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Two species of Porcellidiidae (Copepoda, Harpacticoida) associated with hermit crabs from Korea

Sa Heung Kim and Won Kim
(Department of Molecular Biology, Seoul National University, Seoul 151-742, Korea)

ABSTRACT

Two species of the family Porcellidiidae associated with hermit crabs are described from Korean seas. These are *Porcellidium similis*, new species collected from *Pagurus similis*, *Pagurus pectinatus* and *Porcellidium brevicaudatum* Hicks & Webber collected from *Dardanus impressus*. The new species resemble closely *Porcellidium brevicaudatum* in general body form, but is clearly distinguished from *Porcellidium brevicaudatum* in that the caudal ramus is weakly oblique in its distal border and the lobe of leg 5 is more slender.

Key words : Copepoda, Harpacticoida, *Porcellidium*, new species, hermit crabs, Korea

INTRODUCTION

The harpacticoids of the family Porcellidiidae has been found mainly on the surface of seaweeds in the littoral and subtidal zone, and comprises 42 species (Hicks & Webber, 1983; Harris, 1994). However, only three species in this family, *Porcellidium brevicaudatum* Thompson & A. Scott, 1903, *P. tapui* Hicks & Webber, 1983, and *P. paguri* Ho, 1986 have been known in association with hermit crabs.

The hermit crabs, *Pagurus similis* (Ortmann), *P. pectinatus* (Stimpson), and *Dardanus impressus* (De Haan), especially the large individuals of which, occur commonly in the coastal water of Korea, but their copepod associates have not been investigated. In this paper, the authors describe a new

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species of the genus *Porcellidium* and redescribe *P. brevicaudatum* associated with hermit crabs of two families (Diogenidae, Paguridae) from the Korean seas.

The materials examined in the present study were collected mainly by the authors or obtained from hermit crabs preserved in Seoul National University (SNU). Host specimens were collected either from littoral habitats during the low tide or from subtidal habitats by scuba diving. Some of them were obtained from the fishing nets. In order to collect the copepods, the host specimens were first anesthetized in diluted alcohol solution (about 10 %). This washings were then filtered through a fine mesh plankton net (pore size 150 ㎛). All copepod specimens were fixed with 7 % formalin and preserved in 4 % formalin or 75 % ethanol. The copepods were sorted and dissected with tungsten needles under stereomicroscope. Lactophenol was used as mounting media. Drawing and measuring were made with the aid of drawing tube.

DESCRIPTIONS

Family Porcellidiidae Sars, 1904

Genus *Porcellidium* Claus, 1860

1. *Porcellidium similis*, new species (Figs. 1-3)

Type Specimens. 88♀♀, 43♂♂, and 29 copepodids, washed from 12 individuals of hermit crab, *Pagurus similis* Stimpson, collected from Chŏdong, Ullung Island. (35 ° 05 ′ N, 128 ° 44 ′ E) in Sea of Japan(East sea) by SCUBA diving (35 m), Apr. 7, 1995. Holotype ♀, allotype ♂, and undissected paratypes (15 ♀♀, 10 ♂♂) will be deposited in the U.S. National Museum of Natural History, Smithsonian Institution. Other paratypes (72♀♀, 22♂♂ including dissections of 5♀♀, 4 ♂♂) and copepodids are kept in the collection of the authors.

Other Material examined. 63♀♀, 47♂♂, and 25 copepodids, from 26 individuals of *Pagurus similis*, Ull ng Island, Aug. 17, 1995; 28♀♀, 20♂♂, and 11 copepodid, from 9 individuals of *Pagurus pectinatus* (Stimpson), Ullung Island, Aug. 17, 1995; 12♀♀, 5♂♂, and 6 copepodids from 3 individuals of *Pagurus similis*, Tokdo Island, Aug. 14, 1995; 24♀♀, 16♂♂, from 8 individuals of *Pagurus similis*, Mip' o Port, Haeundae, Pusan, Jul. 29, 1994; 7♀♀, 5♂♂, and 2 copepodids, from 7 individuals of *Pagurus similis*, Chujado Island, Jul. 12, 1972; 12♀♀, 7♂♂, and 7 copepodids, from 3 individuals of *Pagurus similis*, Muns m, Cheju Island, Jan. 22, 1995.

