

# Three New Species of *Kelleria* (Copepoda: Poecilostomatoida: Kelleriidae) from Korea

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## ABSTRACT

Three new species of *Kelleria* are described based on the females from the invertebrate burrows in the Port Seogwipo, Jeju Island, Korea. These species possess in common no process on the inner margin of the free segment of leg 5. *Kelleria grandisetiger* n. sp. possesses a large seta on lateral sides of the genital double-somite and a small thumb-like process near base of the free segment of leg 5. *Kelleria undecidentata* n. sp. possesses the elongated free segment of leg 5 which is more than four times as long as wide and 11 teeth on the distal margin of the second maxillary segment. *Kelleria portiviva* n. sp. possesses one seta and one distinct spine on the distal margin of the free segment of leg 5, ten or 11 teeth on the distal margin of the second maxillary segment, and a tuft of spinules on the convex outer corner of mandible.

**Key words:** *Kelleria*, new species, Copepoda, Poecilostomatoida, Korea

## INTRODUCTION

*Kelleria* Gurney, 1927 is the only genus of the family Kelleriidae. This family is readily distinguished from other families of the superfamily Lichomolgoidea by the primitive state of maxilliped in the female bearing four discrete setation elements on the endopodal segment (Humes and Boxshall, 1996). Humes and Stock (1973) recognized nine species in this genus, excluding *K. gurneyi* Sewell, 1949 which they treated as a species insufficiently described and of uncertain position. Kim (2000) added a new species *K. vaga* from the Yellow Sea coast of Korea.

Species of this genus live in loose association with other marine invertebrates (Boxshall and Halsey, 2004). Most of them have been found from plankton and invertebrate burrows, except for the following two cases of host records: *Kelleria grata* Stock, 1967, associated with the crinoid *Heterometra savignyi* (J. Müller) in the Gulf of Aqaba (Stock, 1967) and *K. australiensis* Bayly, 1971, associated with the starfish *Pentaceraster regulus* (Müller and Troschel) in New Caledonia (Kim, 2003). In the present paper three new species are described from the intertidal invertebrate burrows in Korea.

## MATERIALS AND METHODS

Copepods studied in the present work were collected at the

Port Seogwipo (33° 14' 11" N, 126° 33' 44" E) in Jeju Island, Korea. At the southwestern shore in this port intertidal muds (inhabited most commonly by polychaetes, shrimps, and crabs) under rocks and gravels were shovelled up during the time of low tide and the resulting stagnated water was filtered through a dip net. The filtrates were poured into a jar containing the absolute ethanol and in the laboratory copepod materials were sorted out from the filtrates under the dissecting microscope.

The copepod specimens were measured and dissected after soaking in lactic acid. The dissection was done using the reverse slide method of Humes and Gooding (1964). In the following descriptions, the body length does not include setae on the caudal rami. Roman and Arabic numerals represent spines and setae, respectively. All figures were drawn with the aid of a camera lucida.

## DESCRIPTIONS

Order Poecilostomatoida Kabata, 1979

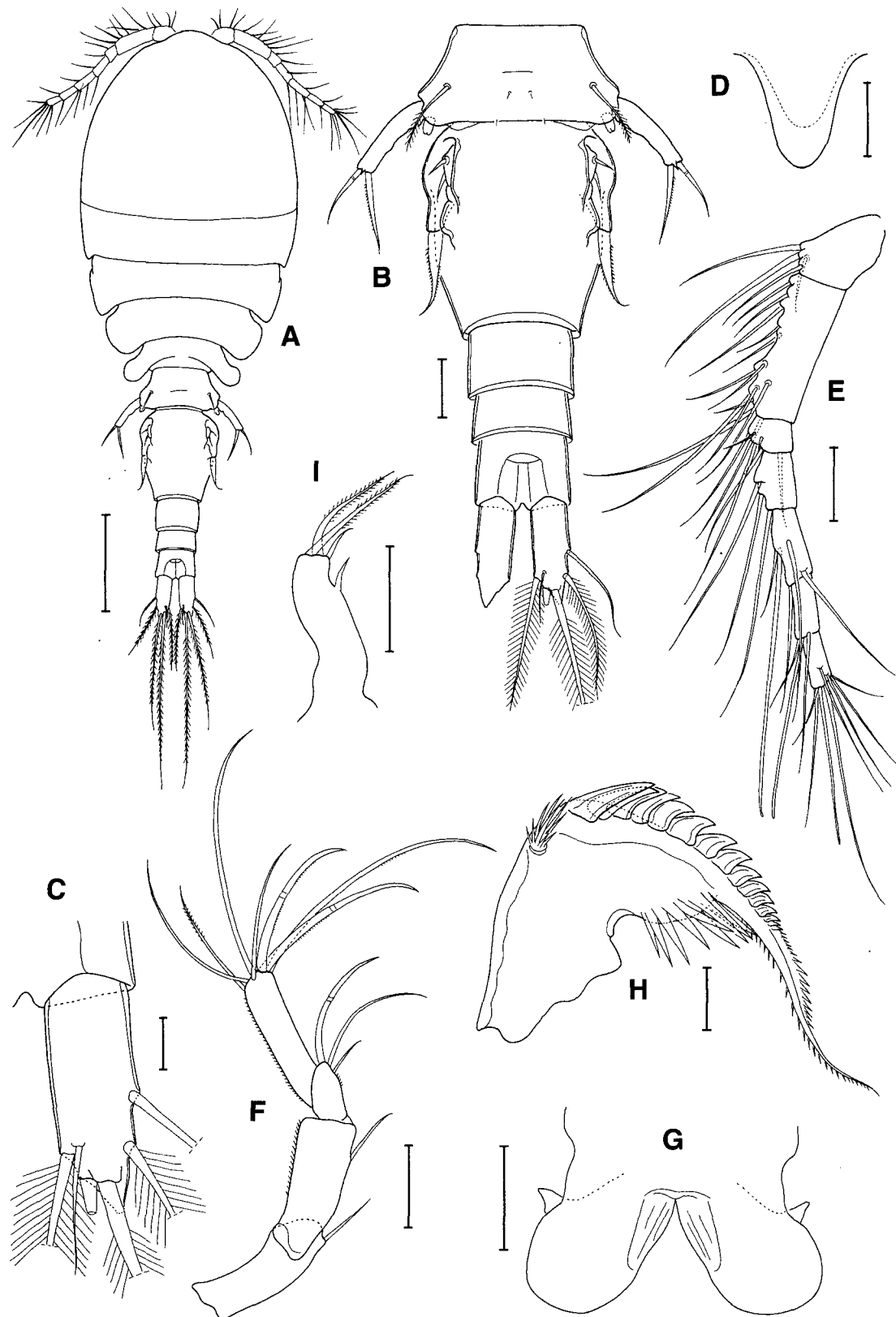
Family Kelleriidae Humes and Boxshall, 1996

