal. Scale bars: A, C–F=0.05 mm, B, G, H=0.02 mm.
Genital double-somite 178 × 150 μm, with expanded anterior half and narrower posterior half; expanded anterior half with angular lateral apex, narrower posterior half gradually narrowing distally. Genital apertures located dorsally. Three free abdominal somites 61 × 75, 44 × 67, and 67 × 65 μm, respectively. Anal somite with minute spines along posteroventral margin; anal aperture large. Caudal rami (Fig. 15C) directed backwards; each ramus 103 × 32 μm (ratio 3.22 : 1), with 6 setae and 2 large, conical ducts bearing terminal pore; outer lateral seta (seta II) naked and locating at 0.6 of outer margin; other 5 setae pinnate; inner dorsal seta articulated at base.

Rostrum (Fig. 15D) strongly tapering and wider than long. Antennule (Fig. 15E) 347 μm long, gradually narrowing distally, and 7-segmented; armature formula 4, 13, 6, 3, 4+aesthetasc, 2+aesthetasc, and 7+aesthetasc; setae generally long and all of them naked. Antenna (Fig. 15F) 4-segmented; first segment with 1 inner distal seta; second segment similar in length to first segment, with fine spines along outer margin and 1 subdiscal seta on inner margin; third segment short and armed with 2 setae and 1 setiform claw; terminal segment 80 × 22 μm (ratio 3.64 : 1), armed with 2 slender claws and 5 long setae, and ornamented with fine spines on outer margin.

Labrum (Fig. 16A) with large posterior lobes and deep median incision; each lobe slightly broadened distally, with broad membrane on proximal half of inner margin. Mandible (Fig. 15G) with shallow proximal notch; inner margin oblique, not distinctly demarcated from distal lappet, with about 9 large spines, proximal 3 of them being slender; convex margin with small knob tipped with 4 or 5 minute spines, and followed by about 17 thick teeth (these teeth becoming gradually smaller from proximal to distal); distal lappet spinulose on both margins. Paragnath (Fig. 15H) tapering in distal half, with 1 small, dentiform process laterally and setules subdistally. Maxillule (Fig. 15I) with serrate membrane on distal region of outer margin and armed with 1 lateral, 1 subdiscal, and 2 large distal setae; lateral seta naked and articulated at base; other 3 setae weakly pinnate unilaterally. Maxilla (Fig. 16B) 2-segmented; basal segment with 1 small, tooth-like tubercle on outer side; distal segment armed with large inner spine, slender, naked anterior seta, and minute outer, proximal seta, and terminating in straight, rigid distal lappet; distal lappet almost perpendicular to proximal part of segment, articulated near middle, and armed with large teeth along distal margin (proximal third and fourth teeth smaller than other teeth and distal 3 teeth locating distal to articulation); inner spine extending slightly over distal lappet, with 7 spines on distal margin and about 10 spines on proximal margin; spines on both margins of inner spine becoming larger from proximal to distal. Maxilliped (Fig. 16C) 3-segmented. First segment longest but unramed. Second segment with protruded inner margin bearing 2 large setae; proximal seta with about 10 spines a proximal part of proximal margin and row of setules along distal margin; distal seta setulose along both margins. Terminal segment terminating in elongate setiform process and armed with 1 pinnate seta and 2 smaller naked setae.

Legs 1 and 2 (Fig. 16D, E) and leg 3 with 3-segmented exopod and endopod. Leg 4 (Fig. 16F) with 3-segmented exopod and 1-segmented endopod. Leg 3 similar to leg 2, but its third endopodal segment armed with 3 spines and 2 setae (formula I, II, 2). Outer seta on basis of legs 2 and 3 small and naked; those of legs 1 and 4 larger and pinnate. Inner distal corner of basis of leg 2 weakly bilobed. Leg 4 endopod 67 × 21 μm (ratio 3.19 : 1), with small dentiform process at proximal 0.4 of inner margin; inner seta not extending to distal end of segment; 2 distal spines large, 65 μm (inner) and 46 μm (outer); both outer and inner distal corners pointed. Armature formula of legs 1–4 as follows:

| Coxa | Basis | Exopod | Endopod |
|------|-------|--------|---------|
| Leg 1: 0-1 | 1-0 | I-0; I-1; III, I, 4 | 0-1; 0-1; I, 1, 4 |
| Leg 2: 0-1 | 1-0 | I-0; I-1; III, I, 5 | 0-1; 0-2; I, II, 3 |
| Leg 3: 0-1 | 1-0 | I-0; I-1; III, I, 5 | 0-1; 0-2; I, II, 2 |
| Leg 4: 0-1 | 1-0 | I-0; I-1; II, I, 5 | 0, II, 1 |

Leg 5 consisting of 1 pinnate dorsolateral seta on fifth pederigerous somite and free exopod; exopod (Fig. 16G) approximately 82 × 47 μm, with strongly projected inner margin tipped with digitiform process and 2 naked distal setae. Leg 6 (Fig. 16H) probably represented by 1 seta, 1 conical process, and laterally positioned, seta-tipped knob in genital region. Male. Unknown.

Etymology. The specific name vasfera is a combination of Latin words vas (a duct) and ferre (to bear). It alludes to the presence of a pair of tapering, duct-like distal structures on the caudal ramus of the new species, although it is probable that the duct-like structures are common in at least in the genus Kelleria.

Remarks. The exopod of leg 5 in Kelleria is armed distally with two spines (formula II) in six species, or one spine plus one seta (I,1) in five species, or two setae (2) in seven species. In having two setae on the exopod of leg 5, Kelleria vasfera n. sp. can be compared with the latter seven species, as follows: K. andamanensis Sewell, 1949; K. camortensis Sewell, 1949; K. corioensis Arnott and McKinnon, 1981; K. gradata Stock, 1967; K. grandisetiger Kim, 2006; K. multioviger Kim, 2009; and K. purpuricincta Gurney, 1927. Of these seven, only the last two species have, like the new species, a prominent inner process on the exopod of leg 5. K. vasfera n. sp. differs from K. corioensis and K. purpuricincta, because the latter two species have the following characters.
In *K. corioensis*, the body length is at most 0.85 mm in the female (vs. 1.08 mm in *K. vasfera*); the mandible with seven large and five or six smaller spines (vs. about 10 subequal spines in *K. vasfera*) on the concave margin; the distal process of the second maxillary segment is armed with nine unequal teeth (vs. eleven subequal teeth in *K. vasfera*); and the inner proximal seta on the terminal maxilliped segment is elongate (vs. short in *K. vasfera*).