Adult female. Body (Fig. 1A) ovoid, dorsoventrally depressed, 0.76 mm measured from tip of rostrum to end of leg 5. Greatest width 0.48 mm including hyaline border. Ratio of length to width 1.583 : 1. Dorsal surface of body sparsely covered with fine setules, and conspicuously pitted (Fig. 1D). Cepalothorax length 0.39mm excluding rostrum, length to width ratio approxmately 0.81 : 1; anterior outline of cephlosome semicircular (Fig. 1B, C). Rostrum triangular, prominent, and 80 ㎛ in width. First and second metasomal somites as wide as cephalosome, with fine setules and hyaline border. Third somite with reduced epimeral lobe, without hyaline border. Fourth somite short and narrow, without expended epimeral area or hyaline border. Urosome (Fig. 1K, L) wider than long (about 1.57 times). Dorsal surface with fine setules, and conspicuously pitted. Anterior and posterior lobe indistinctly divided; posterior lobe small, triangular with fine setules, its apex acutely rounded. Urosome length about 2.3 times longer than depth of caudal arch. Caudal rami (Fig. 1M) 1.73 times

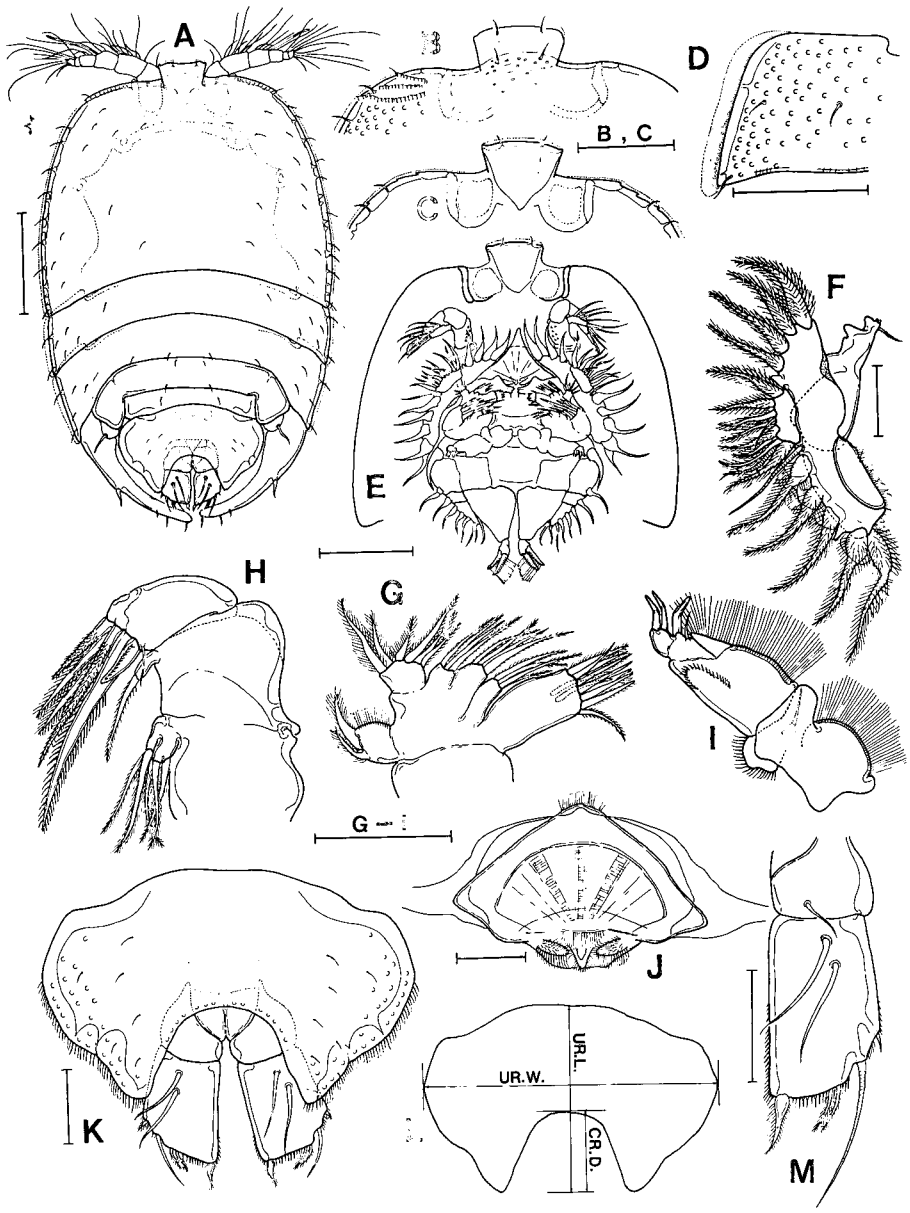

Fig. 1. *Porcellidium similis,* n. sp. Female. A, habitus, dorsal; B, rostral area, dorsal; C, same, ventral; D, First metasomal somite, left dorsal; E, cephalothorax, ventral; F, mandible; G, maxillule; H, maxilla; I, maxilliped; J, labrum and paragnaths, ventral; K, urosome, dorsal; L, outline of urosome; M, caudal ramus, dorsal. Scales: A, E=0.2mm; B-D=0.1mm; F-K, M=0.05mm. onger than wide (85 x 49 ㎛ in geatest dimension); a pair of rami *nealy parallel, or somewhat open,* Abbreviations: UR.L.=urosome lenth; UR.W=urosome width; CR.D.=depth of caudal ramus arch.

and often bent ventrally; outer and inner margin straight; terminal border slightly convex with setules, and weakly oblique; external corner strongly emarginated as flatform. Caudal setae α and β relatively close together, γ seta long and naked. Terminal border with 4 setae; seta 2 and 3 close together with fine hairs; seta 4 bulbous and pilose.