Genus *Kelleria* Gurney, 1927

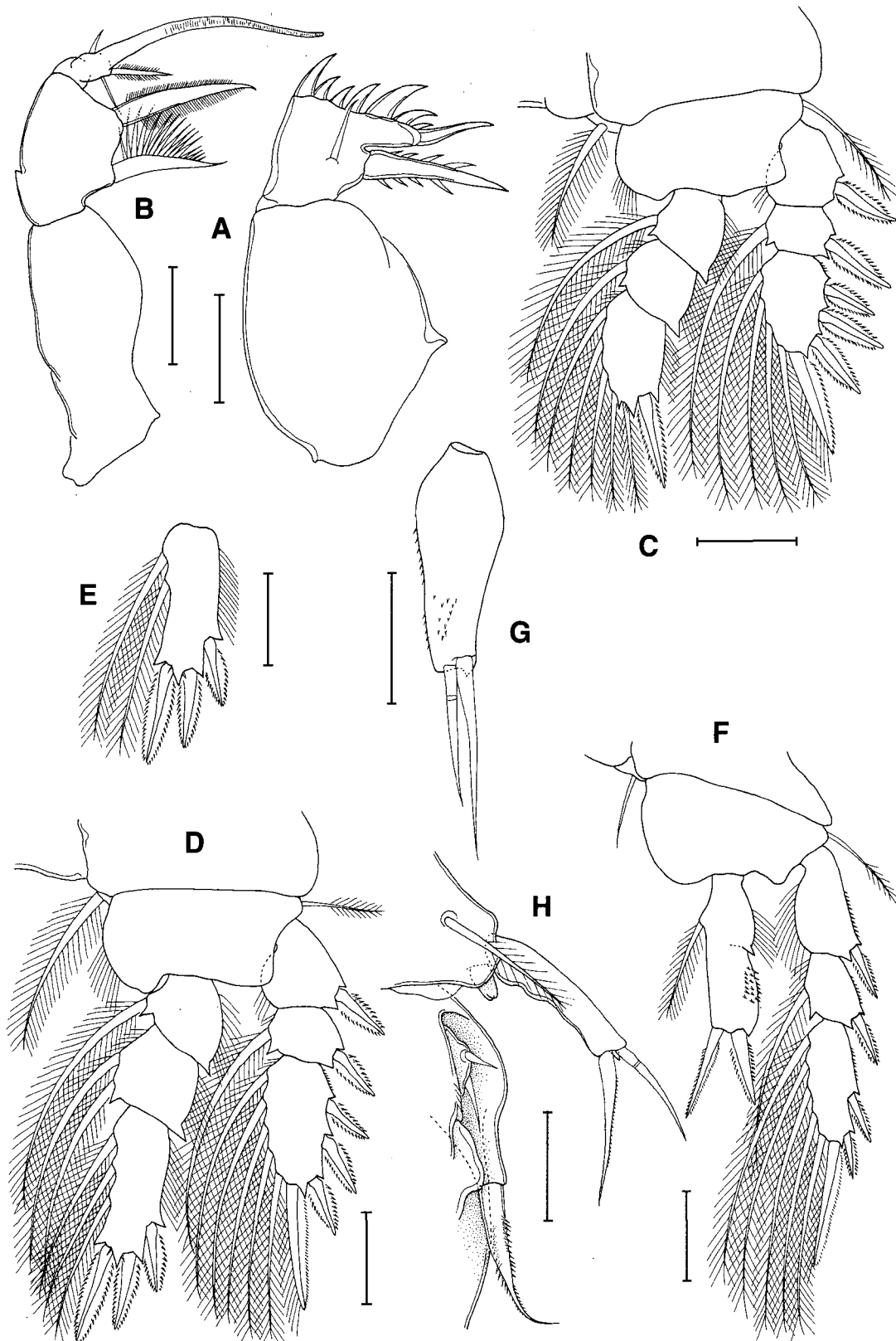
*Kelleria grandisetiger* n. sp. (Figs 1, 2)

*Material examined.* Three ♀♀ collected from invertebrate burrows on the intertidal shore in Port Seogwipo, Jeju Island, on 17 September 2005. Holotype (♀) and paratype (♀) will be deposited in the Biological Resource Center, Ministry of Environment, Korea. Dissected paratype (♀) is remained in the collection of the author.