In *K. purpuracincta*, as figured in the original description (Gurney, 1927), the inner margin of the mandible bears several large proximal spines followed by row of small spines (vs. spines are subequal in *K. vasfera*); the inner spine (originally seta I) on the second maxillary segment bears 3 large proximal spines followed by small spines (vs. becoming progressively larger distally in *K. vasfera*); and the endopod of leg 4 bears no pointed process on the outer margin (vs. present in *K. vasfera*).

Family Pseudanthessiidae Humes and Stock, 1972
Genus *Pseudanthessius* Claus, 1889

**Pseudanthessius stenosus n. sp. (Figs. 17, 18)**

Material examined. 2 ♀ ♂ from invertebrate burrows on sands of coral reef in Kantary Bay, southern coast of Phuket Province, Thailand, 7° 48′ 14″N, 98° 24′ 20″E, 15 Dec 2012. Holotype (♀, CR00233161) has been deposited in the MABIK, Seocheon, Korea. Dissected paratype (♂) is retained in the collection of the senior author.

Female. Body (Fig. 17A) slender, 1.25 mm long. Prosome 704 μm long. Cephalothorax 473 × 342 μm, distinctly longer than wide and divided by dorsal suture line into cephalosome and first pedigerous somite. Urosome (Fig. 17B) 5-segmented. Fifth pedigerous somite 112 μm wide and laterally tapering. Genital double-somite 162 μm long. Coxocephalic somite 53 × 57, 32 × 49, and 66 × 42 μm, respectively. Anal somite distinctly longer than wide and unornamented, without spines or setules. Caudal rami close to each other and elagante; each ramus 170 × 17 μm, 10 times as long as wide, slightly broadened at distal region, and armed with 6 setae; outer lateral seta located at 0.73 of ramus length; all of setae pinnate.

Rostrum (Fig. 17C) tapering, as long as its basal width, with round posterior apex. Antennule (Fig. 17D) 320 μm long and 7-segmented; armature formula 4, 13, 6, 3, 4+aesthetasc, 2+aesthetasc, and 7+aesthetasc; all of setae naked and one of subdistal setae on second segment distinctly larger than others; terminal segment short, half as long as penultimate segment. Antenna (Fig. 17E) 4-segmented; first segment with 1 inner distal seta; second segment distinctly longer than first, with fine spines on distal half of outer margin and 1 subdistal seta on inner margin; third segment with 1 slender claw and 2 setae; terminal segment 3.1 times as long as wide and armed with 4 slender claws (2 middle ones shorter than other 2) and 3 setae.

Labrum (Fig. 17F) with elongate, divergent, tapering posterior lobes fringed with narrow membrane along posterior margin and with deep median incision. Mandible (Fig. 17G) consisting of short proximal part and tapering blade, with deep but narrow proximal notch; inner margin not differentiated; convex outer side with large, well-sclerotized, distally-directed process; inner margin of blade serrate; outer convex margin of blade smooth. Maxillule (Fig. 17H) armed with 1 lateral, setiform process and 3 distal setae, median one of latters larger than other 2, with several minute spines distally; outermost one of distal setae broad, process-like, with articulation at base. Maxilla (Fig. 18A) 2-segmented; basal segment unarmed; distal segment with large inner spine bearing membranous fringe along inner (proximal) margin and spines along distal half of outer (distal) margin, spiniform anterior seta tipped with 1 seta and 1 small dentiform process, and terminating in long, thin, spinulose distal lach; distal region of second segment near base of distal lach with 1 large, tooth-like process and 3 small denticles; outer proximal seta (seta III) absent. Maxilliped (Fig. 18B) 3-segmented; first segment unarmed; second segment with slightly inflated inner margin, 2 unequal setae, and several oblique rows of minute spines; terminal segment tapering, distally forming pointed claw, with 2 setae proximally.

Legs 1 and 2 (Fig. 18C, D) and leg 3 with 3-segmented rami. Leg 4 (Fig. 18F) with 3-segmented exopod and 1-segmented endopod. Leg 5 similar to leg 2, but its third endopodal segment armed with 3 spines and 2 setae (Fig. 18E).

Legs 1–4 (Fig. 18, D) and leg 3 with 3-segmented rami. Armature formula of legs 1–4 as follows:

| Leg | Coxa | Basis | Exopod | Endopod |
|-----|------|-------|--------|---------|
| Leg 1 | 0-1 | 1-0 | I-0; I-1; III, I, 4 | 0-1; 0-1; I, I, 4 |
| Leg 2 | 0-1 | 1-0 | I-0; I-1; III, I, 5 | 0-1; 0-2; I, II, 3 |
| Leg 3 | 0-1 | 1-0 | I-0; I-1; III, I, 5 | 0-1; 0-2; I, II, 2 |
| Leg 4 | 0-1 | 1-0 | I-0; I-1; II, I, 5 | II |

Leg 5 (Fig. 18G) represented by produced lateral region of fifth pedigerous somite bearing pinnate proximal seta and 2 distal elements (short spine of 18 μm long and longer, naked.
Fig. 17. *Pseudanthessius stenosus* n. sp., female. A, Habitus, dorsal; B, Urosome, dorsal; C, Rostrum; D, Antennule; E, Antenna; F, Labrum; G, Mandible; H, Maxillule. Scale bars: A = 0.2 mm, B–D = 0.05 mm, E–H = 0.02 mm.
Fig. 18. *Pseudanthessius stenosus* n. sp., female. A, Maxilla; B, Maxilliped; C, Leg 1; D, Leg 2; E, Leg 3 endopod; F, Leg 4; G, Right side of first two urosomites, dorsal. Scale bars: A–G=0.02 mm.
several species of the genus, as follows:

**Remarks.** One of diagnostic features of *Pseudanthessius stenosus* n. sp. is the possession of elongate caudal rami which are ten times as long as wide. Similarly elongate caudal rami being more than seven times as long as wide are known in several species of the genus, as follows: *P. aestheticus* Stock, Humes and Gooding, 1964; *P. concinnus* Thompson and A. Scott, 1903; *P. deficiens* Stock, Humes and Gooding, 1964; *P. dentatus* Kim, 2000; *P. dubius* Sars, 1918; and *P. thorelli* (Brady and Robertson, 1875). *Pseudanthessius deficiens* and *P. dubius* cannot be confused with the new species, because they have a 4-segmented urosome. The remaining four species can be differentiated from the new species by their features, as follows:

*Pseudanthessius aestheticus*; the mandible is simple, with a smooth convex margin; the maxillule is armed only with three (not four) distal setae; leg 4 endopod is 96 × 23 μm in size (vs. 69 × 23 μm in the new species); and leg 5 consists of three simple setae (Stock et al., 1964).