Antennule (Fig. 2G) 6-segmented; first segment with numerous hair-like spine on anterior margin and bearing single plumose seta; second segment longest, with 11 setae; third segment with 8 setae; fourth segment with 7 setae and 1 aesthete; fifth segment with 6 setae; terminal segment with 6 naked and 4 plumose setae. Most setae segmented, exept for a few in terminal segment.

Antenna (Fig. 2H) biramous; coxa small, unarmed; basis largest, armed with spinules. Exopod 1-segmented, bearing 6 setae. Endopod 2-segmented; first segment with spinules on dorsal surface; second segment with 3 setae in medial part, 3 setae on subterminal part, and 3 bent and 1 pectinated claw posteriorly.

Mandible (Fig. 1F) largest appendage; precoxa (corpus mandiblae) tapering toward cutting edge, with denticles and a simple seta on terminal edge, with 2 knobs on its shaft and distal end. Basis with 4 pilose setae. Endopod with 10 setae; exopod with 6 setae.

Maxillule (Fig. 1G) very small; precoxa with 2 subterminal setae, 5 terminal setae, and 5 spine; coxa-basis with 3 endites bearing 4 setae respectively. Exopod tipped with 2 setae. Endopod with 6 setae.

Maxilla (Fig. 1H) very compactly fused; precoxa indistinctly divided into 2 rami with 3 and 2 spinulose setae, respectively. Division of coxa, basis, and endopod indistinct; coxa with 1 plumose seta; basis-endopod with 5 long spines, 1 short spatulate claw, 1 small and naked seta.

Maxilliped (Fig. 1I) slightly prehensile. Syncoxa with long hairs on anterior margin, with a small seta distally. Basis with fimbriate process, with long hairs on anterior margin; endite of basis with 1 small seta and 1 geniculate seta. Endopod small, 1-segmented, and with 2 short geniculate setae.

Leg 1 (Fig. 11B) strongly modified. Intercoxal plate nearly quadrate, with 1 small seta. Clawlike seta of basis strong and pilous. Exopod 3-segmented; first segment bordered with filiform setules; second and third segment with 1 bulbous seta on outer margin; third segment with 4 bulbous setae, 1 annulate seta, and plumose internal seta lying dorsal to endopod. Endopod 2-segmented; first segment broadly triangular, with 1 strap-like plumose seta on inner border, with 1 long filiform setules on ventral surface; second segment with 2 lamellate claws.

Legs 2-4 (Fig. 2B, C, D) with 3-segmented exopods and endopods, except for endopod of leg 1. Armature formula of legs 2-4 as follow (Roman numerals represent spines, and Arabic ones setae):

Leg 2:	Exp I-1; I-1; III, 2, 2	Enp 0-1; 0-2; 3, I
Leg 3:	Exp I-1; I-1; III, 2, 3	Enp 0-0; 0-I; 3, I, 1
Leg 4:	Exp I-1; I-1; III, 2, 3	Enp 0-1; 0-1; 1, 2, 1

Endopod of leg 2 (Fig. 2B) broad, about 1.5 times longer than exopod; first segment with 1 plumose seta and setules near inner margin; terminal segment with 1 serrulate seta and 3 plumose ones.

Endopod of leg 3 (Fig. 2C) without seta or spine on first segment; second segment with 1 serrulate and 1 plumose setae; third segment with 1 serrate and 4 plumose setae.

Endopod of leg 4 (Fig. 2D) with 1 plumose seta on first segment; third segment with 1 spinous and