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**Fig. 1.** *Kellera grandisetiger* n. sp. female. A, habitus, dorsal; B, urosome, dorsal; C, right caudal ramus, dorsal; D, rostrum; E, antennule; F, antenna; G, labrum; H, mandible; I, maxillule. Scale bars=0.2 mm (A), 0.05 mm (B, D-G, I), 0.02 mm (C, H).



**Fig. 2.** *Kelleria grandisetiger* n. sp. female. A, maxilla; B, maxilliped; C, leg 1; D, leg 2; E, third endopodal segment of leg 3; F, leg 4; G, free segment of leg 5; H, right leg 5 and genital area, dorsal. Scale bars=0.05 mm.

*Female.* Body (Fig. 1A) moderately broad. Body length 1.30 mm (other 2 specimens 1.41 and 1.44 mm respectively). Greatest width 450  $\mu\text{m}$ . Prosoma 787  $\mu\text{m}$  long. Cephalothorax with faint dorsal suture line delimiting cephalosome and first pedigerous somite. Urosome (Fig. 1B) 5-segmented. Fifth pedigerous somite 170  $\mu\text{m}$  wide, with distinct thumb-like process near base of free segment of leg 5. Genital double-somite 173  $\times$  163  $\mu\text{m}$  in size, gradually tapering posteriorly, armed on both sides with 1 large spinulated seta at place posterior to genital area. Genital area located dorsolaterally. Three abdominal somites 54  $\times$  90, 40  $\times$  83, and 66  $\times$  81  $\mu\text{m}$ , respectively, from anterior to posterior. No spinules or other ornamentations on posteroventral margin of urosomal somites. Caudal ramus (Fig. 1C) 95  $\times$  32  $\mu\text{m}$  (ratio 2.97 : 1), with strongly tapering posterior margin and 6 caudal setae; outer lateral and dorsal setae smooth, other setae plumous.

Rostrum (Fig. 1D) as long as wide, tapering, with rounded posterior apex. Antennule (Fig. 1E) 333  $\mu\text{m}$  long and 7-segmented, with armature formula of 4, 13, 6, 3, 4+1 aesthetasc, 2+1 aesthetasc, and 7+1 aesthetasc. All setae smooth. Aesthetascs slender and seta-like. Antenna (Fig. 1F) 4-segmented. First and second segments each armed with 1 inner seta. Second and fourth segments each with fine spinules on outer margin. Third segment with 2 setae and 1 setiform claw; claw slightly shorter than nearby seta. Fourth segment 75  $\times$  20  $\mu\text{m}$ , distally with 5 setae and 2 setiform claws.

Labrum (Fig. 1G) with 2 round posterior lobes. Mandible (Fig. 1H) with shallow inner proximal notch. Inner margin with 10 spines. Convex corner with tuft of about 9 spinules of unequal sizes. Distal margin with more than 10 thick teeth. Distal lash elongate, with spinules on both margins. Maxillule (Fig. 1I) armed with 1 subterminal setiform process and 3 terminal setae, one of them distinctly smaller and smooth; other 2 larger spinulated. Maxilla (Fig. 2A) with unarmed first segment. Second segment with 7 teeth of unequal sizes on distal margin and continued to terminal spine; this terminal spine delimited by suture line from segment; anterior seta smooth; inner spine strong, extending beyond terminal spine of segment, armed with 4 or 5 spinules on distal margin and 4 spinules on proximal margin. Maxilliped (Fig. 2B) 3-segmented. First segment longest but unarmed. Second segment with angular process proximally on outer margin and armed with 2 large inner setae; proximal seta with large spinules along distal margin and smooth proximal margin; distal seta with fine hairs on both margins, those of proximal margin longer. Third segment subdivided by incomplete division; proximal division unarmed; distal division with 3 setae and continued to large, smooth seta.

Legs 1-3 (Figs 2C-E) with 3-segmented exopod and endopod. Leg 4 (Fig. 2F) with 3-segmented exopod and 1-segmented endopod. Endopod of leg 4 86  $\times$  28  $\mu\text{m}$ , with small pointed process on outer margin and patch of minute spinules on outer surface; 2 terminal spines 55 and 43  $\mu\text{m}$ , respectively. Armature formula of legs 1-4 as follows:

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

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

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

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

Free segment of leg 5 (Fig. 2G) 87  $\times$  55  $\mu\text{m}$  (ratio 2.64 : 1), slightly swollen proximally in lateral view, with small spinules on surface and 2 terminal setae of 78  $\mu\text{m}$  (inner) and 54  $\mu\text{m}$  (outer). Leg 6 represented by 2 setae in genital area (Fig. 2H).

*Male.* Unknown.