*Pseudanthessius concinnus*: leg 4 endopod has one lanceolate spine and one plain spine distally (Thompson and Scot, 1903); and last two urosomal somites are subequal in length (Stock et al., 1964).

*Pseudanthessius dentatus*: the mandible has three spines on concave margin; the posteroventral margin of the fifth pedigerous somite is fringed with membrane; leg 4 endopod bears a notch and a point on the outer margin; the anterior seta (seta II) on the second maxillary segment is specialized, tipped with three processes and one seta (Kim, 2000).

*Pseudanthessius thorelli*: this species was redescribed by Stock and Weinberg (1985). According to the latter authors, the genital double-somite is evenly tapering towards distal border; the abdominal somites are ornamented with spines on posteroventral margin; the outer lateral seta on the caudal ramus is positioned at about 60% of the ramus length (vs. at 73% in the new species).

**Pseudanthessius phuketensis** n. sp. (Figs. 19, 20)

**Material examined.** 1 ♀ (holotype) from invertebrate burrows on sands of coral reef in Kantary Bay, southern coast of Phuket Province, Thailand, 7° 48′ 14″ N, 98° 24′ 20″ E, 15 Dec 2012. Holotype (CR00233162, dissected and mounted on a glass slide) has been deposited in the MABIK, Seocheon, Korea.

**Female.** Body (Fig. 19A) slender, 942 μm long. Prosome 581 × 308 μm. Cephalothorax 385 μm long, with dorsal suture line delimiting cephalosome and first pedigerous somite. Urosome (Fig. 19B) 5-segmented. Fifth pedigerous somite 88 μm wide and laterally tapering. Genital double-somite 134 × 81 μm (ratio 1.65 : 1), with slightly expanded anterior 0.6 and narrower, weakly tapering posterior 0.4. Genital aperture locating laterally near midlength of somite. Three free abdominal somites 35 × 43, 25 × 40, and 46 × 38 μm, respectively. Anal somite (Fig. 19B) with fine spines along posteroventral margin. Caudal rami (Fig. 19C) straight, close to each other; each ramus 88 × 17 μm, 5.18 times as long as wide; outer lateral seta naked and locating at 0.69 of ramus length; inner dorsal seta (seta VII) naked and lacking basal articulation; other 4 setae pinnate.

Rostrum (Fig. 19D) strongly tapering, as long as its basal width, with round posterior apex. Antennule (Fig. 19F) 248 μm long and 7-segmented; armature formula 4, 13, 6, 3, 4+ aesthetasc, 2+aesthetasc, and 7+aesthetasc; all of setae naked; one of distal setae on second segment very large. Antenna (Fig. 19F) 4-segmented; first segment with 1 inner distal seta; second segment distinctly longer than first, with fine spines on outer margin and 1 subdistal seta on inner margin; third segment with 1 claw and 2 setae; terminal segment 3.0 times as long as wide and armed with 4 claws (second outer one broader and stronger than other 3 spines) and 3 setae.

Labrum (Fig. 19G) very similar to that of preceding species. Mandible (Fig. 19H) consisting of short proximal part and tapering blade, with deep proximal notch; inner margin not differentiated; convex outer side with claw-like process; inner margin of blade serrate and outer convex margin of blade smooth; distal lappet short. Maxillule (Fig. 20A) with 1 digitiform process on lateral margin and 3 naked, unequal, distal setae. Maxilla (Fig. 20B) similar to that of preceding species; inner spine of distal segment serrate on distal part of distal margin; anterior seta bifurcate; distal part of segment near base of distal lappet with 2 tooth-like processes. Maxilliped (Fig. 20C) 3-segmented; first segment longest but unarmed; second segment with 2 very unequal setae and scattered spines on inner side; terminal segment narrow and tapering, with 1 small proximal seta and several spines on distal region of distal margin.

Legs 1 and 2 (Fig. 20D, E) and leg 3 segmented and armed as in preceding species. Outer seta on basis of leg 1 weakly pinnate, and those of legs 2–4 naked. Terminal segment (Fig. 20F) of leg 3 endopod with 3 spines and 2 setae as in preceding species. Leg 4 (Fig. 20G) endopod 63 × 25 μm (ratio 2.52 : 1), with blunt process on outer margin; 2 distal spines 62 μm (inner) and 46 μm long (outer). Armature formula of legs 1–4 as in preceding species.

Leg 5 (Fig. 20H) represented by produced lateral region of
Fig. 19. *Pseudanthessius phuketensis* n. sp., female. A, Habitus, dorsal; B, Urosome, dorsal; C, Caudal rami, dorsal; D, Rostrum; E, Antennule; F, Antenna; G, Labrum; H, Mandible. Scale bars: A=0.1 mm, B, E=0.05 mm, C, D, F–H=0.02 mm.
Fig. 20. *Pseudanthessius phuketensis* n. sp., female. A, Maxillule; B, Maxilla; C, Maxilliped; D, Leg 1; E, Leg 2; F, Third endopodal segment of leg 3; G, Leg 4; H, Left side of first two urosomites, dorsal. Scale bars: A–H=0.02 mm.
fifth pedigerous somite, bearing pinnate proximal seta and 2 distal elements (short, naked spiniform seta and pinnate seta). Leg 6 (Fig. 20H) represented by 2 setae (pinnate anterior seta and smaller, naked, undulated posterior seta) on genital operculum.