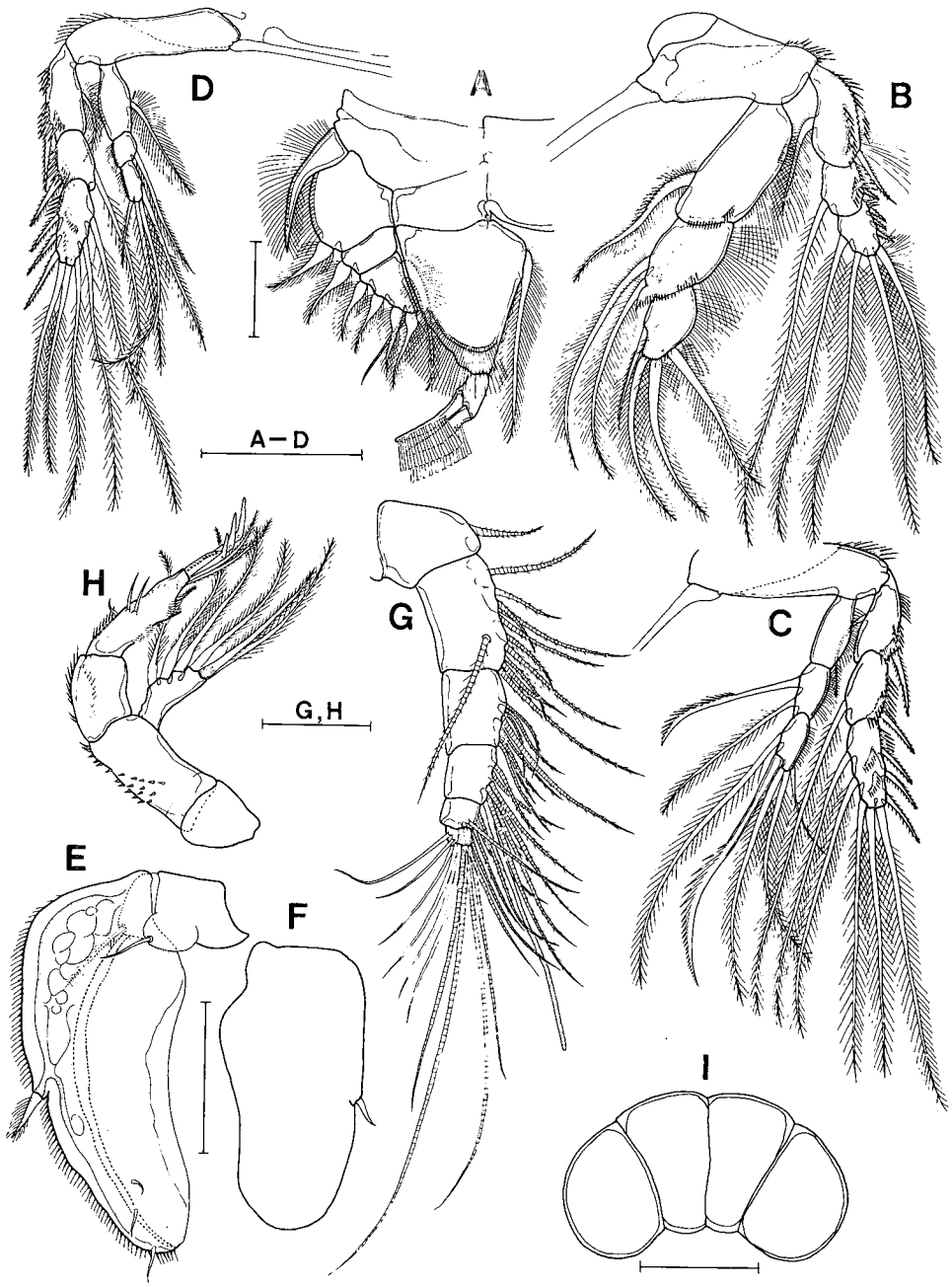

Fig. 2. *Porcellidium similis*, n. sp. Female. A, leg 1; B, leg 2; C, leg 3; D, leg 4; E, leg 5; F, lobe of leg 5; G antennule; H, antenna; I, egg sac. Scales; B-E, I=0.1mm; A, G, H=0.05mm.