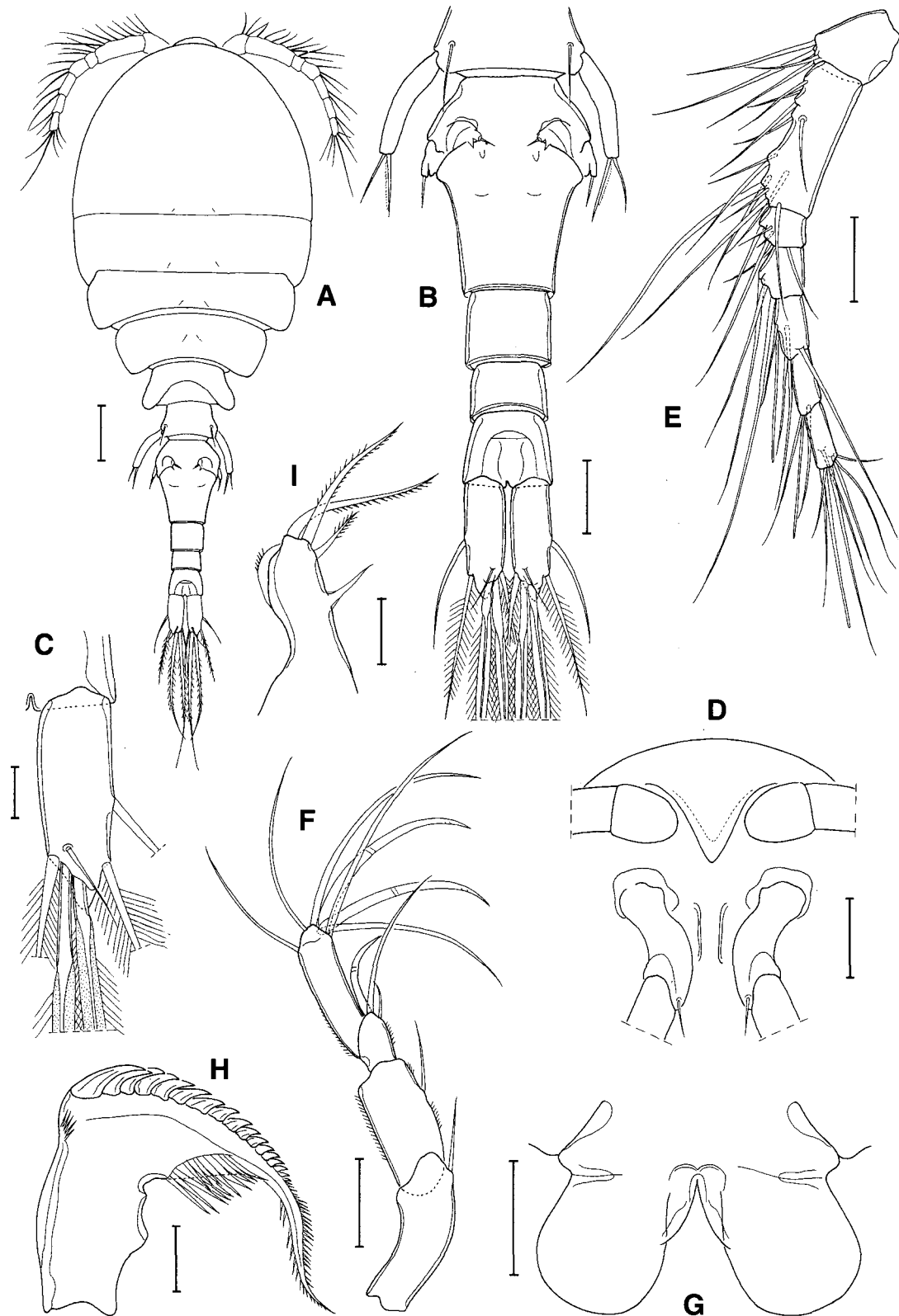
*Etymology.* The specific name *grandisetiger* is a combination of the Latin words *grandis* (=large), *saeta* (=seta), and *gero* (=to carry). It alludes to the large lateral seta at the place posterior to genital area in the female.

*Remarks.* The most characteristic feature of *Kelleria grandisetiger* n. sp. is the presence of the enlarged seta on the lateral sides of female genital double-somite posterior to genital area. The presence of this enlarged seta is shared only by *K. andamanensis*, recorded from plankton in the Andaman Sea (Sewell, 1949). The shape of the distal segment of maxilla, including the identical number of teeth on the distal margin, is similar as well between the two species. *K. grandisetiger* differs, however, from *K. andamanensis* in having the thumb-like process near the base of the free segment of female leg 5 which is distinctly smaller than that of the latter species. Although *K. andamanensis* was incompletely described, the illustration of the original description reveals the caudal rami slightly expanded distally (not expanded in *K. grandisetiger*), and the mandible carrying five distinct setae (or spines) on the convex outer corner (a tuft of about nine spinules in *K. grandisetiger*), the features not agreeable either with *K. grandisetiger*.