**Male.** Unknown.

**Etymology.** The specific name is derived from the type locality of the new species, Phuket.

**Remarks.** In a key to species of *Pseudanthessius* Claus, 1889 given by Stock et al. (1964), there were six species having a moderately long caudal ramus which is more than four times but not more than 7.5 times as long as wide, as *P. phuketensis* n. sp. They are *P. aestheticus* Stock, Humes and Gooding, 1964; *P. gracilis* Claus, 1889; *P. graciloides* Sewell, 1949; *P. latus* Illg, 1950; *P. nemertophilus* Gallien, 1936; and *P. weberi* A. Scott, 1909. In addition, another 3 species with the similar form of the caudal ramus have been described since, i.e., *P. dentatus* Kim, 2000, *P. limatus* Humes, 1978 and *P. procurrens* Humes, 1966. Of these 9 species, *P. gracilis*, *P. graciloides*, *P. latus*, and *P. nemertophilus*, all of them having the antenna in which the terminal segment is less than twice as long as wide, may be excluded from a further comparison with the new species. The remaining 5 species may be distinguished from the new species, by having the following features.

*Pseudanthessius aestheticus*: the mandible is simple, without any process or tooth on the convex side; the maxillule is armed only with 3 distal setae, without a lateral element; and leg 4 endopod is 96 × 23 μm in size (vs. 639 × 25 μm in *P. phuketensis* n. sp.).

*Pseudanthessius dentatus*: the mandible has 3 spines on concave margin (vs. a row of spinules in *K. phuketensis*); the posterodorsal margin of the fifth pedigerous somite is fringed with membrane (vs. none in *K. phuketensis*); the anterior seta (seta II) on the second maxillary segment is specialized, tipped with three processes and one seta (vs. bifurcate in *K. phuketensis*).

*Pseudanthessius limatus*: the genital double-somite bears a dentiform process on the lateral margin (vs. none in *K. phuketensis*); the maxillule is armed only with three apical setae; and leg 4 endopod lacks a process on the outer margin.

*Pseudanthessius procurrens*: the cephalothorax is broad; the terminal segment of the antenna is armed with two unequal claws and five setae (vs. four claws and three setae in *K. phuketensis*); leg 4 endopod lacks a process on the outer margin; and the mandible lacks a tooth-like process on the convex side (Humes, 1966).

*Pseudanthessius weberi*: the maxilla lacks an inner element on the second segment; and the mandible with simple convex side, without a tooth-like process (A. Scott, 1909).

**Material examined.** 2 ♀, 1 ♂ from 1 *Stichodactyla gigan
tea* (Forskål) on the tidal flat, Ban Pa Khok seagrass bed, northeastern coast of Phuket Province, Thailand, 8°01′23″N, 98°24′55″E, 16 Dec 2012.

**Remarks.** In the female the body length is 1.27 mm. The caudal ramus is 58 × 42 μm (ratio 1.38 : 1). Leg 5 is exopod 131 × 49 μm (ratio 2.67 : 1) and bears with numerous minute scales on the outer surface. The specimens from Phuket showed no other significant differences from the original description of this species.

**Genus Doridicola** Leydig, 1853

**Doridicola pattayensis** n. sp. (Figs. 21–23)

**Material examined.** 4 ♀, 3 ♂ from washings of the zoanthid coral *Palythoa tuberculosa* (Esper), intertidal, Pattaya, in the Gulf of Thailand, 12°54′48″N, 100°51′24″E, 18 Jul 2008. Holotype (♀, CR00233163), allotype (♂, CR00233164), and paratypes (2 ♀, 1 ♂, CR00233165) have been deposited in the MABIK, Sceocheon, Korea. Dissected paratypes (1 ♀, 1 ♂) are retained in the collection of the senior author.

**Female.** Body (Fig. 21A) narrow, 1.00 mm long (other 2 measured females 0.83 and 0.84 mm, respectively). Prosome 737 × 458 μm. Cephalothorax 455 μm long and divided dorsally by suture line into cephalosome and first pedigerous somite. Second pedigerous somite with slightly projected, angular posterolateral corners. Urosome (Fig. 21B) 5-segmented, short and stout, about 0.36 times as long as prosome. Fifth pedigerous somite 112 μm wide. Genital double-somite 115 × 115 μm, as long as wide, and consisting of expanded anterior 0.75 and narrower posterior 0.35; genital aperture locating at 0.55 of somite length. Three free abdominal somites 19 × 66, 16 × 62, and 26 × 59 μm, respectively. Anal somite unornamented. Caudal ramus (Fig. 21C) very short, 27 × 25 μm (ratio 1.08 : 1) with 6 setae and with fine spinules on posteroventral margin; outer lateral seta naked; outermost distal seta (seta III) pinnate only along inner margin; other 4 setae bilaterally pinnate.

Rostrum hemicircular, with round posterior apex. Antennule (Fig. 21D) slender, 336 μm long, and 7-segmented; armature formula 4, 13, 6, 3, 4+æsthetasc, 2+æsthetasc, and 7+æsthetasc; all of setae naked. Antenna (Fig. 21E) 4-segmented; first segment slightly curved, with 1 seta at inner distal corner; second segment as long as first, with 1 seta on

**Family Rhynochomolgidae** Humes and Stock, 1972

**Genus Critomolgus** Humes and Stock, 1983

**Critomolgus gemmatus** (Humes, 1964)

**Material examined.** 2 ♀, 1 ♂ from 1 *Stichodactyla gigan
tea* (Forskål) on the tidal flat, Ban Pa Khok seagrass bed, northeastern coast of Phuket Province, Thailand, 8°01′23″N, 98°24′55″E, 16 Dec 2012.

**Remarks.** In the female the body length is 1.27 mm. The caudal ramus is 58 × 42 μm (ratio 1.38 : 1). Leg 5 is exopod 131 × 49 μm (ratio 2.67 : 1) and bears with numerous minute scales on the outer surface. The specimens from Phuket showed no other significant differences from the original description of this species.

**Genus Doridicola** Leydig, 1853

**Doridicola pattayensis** n. sp. (Figs. 21–23)

**Material examined.** 4 ♀, 3 ♂ from washings of the zoanthid coral *Palythoa tuberculosa* (Esper), intertidal, Pattaya, in the Gulf of Thailand, 12°54′48″N, 100°51′24″E, 18 Jul 2008. Holotype (♀, CR00233163), allotype (♂, CR00233164), and paratypes (2 ♀, 1 ♂, CR00233165) have been deposited in the MABIK, Sceocheon, Korea. Dissected paratypes (1 ♀, 1 ♂) are retained in the collection of the senior author.