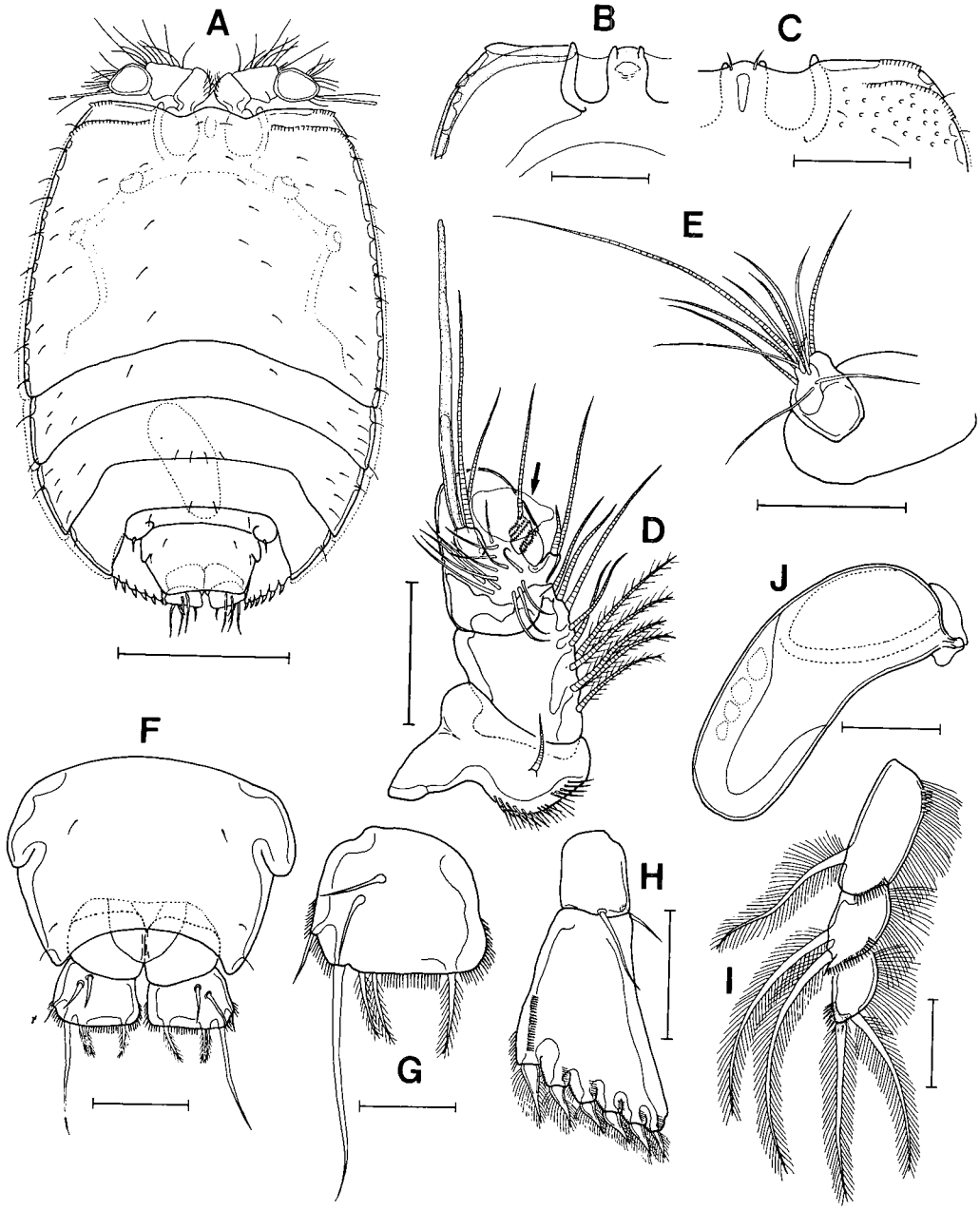

Fig. 3. *Porcellidium similis*, n. sp. Male. A, habitus, dorsal; B, anterior region of cephalothorax, ventral; C, same, dorsal; D, antennule; E, terminal segment of antennule; F, urosome, dorsal; G, caudal ramus, dorsal; H, leg 5; I, endopd of leg 2; J, seminal receptacle. Scales: A=0.2mm; B, C=0.1mm; D-F, H-J=0.05mm; G=0.025mm.

3 plumose setae.

Leg 5 (Fig. 2E, F) 2-segmented, surrounding urosome and caudal rami, and touch in posterior midline; first segment with 1 barbed seta ventrally and naked seta dorsally; second segment with 1 plumose seta in medial part and 3 naked setae distally.

Adult male. Body (Fig. 3A) ovoid, shield shaped. Total length 0.5±0.03mm, width 0.36± 0.02mm; ratio 1.41: 1. Anterior outline of cephalosome (Fig. 3B, C) truncated, rounded in shoulder, and slightly convex in midline. Rostrum projected as rounded tip. Metasomal somites 1-3 with epimeral lobe and hyaline border. Urosome (Fig. 3F) narrower and smaller than that of female. Caudal rami (Fig. 3G) quadrate, wider than long. α and β seta close together. γ seta long and naked. Distal border flattened; distal setae 2 and 3 close together.

Antennule (Fig. 3D, E) prehensile, 4-segmented, with formula for armature 1, 13, 17+1 aesthete, and 11. Accessory lobe of compound segment with small ventral blade and 2 denticulate pads.

Endopod of leg 2 (Fig. 3I) with 2 plumose setae on terminal segment. Legs 1, 3, 4 as in female.

Leg 5 relatively broad, with 6 pinnated setae on posterior border; ratio of anterior (near basis) to posterior border (near terminal margin) about 1 : 1.56.

Variation. Characters assessed to the leg 5, urosome, and caudal ramus are taxomomically most significant in the Porcellidiidae (Wells, 1967; Hicks, 1982). But these characters often show the minor differences among the same species. In the new species, variations occur in the caudal ramus and leg 5 in females. The ratio of caudal ramus length to width is 1. 67-2.0 : 1 range and the ratio of leg 5 is 1.96-2.18 : 1 range. The distal border of caudal ramus is not regular in the intraspecies and the same individual (between the left and right ramus). Some of specimens from Ullung Island show typically the abnormal features. The specimens bearing the abnormally enlarged anterior lobe of urosome posses the short caudal rami and abnormal leg 5. However, these variations do not occur in a regular pattern.

Etymology. The specific name *similis* (= resembling in Latin) refers to the resemblance of the new species to other congeners associated with the hermit crabs.

Remarks. Discussed in the remarks of the next species.