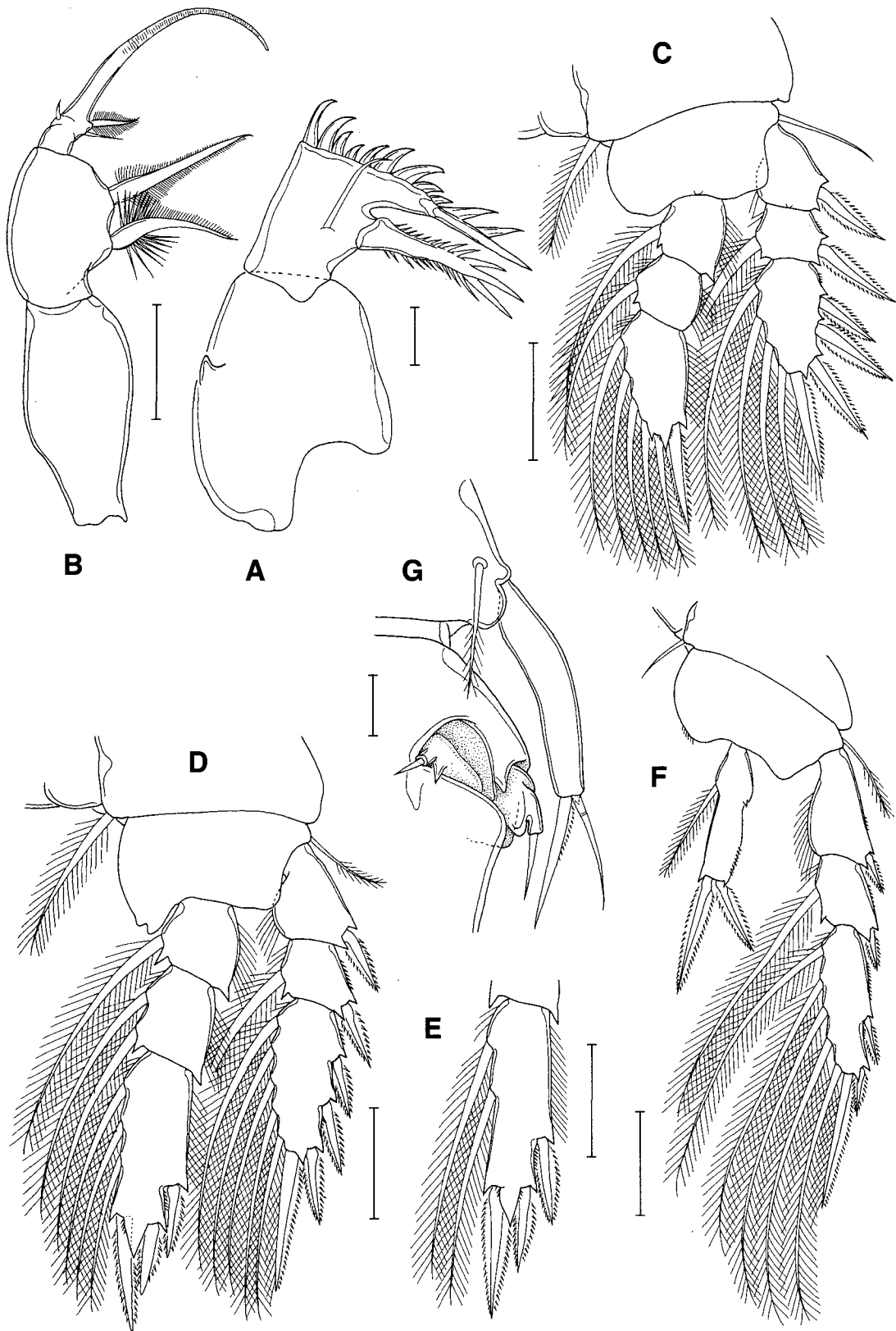
#### *Kelleria undecidentata* n. sp. (Figs 3, 4)

*Material examined.* Four ♀♀ collected from invertebrate burrows on the intertidal shore in Port Seogwipo, Jeju Island, on 17 September 2005. Holotype (♀) and paratypes (2♀♀) will be deposited in the Biological Resource Center, Ministry of Environment, Korea. Dissected paratype (♀) is remained in the collection of the author.

*Female.* Body (Fig. 3A) with relatively broad prosoma and



**Fig. 3.** *Kelleria undecidentata* n. sp. female. A, habitus, dorsal; B, urosome, dorsal; C, right caudal ramus, dorsal; D, rostral area, ventral; E, antennule; F, antenna; G, labrum; H, mandible; I, maxillule. Scale bars=0.1 mm (A), 0.05 mm (B, D-G), 0.02 mm (C, H, I).



**Fig. 4.** *Kellera undecidentata* n. sp. female. A, maxilla; B, maxilliped; C, leg 1; D, leg 2; E, third endopodal segment of leg 3; F, leg 4; G, right leg 5 and genital area, dorsal. Scale bars=0.02 mm (A, G), 0.05 mm (B-F).

narrow urosome. Body length of dissected specimen 1.04 mm. Greatest width 420  $\mu\text{m}$ . Prosome 646  $\mu\text{m}$  long. Cephalothorax with faint dorsal suture line delimiting cephalosome and first pedigerous somite. Urosome (Fig. 3B) 5-segmented. Fifth pedigerous somite 97  $\mu\text{m}$  wide. Genital double-somite 148  $\times$  121  $\mu\text{m}$ , anteriorly expanded and posteriorly narrowed and slightly tapering, armed on both sides with 1 small seta at lateral tip. Genital area located dorsally. Three abdominal somites 50  $\times$  58, 33  $\times$  53, and 52  $\times$  63  $\mu\text{m}$ , respectively, from anterior to posterior. These abdominal somites unornamented on posterior margins. Caudal ramus (Fig. 3C) 85  $\times$  29  $\mu\text{m}$  (ratio 2.93 : 1), with strongly tapering posterior margin and 6 caudal setae; outer lateral and dorsal setae smooth, other setae plumous; 2 median terminal setae expanded by having hyaline membrane on both sides along whole length (Fig. 3C).

Rostrum strongly tapering, with pointed posterior apex (Fig. 3D). Antennule (Fig. 3E) 284  $\mu\text{m}$  long and 7-segmented, with armature formula of 4, 13, 6, 3, 4+1 aesthetasc, 2+1 aesthetasc, and 7+1 aesthetasc. All setae smooth. Aesthetascs thin and setiform. Antenna (Fig. 3F) 4-segmented. First and second segments each armed with 1 inner seta. Inner margin of second and third segments and outer margin of second and fourth segments with fine spinules. Third segment with 2 setae and 1 setiform claw; this claw distinctly shorter than nearby seta. Fourth segment 65  $\times$  21  $\mu\text{m}$ , distally with 5 setae and 2 setiform claws.

Labrum (Fig. 3G) with 2 prominent posterior lobes. Median incision deep and wide. Mandible (Fig. 3H) with indistinct inner proximal notch. Inner margin with about 13 spines. Convex outer corner with row of about 5 minute spinules. Distal margin with about 15 thick teeth. Distal lash elongate, with spinulated margins. Maxillule (Fig. 3I) armed with 1 subterminal setiform process, 3 terminal setae (one of them distinctly smaller than other 2), and hyaline membrane on distal outer margin. Maxilla (Fig. 4A) with first segment unarmed but bearing 1 blunt process on outer side. Second segment with 11 teeth of unequal sizes on distal margin, 2 of them on elongated terminal spine demarcated by suture line from segment; anterior seta smooth; inner spine strong, extending to tip of terminal spine of segment, armed on both margins with many spinules becoming larger distally. Maxilliped (Fig. 4B) 3-segmented. First segment longest but unarmed. Second segment expanded medially and armed with 2 large inner setae; proximal seta with large spinules on proximal part of both margins and fine hairs along distal two-thirds of distal margin; distal seta with fine hairs on both margins. Third segment with 3 setae and continued to smooth, enlarged seta.