**Female.** Body (Fig. 21A) narrow, 1.00 mm long (other 2 measured females 0.83 and 0.84 mm, respectively). Prosome 737 × 458 μm. Cephalothorax 455 μm long and divided dor
dally by suture line into cephalosome and first pedigerous somite. Second pedigerous somite with slightly projected, angular posterolateral corners. Urosome (Fig. 21B) 5-segmented, short and stout, about 0.36 times as long as prosome. Fifth pedigerous somite 112 μm wide. Genital double-somite 115 × 115 μm, as long as wide, and consisting of expanded anterior 0.75 and narrower posterior 0.35; genital aperture locating at 0.55 of somite length. Three free abdominal somites 19 × 66, 16 × 62, and 26 × 59 μm, respectively. Anal somite unornamented. Caudal ramus (Fig. 21C) very short, 27 × 25 μm (ratio 1.08 : 1) with 6 setae and with fine spinules on posteroventral margin; outer lateral seta naked; outermost distal seta (seta III) pinnate only along inner margin; other 4 setae bilaterally pinnate.

Rostrum hemicircular, with round posterior apex. Antennule (Fig. 21D) slender, 336 μm long, and 7-segmented; armature formula 4, 13, 6, 3, 4+æsthetasc, 2+æsthetasc, and 7+æsthetasc; all of setae naked. Antenna (Fig. 21E) 4-segmented; first segment slightly curved, with 1 seta at inner distal corner; second segment as long as first, with 1 seta on
Fig. 21. *Doridicola pattayensis* n. sp., female. A, Habitus, dorsal; B, Urosome, dorsal; C, Caudal rami, dorsal; D, Antennule; E, Antenna; F, Labrum; G, Mandible; H, Paragnath; I, Maxillule. Scale bars: A = 0.2 mm, B, D = 0.05 mm, C, F - I = 0.02 mm.
Fig. 22. *Doridicola pattayensis* n. sp., female. A, Maxilla; B, Maxilliped; C, Terminal segment of maxilliped; D, Leg 1; E, Leg 2; F, Third endopodal segment of leg 3; G, Leg 4; H, Exopod of leg 5; I, Left genital aperture, dorsal. Scale bars: A–C, H, I=0.02 mm, D–G=0.05 mm.
inner margin; short third segment with 1 slender claw and 2 setae; terminal segment $66 \times 17.5 \mu m$, about 3.8 times as long as wide, with 2 claws of similar length (slender inner one $45 \mu m$ long and outer one slightly broader and $44 \mu m$ long) and

**Fig. 23.** *Doridicola pattayensis* n. sp., male. A, Habitus, dorsal; B, Urosome, ventral; C, Antenna; D, Maxilliped; E, Leg 1; F, Leg 5 exopod. Scale bars: A=0.1 mm, B-F=0.02 mm.
5 setae, one of latters inserting to base of inner spine.

Labrum (Fig. 21F) with broad posterior lobes and deep median incision; inner distal corner of lobes pointed. Mandible (Fig. 21G) with broad proximal notch; inner margin distinct, perpendicular to distal lash, and densely spinulose; outer proximal region of blade projected, with row of small denticles; cutting edge finely serrate; distal lash elongate and spinulose on both margins. Paragnath (Fig. 21H) lobate, bearing setules distally. Maxillule (Fig. 21I) armed with 1 small, setiform lateral element and 3 distal, naked setae. Maxilla (Fig. 22A) with unarmed basal segment; distal segment with minute outer proximal seta, weakly spinulose anterior seta, 5-spinules-bearing inner spine, and elongate distal lash; distal lash with 6 proximal teeth followed by fine spinules on outer margin. Maxilliped (Fig. 22B) 3-segmented; first segment with several, scattered spines; second segment slightly swollen, with 1 small and 1 extremely large setae, latter 104 μm long, about 20 times as long as shorter seta, and unilaterally spinulose; terminal segment (Fig. 22C) armed with 1 naked seta and 1 spinulose spine and terminating in spinulose, spiniform process.

Legs 1 and 2 (Fig. 22D, E) and leg 3 with 3-segmented rami. Leg 4 (Fig. 22G) with 3-segmented exopod and 2-segmented endopod. Leg 3 similar to leg 2, but its third endopodal segment (Fig. 22F) with 3 spines and 2 setae. Inner coxal seta of leg 4 small and naked. Distal segment of leg 4 endopod 59 × 21 μm, about 2.8 times as long as wide, distally with 3 pointed processes and 2 unequal spines; outer spine 27 μm long and inner one 55 μm long. Armature formula of legs 1–4 as follows:

| Coxa | Basis | Exopod | Endopod |
|------|-------|--------|---------|
| Leg 1: | 0-1 1-0 | I-0; I-1; III, I, 4 | 0-1; 0-1; I, 1, 4 |
| Leg 2: | 0-1 1-0 | I-0; I-1; III, I, 5 | 0-1; 0-2; I, II, 3 |
| Leg 3: | 0-1 1-0 | I-0; I-1; III, I, 5 | 0-1; 0-2; I, II, 2 |
| Leg 4: | 0-1 1-0 | I-0; I-1; II, I, 5 | 0-1; II |

Leg 5 consisting of 1 pinnate dorsolateral seta on fifth pedigerous somite and free exopod; exopod (Fig. 22H) 81 × 29 μm, 2.79 times as long as its greatest width, with prominent inner proximal swelling, scattered spinules on outer surface and 2 distal setae; outer seta 41 μm long, and inner seta 66 μm long, with thin membranous fringe along outer margin. Leg 6 represented by 1 small seta, 1 small spine and 1 dentiform process on genital operculum (Fig. 22I).