2. *Porcellidium brevicaudatum* Thompson & A. Scott, 1903 (Fig. 4)

Porcellidium brevicaudatum Thompson & A. Scott, 1903 (pp. 275-276, figs. 11-14; Humes & Ho, 1969 (pp. 113-122, figs. 1-28)

Acutiramus brevicaudatus: Harris & Robertson, 1994 (p. 257)

Material examined. 4 ♀♀, 1 ♂, and 2 copepodids, from 6 individuals of *Dardanus impressus* (De Haan), Hanrim, Cheju Island, July 7, 1972.

Adult female. Body (Fig. 4A) broadly ovoid, 0.68±0.03 mm long and 0.45±0.02 mm wide. Hyaline border distinct and broad. Anterior outline of cephalothorax (Fig. 4B) semicircular. Rostrum inverted triangular, 0.1mm wide. Metasomal segments 1 and 2 with epimeral lobes, as wide as cephalothorax. Urosome (Fig. 4C) width to length ratio about 1 : 1.74; posterior lobe of urosome small, triangular, and with fine setules; apex of posterior lobe acutely rounded. Caudal arch depth to urosome length ratio about 1 : 3.50. Caudal rami (Fig. 4F) pointed with strongly oblique in terminal

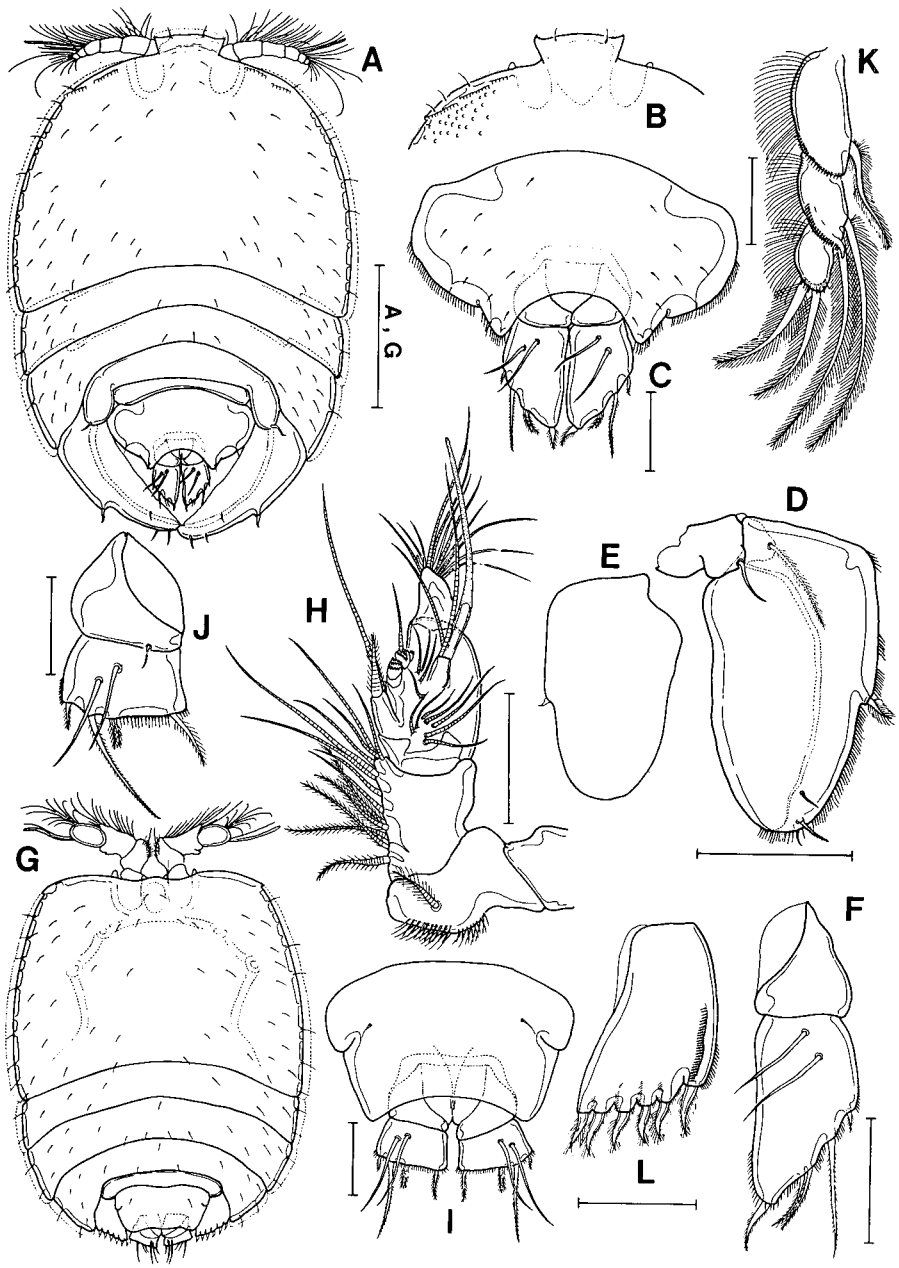

Fig. 4. *Porcellidium brevicaudatum* Thompson & A. Scott, 1903. Female. A, habitus, dorsal; B, anterior region of cephalothorax; C, urosome, dorcal; D, leg 5; E, lobe of leg 5; F, caudal ramus. Male. G, habitus, dorsal; H, antennule; I, urosome, dorsal; J, caudal ramus, dorsal; K, endopod of leg 2. Scales: A, G=0.2mm; D=0.1mm; C, F, H, I, K, L=0.05; J=0.025.

sborder. α and β setae close together near basis, γ seta weakly plumose.