Legs 1-3 (Figs 4C-E) with 3-segmented exopod and

endopod. Leg 4 (Fig. 4F) with 3-segmented exopod and 1-segmented endopod. Third endopodal segment of legs 2 and 3 with prominent terminal process. Endopod of leg 4 64  $\times$  19  $\mu\text{m}$ , with small pointed process on outer margin and row of minute spinules on distal part of outer margin; 2 terminal spines 57 and 38  $\mu\text{m}$ , respectively. Armature formula of legs 1-4 as follows:

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

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

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

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

Free segment of leg 5 (Fig. 2G) widest across proximal one-third (in lateral view), 79  $\times$  17  $\mu\text{m}$  (ratio 4.66 : 1), terminally with 1 spine (43  $\mu\text{m}$ ) and 1 seta (30  $\mu\text{m}$ ). Leg 6 represented by 1 spiniform seta and 1 pointed process in genital area (Fig. 4G).

*Male*. Unknown.

*Etymology*. The specific name *undecidentata* is derived from the Latin *undecim* (=eleven) and *dentatus* (=toothed). It alludes the eleven teeth on the second segment of maxilla.

*Remarks*. The free segment of female leg 5 is variable with species of *Kelleria* and offers characters for the differentiation of species. The inner (medial) margin of the segment bears, unlike the new species, one or two processes in the following species: *K. australiensis* Bayly, 1971, *K. gradata* Stock, 1967, *K. propinqua* (T. Scott, 1909), *K. purpurocineta* Gurney, 1927, and *K. regalis* Gurney, 1927. In addition, *K. rubimaculata* Krishnaswamy, 1952, which was insufficiently described, appears in the illustration of the original description (Krishnaswamy, 1952) to have also one or two small processes on the inner margin of the free segment. *Kelleria undecidentata* n. sp. can be differentiated from the remaining five species by the following ways.

It differs from *K. andamanensis* Sewell, 1949 and the preceding *K. grandisetiger* in having the smaller lateral setae on the genital double-somite in the female and the different body size (the body length is recorded by Sewell, 1949, to be 0.8 mm in *K. andamanensis* but is 1.30-1.44 mm in *K. grandisetiger*); from *K. camortensis* Sewell, 1949 and *K. pectinata* (A. Scott, 1909) which was redescribed by Humes and Ho (1969) in having the elongate free segment of female leg 5 bearing no proximal swelling; and from *K. vaga* Kim, 2003, by having the stockier caudal rami (the rami are 2.93 times as long as wide, in contrast to 4.76 times in *K. vaga*) and the longer free segment of female leg 5 (the segment is 4.65 times as long as wide, in contrast to 3.27 times in *K. vaga*).

***Kelleria portiviva* n. sp. (Figs 5, 6)**

*Material examined.* Three ♀♀ collected from invertebrate burrows on the intertidal shore in Port Seogwipo, Jeju Island, on 17 September 2005. Holotype (♀) and paratype (♀) will be deposited in the Biological Resource Center, Ministry of Environment, Korea. Dissected paratype (♀) is remained in the collection of the author.

*Female.* Body (Fig. 5A) relatively narrow. Body length dissected specimen 1.23 mm (other 2 specimens 1.20 and 1.34 mm respectively). Greatest width 408 µm. Prosome 729 µm long. Cephalothorax divided by faint dorsal suture line into cephalosome and first pedigerous somite. Urosome (Fig. 5B) 5-segmented. Fifth pedigerous somite 129 µm wide. Genital double-somite 175 × 158 µm, distinctly expanded anteriorly, armed on both sides with 1 seta at posterior part of anterior expansion. Genital area located dorsally. Three abdominal somites 52 × 73, 36 × 67, and 60 × 67 µm, respectively, from anterior to posterior. These abdominal somites unornamented on posterior margins. Caudal ramus (Fig. 5C) 120 × 29 µm (ratio 4.14 : 1), with oblique posterior margin and 6 caudal setae; outer lateral seta smooth, and other 5 setae plumous.

Rostrum elongate and strongly tapering, with rounded posterior apex (Fig. 5D). Antennule (Fig. 5E) 329 µm long and 7-segmented, with armature formula of 4, 13, 6, 3, 4+1 aesthetasc, 2+1 aesthetasc, and 7+1 aesthetasc. some setae on distal 2 segments distally plumous. Aesthetascs thin and setiform. Antenna (Fig. 5F) 4-segmented. First and second segments each armed with 1 inner seta. Outer margin of second and fourth segments with fine spinules. Third segment with 2 setae and 1 setiform claw; this claw similar in length to nearby seta. Fourth segment 78 × 21 µm, distally with 5 setae and 2 setiform claws.