**Male.** Body (Fig. 23A) narrower than that of female and 775 μm long (other 2 examined specimens 744 and 697 μm, respectively). Prosome 495 × 277 μm. Cephalothorax 313 μm long; dorsal suture line between cephalosome and first pedigerous somite very faint and limited to lateral sides. Urosome (Fig. 23B) 6-segmented. Fifth pedigerous somite 71 μm wide. Genital somite large, 146 × 137 μm. Four abdominal somites small, 17 × 43, 14 × 45, 11 × 43, and 15 × 47 μm, respectively. Caudal ramus (Fig. 23B) 18 × 20 μm, slightly wider than long.

Rostrum as in female. Antennule with 3 additional aesthetascs, 2 on second and 1 on fourth segments, as indicated by dark dots in Fig. 21D. Antenna (Fig. 23C) with spinules on inner margin of 2 proximal segments and on outer margin of second segment; setae on 2 proximal segments finely spinulose along their inner margin.

Labrum, mandible, paragnath, maxillule, and maxilla as in female. Maxilliped (Fig. 23D) consisting of 3 segments and terminal claw; first segment unarmed; second segment slightly expanded around 0.6 region of segment length, with 2 small setae near 0.4 region and 2 longitudinal rows of spinules, one of latters limited to distal half of segment; small third segment unarmed; terminal claw elongate, proximally with 1 seta and 1 setule.

Leg 1 (Fig. 23E) armed with 2 spines and 4 setae on third endopodal segment, otherwise same as that of female. Legs 2–4 as in female.

Leg 5 exopod (Fig. 23F) small, 36 × 11 μm, 3.27 times as long as wide, slightly curved, and armed distally with 1 spinulose spine and 1 naked seta. Leg 6 (Fig. 23B) represented by 2 thin, unequal setae on genital operculum.

**Etymology.** The specific name is derived from Pattaya, the type locality of the new species.

**Remarks.** Ten species of the genus *Doridicola* Leydig, 1853 share with *D. pattayensis* n. sp the following combination of characters in the female: the caudal ramus is less than 1.5 times as wide as the exopod of leg 5 has an inner proximal swelling. Of these 10 species, five have the antenna bearing very unequal (in thickness or length) pair of terminal claws, unlike the new species. The remaining 5 species are distinguishable from the new species by having the following features.

* Doridicola antheliae (Humes and Stock, 1973): expanded anterior part of genital double-somite with parallel lateral margins; two terminal claws of antenna of female short and thick, only 28 and 21 μm long, respectively (Humes and Stock, 1973).

* Doridicola cinctus (Humes and Stock, 1973): genital double-somite constricted at region of genital aperture; leg 5 exopod of female tapering; two terminal claws of antenna of female 36 and 32 μm, respectively (Humes and Stock, 1973).

* Doridicola parvicaudatus Kim, 2003: two terminal claws of antenna longer than its terminal segment; two setae on second segment of female maxilliped equal in length; leg 5 exopod of male 47 × 10 μm, 4.7 times as long as wide (Kim, 2003).

* Doridicola securiger (Humes, 1964): mandible narrow,
without protuberance on its convex side; proximal expansion of leg 4 endopod of female much more prominent than in *D. pattayensis* n. sp.; three free abdominal somites of female 52, 40, and 43 μm long, respectively (compared to 19, 16, and 26 μm long in *D. pattayensis*) (Humes, 1964).

*Doridicola sensilis* (Humes, 1964): mandible slender, without protuberance on convex side; two setae on the second segment of maxilliped bears 1 spiniform process, 1 small spine and 2 like swellings (Humes and Ho, 1968), which are otherwise not similar to the new species.

Species of *Doridicola* are associated with various invertebrates, but only a single species, *D. inaequalis* (Humes and Ho, 1966), was known previously to live on the zoanthid corals (Ho and Kim, 2001). Thus, *D. pattayensis* n. sp. is the second species of the genus found on the zoanthid corals.

**Doridicola inaequalis** (Humes and Ho, 1966)

**Material examined.** 26 ♀ ♂♀, 7 ♀ ♂ from washings of the zoanthid coral *Palythoa tuberculosa* (Esper), intertidal, Pattaya, in the Gulf of Thailand, 12° 54’48”N, 100° 51’24”E, 18 Jul 2008.

**Female.** The mean body length is 938 μm (815–1,023 μm), based on 10 specimens. The body length of dissected specimen is 1.01 mm. The cephalothorax is 446 × 525 μm. The genital double-somite is 131 × 120 μm. The caudal ramus is 48 × 32 μm (ratio 1.50 : 1). Two setae on the second segment of maxilliped are equal in size; the terminal segment of the maxilliped bears 1 spiniform process, 1 small spine and 2 setae. The outer seta on the basis of legs 1–4 are weakly pinnate. Leg 5 exopod is 97 × 27 μm (ratio 3.57 : 1).

**Male.** The mean body length is 815 μm (777–857 μm), based on 6 specimens. Leg 5 exopod is 28 × 13 μm (ratio 2.15 : 1) and armed distally with 1 spine (18 μm) and 1 seta (40 μm).

**Remarks.** This species was originally recorded as an associate of *Palythoa*, a zoanthid coral genus (Humes and Ho, 1966). Later, Kim (2003) reported this species from New Caledonia.

**Doridicola cuspis** (Humes, 1964)

**Material examined.** 3 ♀ ♂♀, 2 ♀ ♂ from 1 Stichodactyla gigantea (Forskål) on a tidal flat on the northeastern coast of Phuket, Thailand, 8°01’23”N, 98°24’55”E, 16 Dec 2012.

**Remarks.** The body length of a dissected female is 1.52 mm, not significantly different from those of type specimens of Humes (1964). This species is characteristic in having greatly expanded cephalothorax which is much wider than the second pedigerous somite.

Genus *Indomulgus* Humes and Ho, 1966

**Indomulgus brevisetosus** Humes and Ho, 1966

**Material examined.** 1 ♂ from washings of the zoanthid coral *Palythoa tuberculosa* (Esper), intertidal, Pattaya, in the Gulf of Thailand, 12° 54’48”N, 100° 51’24”E, 18 Jul 2008.

**Remarks.** The body length of the observed single male is 2.33 mm. The caudal ramus is 246 × 81 μm (ratio 3.04 : 1). Leg 5 exopod is 60 × 33 μm (ratio 1.82 : 1), a measurement quite different from that of type specimens of Humes and Ho (1966), probably due to the difference of viewing angles. This is the first record on this species outside of Madagascar.