Antennule, antenna, mandible, maxillule, maxilla, maxilliped as in *P. similis*.

Armature formula of leg 1 - 4 as in *P. similis*.

Leg 5 (Fig. 4K) 2-segmented. Basis-endopod with 1 barbed and 1 naked setae. Exopod nealy elipsoid, 1.78 times longer than wide, and completely surrounding urosome and caudal rami; 1 plumose seta medially, 3 minutely plumose setae distally.

Adult male. Body (Fig. 4G) 0.50±0.03mm long and 0.38±0.03 mm wide. Anterior outline of cephalothorax truncated, rounded in shoulders, slightly convex in midline. Rostrum projected with rounded tip. First, second, and third metasomal somites with epimeral lobe and hyaline border. Caudal rami (Fig. 4J) nearly quadrate, slightly wider than long. α and β setae close together, γ seta plumose. Terminal setae 2 and 3 close together.

Antennule prehensile (Fig. 4H) 4-segmented, with formula for armature 1, 13, 19+1 aesthete, and 11. Accessory lobe of compound segment with small ventral blade. Endopod of leg 2 with 2 plumose setae on terminal segment.

Legs 1, 3, 4 as female and leg 5 (Fig. 4L) distinctly longer than wide, with 6 pinnated terminal setae.

Variation. The persent species differs from Humes & Ho' specimen in minor character. Variations occur in the γ seta of caudal ramus in female. In their specimen, γ seta is short with distinct hairs, but that of the present species is long with indistict hairs. In male, the shape of caudal ramus differs from their specimen in that its distal border is longer than the basis. The leg 5 of male is shorter. Within the Korean specimens, distal border of caudal ramus is not regular, which it is also different between the left and right in the same individual. When measuring Humes & Ho' s figure, the body size of female is 0.72 mm measured from tip of rostrum to posterior margin of leg 5 in length (0.77-0.78 mm range in their measurement).

Remarks. Three recorded species of the family Porcellidiidae associated with hermit crabs are currently known to be valid. Of these, *Porcellidium brevicaudatum* Tompson & Scott, 1903 associated with the pearl oysters and collected from the general washings of inverterbrates (ascidians, sponges, corals, peal oysters, and etc.) was originally described from Ceylon (Thompson and A. Scott, 1903). This species has more recently been redescribed from two families of hermit crabs (Paguridae and Diogenidae) in Madagascar and Mauritius (Humes & Ho, 1969). Another morphologically similar species, *P. tapui* Hicks & Webber, 1983 from New zealand and *P. paguri* Ho, 1986 from Japan are known to show commensal relationships with hermit crabs. Other invertebrate-inhabiting species, *P. echinophilum* Humes & Gelermann, 1962 is known to associate with an echinoid from Nosy Bé, Madagascar and *P. fimbriatum* Claus, 1863 (=*P. viride* Philippi, 1840), *P. acuticaudatum* Thompson and A. Scott, 1903 (=*P. ovatum* Haller, 1880), *P. ravanae* Thompson and A. Scott, 1903 were reported from pearl oysters of Ceylon (Thompson & A. Scott, 1903).

The present new species resembles closely other congeners associated with hermit crabs in general body form and size. However, it is markedly distinguished from other three species by the shape of the caudal rami, notably, in that its distal border is weakly oblique (strongly oblique in *P.*

Table 1. Comparisons of four species of the genus *Porcellidium* associated with hermit crabs.