Labrum (Fig. 5G) with 2 prominent posterior lobes and deep median incision. Mandible (Fig. 5H) with indistinct inner proximal notch and narrow hyaline membrane along outer margin. Inner margin with 12 spines. Convex outer corner with tuft of small spinules. Distal margin with thick teeth, several proximal ones of them spiniform. Distal lash elongate, with spinulated margins. Maxillule (Fig. 5I) armed with 1 inner setiform process, 3 terminal setae, and narrow hyaline membrane on distal outer margin. Maxilla (Fig. 6A) with first segment unarmed. Second segment with 10 or 11 teeth of unequal sizes on distal margin, 2 or 3 of them on terminal spine demarcated by suture line from segment; anterior seta smooth; inner spine strong, extending slightly beyond tip of terminal spine of segment, armed on both margins with many spinules becoming larger distally. Maxilliped (Fig. 6B) 3-segmented. First segment longest and unarmed. Second segment expanded medially and

armed with 2 large inner setae; proximal seta with large spinules on proximal part of distal margin, 2 spinules on proximal part of proximal margin, and fine hairs along distal three-fourths of distal margin; distal seta with fine hairs on both margins. Third segment with 3 setae and continued to enlarged seta.

Legs 1-3 (Figs 6C-E) with 3-segmented exopod and endopod. Leg 4 (Fig. 4F) with 3-segmented exopod, 1-segmented endopod, and small naked inner coxal seta. Endopod of leg 4 slender, 64 × 19 µm, with small pointed process on inner margin and row of minute spinules on distal part of inner margin; 2 terminal spines 72 and 50 µm, respectively. Armature formula of legs 1-4 as follows:

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

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

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

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

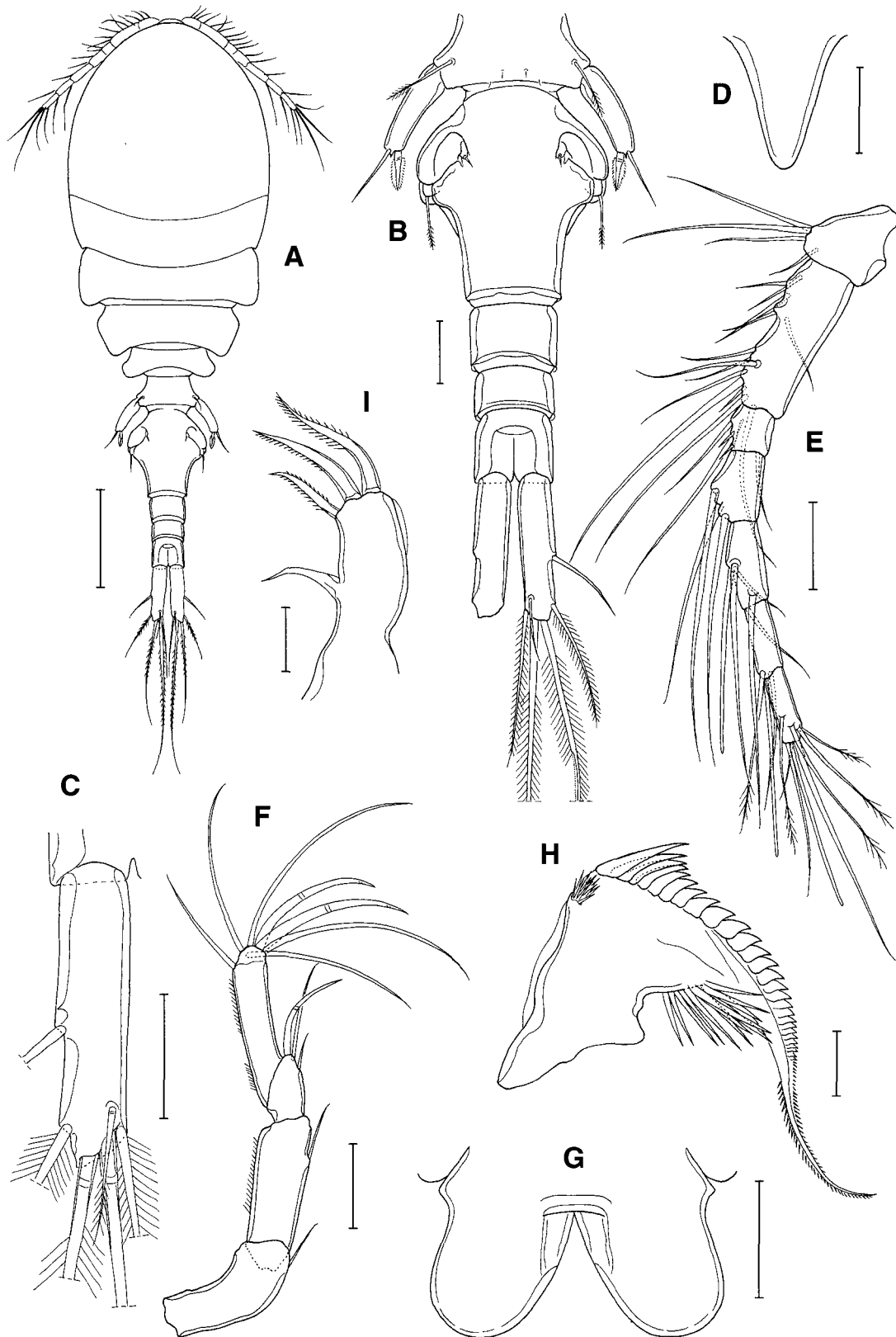
Free segment of leg 5 (Fig. 6G) 79 × 17 µm (ratio 3.57 : 1), with parallel margins and minute spinules on distal half of outer side, and terminally with 1 spine (31 µm) and 1 seta (54 µm). Leg 6 represented by 1 spiniform seta and 1 blunt process in genital area (Fig. 6H).

*Male.* Unknown.