Genus *Lambanetes* Humes, 1982

**Lambanetes stichodactylae** Humes, 1982 (Figs. 24, 25)

**Material examined.** 3 ♀ ♂♀, 10 ♀ ♂ from Stichodactyla gigantea (Forskål) on the tidal flat, Ban Pa Khok seagrass bed, northeastern coast of Phuket Province, Thailand, 8°01’23”N, 98°24’55”E, 16 Dec 2012.

**Female.** Body tapering (Fig. 24B), with dorsally directed urospine (Fig. 24A). Body length 1.35 mm. Greatest width 656 μm. Exoskeleton moderately hard. Prosome 531 μm long. All prosomal somites with rounded lateral margins. Cephalothorax 451 μm long, 1.45 times as wide as long. Second to fourth pedigerous somites 574, 503, and 365 μm wide, respectively. Fourth pedigerous somite with posterolateral protrusions. Urospine (Fig. 24C) 5-segmented. Fifth pedigerous somite 267 μm wide. Genital double-somite (Fig. 24C) 172 × 263 μm, with convex lateral margins; genital aperture circular and located dorsally, slightly anterior to midway. Three free abdominal somites 96 × 171, 77 × 147, and 77 × 131, respectively. Anal region with 2 balloon-like swellings (Fig. 24C). Caudal ramus (Fig. 24D) 47 × 38 μm (ratio 1.24 : 1), strongly tapering, with 6 setae; setae II-IV spiniform and 27, 23, and 51 μm, respectively; seta V largest, 181 μm long. 3.85 times as long as caudal ramus; all setae naked.

Rostrum absent. Antennule (Fig. 24E) 7-segmented, with thick, crowded setae; armature formula 4, 13, 6, 2, 4+aesthetasc, 2+aesthetasc, and 7+aesthetasc; all setae naked. Antenna (Fig. 24F) 3-segmented; first and second segments broad, each with 1 seta on inner margin; third segment much
Fig. 24. *Lambanetes stichodactyla* Humes, female. A, Habitus, left; B, Habitus, dorsal; C, Urosome, dorsal; D, Left caudal ramus, dorsal; E, Antennule; F, Antenna; G, Mandible; H, Maxillule. Scale bars: A, B=0.2 mm, C=0.1 mm, D–F=0.02 mm, G, H=0.01 mm.
Fig. 25. Lambanetes stichodactylae Humes, female. A, Maxilla; B, Maxilliped; C, Leg 1; D, Leg 2; E, Leg 3; F, Leg 4; G, Leg 5; H, Genital aperture. Scale bars: A–H=0.02 mm.
Remarks. Humes (1982) originally described this species, based only on the male. Therefore, the above description is generally as in original description by Humes (1982).

Material examined. 1 ♀, 7 ♂ examined from *Stichodactyla gegan-tea* (Forskål) on the tidal flat, Ban Pa Khok seagrass bed, northeastern coast of Phuket Province, Thailand, 8°01′23″N, 98°24′55″E, 16 Dec 2012. Holotype (♀, CR00233166, dissected and mounted on a glass slide) and paratypes (6 ♂, CR00233167) have been deposited in the MABIK, Seocheon, Korea. Dissected paratype (1 ♂) is retained in the collection of the senior author.

**Female.** Body (Fig. 26A) inflated and flexed, with soft exoskeleton. Length 1.82 mm. Prosome 1.10 mm long. Cephalothorax wider than long. Urosome directed dorsally and 5-segmented. Genital double-somite 170 × 269 μm, 1.58 times as wide as long, with slightly convex lateral margins and row of minute spines along posteroverentral and posterolateral margins; genital aperture circular and locating dorsally at anterior third of somite length (Fig. 26B). Three free abdominal somites 115 × 195, 103 × 167, and 103 × 141 μm, respectively. First and second free abdominal somites with row of minute spines along posterior margin. Anal somite (Fig. 26B) with well-developed anal operculum and posterior inflations. Caudal ramus (Fig. 26C) 46 × 38 μm, 1.21 times as long as wide, with 6 setae; setae II–VII 17, 19, 21, 66, 28, and 25 μm long, respectively; setae II–IV spiniform; seta V less than twice as long as ramus; all setae naked.

Rostrum absent. Antennule (Fig. 26D) 6-segmented; armature formula 4, 13, 6, 2, 4+aesthetasc, and 9+2 aesthetascs; all setae naked. Antenna (Fig. 26E) 3-segmented; first and second segments each with 1 small seta on inner margin; third segment about 1.75 times as long as wide and armed proximally with 3 setae on inner margin and distally with 5 setae and 2 claws; proximal one of claws small and directed laterally; terminal claw much larger and strongly curved.

Labrum (Fig. 26F) weak but with well-sclerotized, tapering posteromedian process. Mandible (Fig. 26G) narrow; spine on outer, convex side trifurcate; convex and concave margins serrate; several spines present on dorsal surface near proximal region of distal lappet. Maxillule (Fig. 26H) with 2 naked distal setae. Maxilla (Fig. 26I) 2-segmented; basal segment unarmed; distal segment terminating in process bearing 3 spines, and proximally with 2 small setae and 1 spine, the latter with 3 spines (1 proximal and 2 distal). Maxilliped (Fig. 26J) unsegmented, with trace of segmentation near middle, and armed with 2 very unequal setae (one of them minute and transparent) near distal third and distally with 2 spiniform processes and 1 small seta.
Fig. 26. *Lambanetes mollis* n. sp., female. A, Habitus, left; B, Genital double-somite and abdomen, dorsal; C, Left caudal ramus, dorsal; D, Antennule; E, Antenna; F, Labrum; G, Mandible; H, Maxillule; I, Maxilla; J, Maxilliped. Scale bars: A=0.2 mm, B=0.1 mm, C-F, I, J=0.02 mm, G, H=0.01 mm.
Legs 1–3 (Fig. 27A–C) with 3-segmented rami. Leg 4 (Fig. 27D) with 3-segmented exopod and 2-segmented endopod. All of these legs without inner seta on coxa. First endopodal segment of legs 3 and 4 unarmed. Distal segment of leg 4 endopod $35 \times 23 \mu m$. Armature formula of legs 1–4 as follows:

| Coxa | Basis | Exopod | Endopod |
|------|-------|--------|---------|
| Leg 1: 0-0 | 1-0 | I-0; I-1; III, I, 3 | 0-1; 0-1; I, 1, 4 |
| Leg 2: 0-0 | 1-0 | I-0; I-1; III, I, 3 | 0-1; 0-1; I, II, 2 |
| Leg 3: 0-0 | 1-0 | I-0; I-1; III, I, 1 | 0-0; 0-1; II |
| Leg 4: 0-0 | 1-0 | I-0; I-1; III, I, 1 | 0-0; I |

Leg 5 (Fig. 27E) consisting of 1 outer seta on fifth pedigerous somite and free exopod; exopod $41 \times 27 \mu m$, 1.52 times as long as wide, terminating in 2 dentiform processes, with 2 naked distal setae. Leg 6 not seen.  