Characters/species	*P. brevicaudatum*	*P. tapui*	*P. paguri*	*P. similis*
Female				
size	0.72mm	0.69mm	-	0.76mm
body length/width ratio	1.53	1.50	1.55	1.58
Cephal. length/width ratio	0.78	0.67	0.77	0.81
hyaline border	distinct (broad)	distinct	distinct	distinct (broad)
formula 3th end. of leg 3	1, 4	1, 4	1, 3	1, 4
formula 1st end. of leg 4	0-0	0-0	0-1	0-0
formula 3th end. of leg 4	1, 2, 1	1, 2, 1	1, 2	1, 2, 1
end. 2 of leg 3 inner spinule row	absence	presence	absence	absence
leg 5 length/width	1.67	2.17	2.60	2.04
leg 5 exp. distal setae	plumose	naked	naked	naked
UR width/length ratio	1.83	1.46	1.60	1.57
UR length/CR arch depth ratio	3.60	2.03	2.71	2.32
UR lateral incisions	absence	presence	weak	absence
CR oblique	strong	week (tapering)	strong	week
CR length/width ratio	1.78	2.68	2.31	1.73
CR γ seta, plumose	yes	somtimes	naked	naked
CR γ seta length	short (elongate)	elongate	elongate	long
Male				
size	0.53	0.51(I), 0.55(II)	-	0.50
body length/width ratio	1.30	1.34(morph. II)	1.21	1.41
Cephal. length/width ratio	0.78	0.74	0.70	0.82
ventral brade of A1	small	large (morph. II)	no	small
leg 5 exp, shape	elongate	stout	stout	tapering (toward basis)
Localities & Hosts	1. Madagascar & Mautitius (Humes & Ho, 1969) *Dardanus megistos* *D. guttatus* *D. lagopodes* 2. Sri Lanka (Thompson & A. Scott, 1903) pearl oyster and invertebrates 3. New ginia (SW) A. Scott, 1909) dredged invertebraes 4. Korea *D. impressus* (Cheju I.)	New Zealand (Hicks & Webber, 1983) *Paguristes barbatus* *P. pilosus* *P. novizealandiae* *Pagurus traversi* *P. rubricatus* *P. spinulimanus* *Pylopagurus* sp.	Japan (Ho, 1986) *Pagurus geminus* (Tassha Bay; Shirahama) *P. similis* (Thasha Bay; Tsukumo Bay) *P. japonicus* (Tsukumo Bay) *Clibanarius himaculatus* (Shirahama)	Korea *Pagurus similis* (Ullung I. Pusan Cheju I.) *P. pectinatus* (Ullung I.)

References: Present paper for *Porcellidium brevicaudatum* and *P. similis*; Ho (1986) for *P. paguri*; Hicks & Webber (1983) for *P. tapui*. Abbreviations: A1=antennule; Cephal.=cephalosome; CR=caudal ramus; end=endopod; exp=exopod; UR=urosome.

brevicaudatum and *P. paguri*; tapering distally in *P. tapui*). In the new species, the ratio of caudal arch depth to urosome length is measured about 1 : 2.12 (1 : 3.50 in *P. brevicaudatum*) and ratio of leg 5 is measured about 2.04 : 1 (1.67 : 1 in *P. brevicaudatus*). The terminal segment of leg 3 endopod in the new species and other two congeneric species are armed with 1 serrate seta and 4 plumose setae, but Japanease species, *P. paguri* bears 1 serrated and 3 plumose setae. In the formula of leg 4 endopod, the new species and other two species shows 0-1, 0-1, and 4, but *P. paguri* has no seta in the first segment and has only 3 setae in terminal segment. The seaweed dwelling species, *P. ovatum* and *P. ravane* are also easily separated from the new species by the shape of caudal ramus and urosome, and setal fomulae of leg 3 endopod and leg 4 endopod (not *P, ravaane*). Comparison of the new species with other congeners associated with hermit crabs is shown in table 1.

Recently, the family Porcellidiidae, formerly regarded as monotypic group was devided into 6 genera, *Porcellidium, Acutiramus, Murramia, Brevifrons, Tectacingulum,* and *Kiloar* by Harris & Robertson (1994) and Harris (1994). However, Huys et al. (1996) pointed out a mistake, in that *P. ovatum* Haller, 1880 is replaced as an *Acutiramus*. Harris & Robertson (1994) also transfered *P. brevicaudatum* Thompson & A. Scott, 1903 to the genus of *Acutiramus*. However, this species is not suitable for the genus *Acutiramus* in that the caudal ramus is not rhomboidal and the urosome is not narrow (highly broad). A systematic account on the relationship between the genus *Acutiramus* and *Porcellidium* needs the informations on the intermediate species and the variations in the intra- and interpopulation. Therefore, we did not follow their new combination on the family Porcellidiidae in this paper.

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REFERENCES

Claus, C., 1860. Beitr ge zur Kenntis der Entomostraken. Erstes Heft. Marburg: 1-28.

Claus, C., 1863. Die freilebenden Copepoden mit besonderer Ber cksichtigung der Fauna Deutschlands, der Nordsee und des Mittelmeeres. Leipzig: 1-230.

Geddes, D.C., 1968c. Marine biological investigations in the Bahamas. 7. Harpacticoid copepods belonging to the families Porcellidiidae Sars, Peltidiidae Sars, and Tegastidae Sars. Sarsia, 35: 9-56.

Harris, V. A. P., 1994. New species belonging to the family Porcellidiidae (Harpacticoida: Copepoda) from Kioloa, New South Wales, Australia. Rec. Austr. Mus., **46**(3): 303-340.

Harris, V.A.P. & H.M. Robertson, 1994. New species belonging to the family Porcellidiidae (Harpacticoida: Copepoda) from the southern coast of New South Wales, Australia. Rec .Austr. Mus., **46**(3): 257-301.