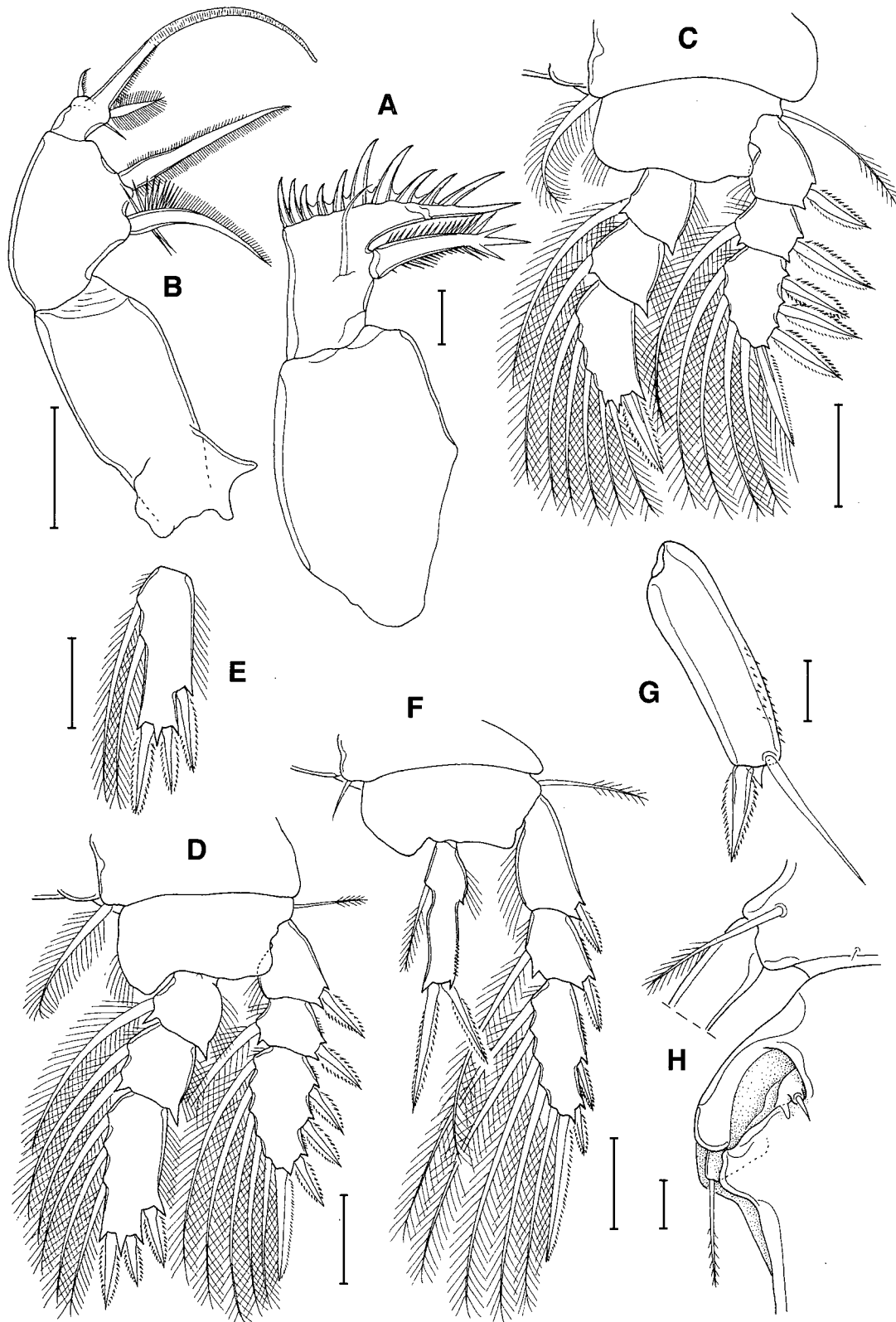
*Etymology.* The specific name *portiviva*, derived from the Latin words *portus* (=port) and *vivus* (=living), refers to the discovery of this species in a port.

*Remarks.* Four species of the genus, *K. andamanensis*, *K. vaga*, *K. undecidentata*, and *K. grandisetiger*, can be selected as relatives of *K. portiviva* n. sp., because these species possess the similar leg 5 in the female in which the free segment bears neither the proximal swelling (in dorsal and ventral views) nor the process on the inner margin. However, one of the two terminal elements on the free segment of *K. portiviva* is a distinct spine which is clearly shorter but broader than the nearby seta. In this respect it differs from *K. andamanensis*, *K. grandisetiger*, and *K. undecidentata* where the both elements are setae. *Kelleria portiviva* is very similar to *K. vaga* and thus needs a careful comparison to be differentiated from the latter species. As the different features, the female of *K. portiviva* bears the broader caudal rami which are 4.14 times as long as wide (4.55 times in *K. vaga*), the longer free segment of leg 5 which is 3.57 times as long as wide (3.30 times in *K. vaga*), the ten or 11 teeth on the distal margin of the second maxillary segment (nine teeth in *K. vaga*), the tuft of spinules on the convex outer corner of the mandible (a row of several spinules in *K. vaga*), and the widely open genital area (closed in *K. vaga*).





**Fig. 5.** *Kelleria portiviva* n. sp. female. A, habitus, dorsal; B, urosome, dorsal; C, left caudal ramus, dorsal; D, rostrum; E, antennule; F, antenna; G, labrum; H, mandible; I, maxillule. Scale bars=0.2 mm (A), 0.05 mm (B-G), 0.02 mm (H).



**Fig. 6.** *Kellera portiviva* n. sp. female. A, maxilla; B, maxilliped; C, leg 1; D, leg 2; E, third endopodal segment of leg 3; F, leg 4; G, free segment of leg 5; H, left side of fifth pedigerous somite and genital double-somite, dorsal. Scale bars=0.02 mm (A, G, H), 0.05 mm (B-F).

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Received September 27, 2005  
Accepted October 28, 2005