**Male.** Body (Fig. 28A) straight and not inflated. Mean body length $0.95 \text{ mm (0.85–1.01 mm)}$, based on 8 specimens. Length of dissected specimen $1.00 \text{ mm}$. Prosome $654 \mu m$ long. Cephalothorax $388 \times 462 \mu m$, with angular posterolateral corners. Second to fourth pedigerous somites $381, 343,$ and $300 \mu m$ wide, respectively. Third and fourth pedigerous somites with rounded, posteriorly protruded posterolateral corners. Urosome (Fig. 28B) 6-segmented. Fifth pedigerous somite $238 \mu m$ wide. Genital somite (Fig. 28B) $117 \times 250 \mu m$, about twice as wide as long. Four abdominal somites $52 \times 122, 54 \times 106, 38 \times 90,$ and $52 \times 81 \mu m$, respectively. First to

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**Fig. 27. Lambanetes mollis n. sp., female. A, Leg 1; B, Leg 2; C, Leg 3; D, Leg 4; E, Leg 5. Scale bars: A–E=0.02 mm.**
third abdominal somites with row of minute spinules along posterior border. Anal somite (Fig. 28B) with row of minute spinules near base of caudal rami. Caudal ramus (Fig. 28C) \(35 \times 25 \mu m\), 1.40 times as long as wide; setae II-VII 18, 19, 38, 86, 38, and 27 \(\mu m\), respectively; longest seta V about 2.5 times as long as ramus.

Rostrum absent. Antennule, antenna, labrum, mandible, and maxillule as in female. Maxilla (Fig. 28D) similar to that of female, but inner seta (seta I) spiniform, with several spinules; distal process with 3 or 4 spines (probability about 1 : 1); anterior spine with 3 or 4 (usually 3) spinules. Maxilliped (Fig. 28E) consisting of 3 segments and terminal claw; first segment longest but unarmed; second segment with projected inner proximal corner, 2 inner setae slightly distal to midlength of segment, and small scales along inner margin; small third segment unarmed; terminal claw extending to

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**Fig. 28.** Lambanetes mollis n. sp., male. A, Habitus, dorsal; B, Urosome, ventral; C, Right side of distal part of abdomen, ventral; D, Maxilla; E, Maxilliped; F, Leg 1. Scale bars: A, B=0.1 mm, C-E=0.02 mm, F=0.01 mm.
proximal border of second segment, strongly curved in distal part, with 2 proximal setae.

Leg 1 (Fig. 28F) with third endopodal segment armed with 2 spines and 4 setae (armature formula I, I, 4), otherwise same as that of female. Legs 2–4 as in female.

Leg 5 (Fig. 28B) exopod 25 × 17 μm, 1.47 times as long as wide. Three setae on leg 5 feebly pinnate and longer than exopod. Leg 6 (Fig. 28B) represented by 1 dentiform process and 2 weakly pinnate setae on genital operculum.

Etymology. The specific name mollis is a Latin meaning “soft”, alluding to the soft, flexible body of the female of the new species.

Remarks. Three known species of Lambanetes Humes, 1982 including L. mollis n. sp., are distinguishable by their armature of legs 1–4. In the female, all rami of legs 1–3 and the exopod of leg 4 of L. gemmulatus Humes, 1982 have fewer setae than those of L. stichodactylae. The reduction of armature occurs further in both sexes of L. mollis in which the first endopodal segment of legs 3 and 4 lacks the inner seta (vs. armature formula 0-0, not 0-1 as in two congeners) and the distal segment of leg 4 endopod has only one spine (vs. armature formula 0, 1, 0, not 0, II, 0 as in two congeners).

Besides the difference in leg armature, other appendages of L. mollis show differences from those of two congeners. The spine on the convex side of the mandible is trifurcate in L. mollis, but smooth in L. gemmulatus or crenate, with many spinules in L. stichodactylae. The anterior spine (originally seta II) of the distal segment of the maxilla of the female is bifurcate, with a proximal spine in L. mollis, but bears five spinules in L. gemmulatus (see illustration by Humes, 1982) or about ten spinules in L. stichodactylae (see Fig. 25A of the present paper). The exopod of leg 5 of the female is 1.52 times as long as wide in L. mollis, but 2.12 times (in L. gemmulatus) or 2.95 times (in L. stichodactylae) as long as wide. The antennule of L. mollis is 6-segmented in both sexes, unlike 7-segmented condition in two congeners. The form of and ornamentation of the distal process (claw) of the maxillary distal segment, relative lengths of caudal setae, and the form of maxillipeds also show differences among the three species.

Family Synapticolidae Humes and Boxshall, 1996
Genus Scambicornus Heegaard, 1944

Scambicornus affinis Ho, 1982

Material examined. 70 ♀ ♂, 35♀♂ from sea cucumbers on coral reef in Kantary Bay, southern coast of Phuket Province, Thailand, 7° 48’14”N, 98°24’20”E, 15 Dec 2012.

Remarks. Scambicornus affinis Ho, 1982 was originally described as an associate of Stichopus japonica Selenka from Japan (Ho, 1982). Ho and Kim (1990) redescribed it from four species of sea cucumbers from Phuket, Thailand, Holothuria leucoselis (Brandt), H. scabra Jaeger, H. atra (Jaeger), and Opheodestes clarki (Heding). According to Ho (1982) and Ho and Kim (1990), this species is closely related to S. idoneus (Humes and Cressey, 1961).

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