

## Two New Species of *Kensakia* Belonging to the Family Porcellidiidae (Crustacea, Copepoda, Harpacticoida) from Japan and Malaysia

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**Abstract** Two new species of *Kensakia*, *K. shimodensis* from Shizuoka Prefecture, Japan and *K. parva* from Tioman Island, Malaysia, are described and the diagnosis of the genus is revised. The autapomorphic characters that separate *Porcellidium* and *Kensakia* are discussed and the validity of *Kensakia* is justified.

**Key words:** *Kensakia*, Porcellidiidae, Copepoda, Harpacticoida, Japan, Malaysia.

### Introduction

In a study of the Porcellidiidae living on macroalgae in Korean coastal waters, Kim and Kim (1997) described a new species—*Porcellidium acutum*. They noted that it was similar in shape of body and caudal furca to *Porcellidium tenuicauda* Claus, 1860. At about the same time Harris and Iwasaki (1997) described a species similar to *P. acutum* from Kadonohama Bay, Japan under the name *Kensakia aiioa*. A new genus, *Kensakia*, was created because the animals did not fit the diagnosis for *Porcellidium* given by Huys *et al.* (1996).

*Porcellidium acutum* and *K. aiioa* are now considered the same species and *K. aiioa* becomes the junior synonym (Walker-Smith, 2001). But the question remains, does it belong to *Porcellidium* or *Kensakia*?

The two new species described here share the same characters as the Japanese and Korean animals. This allows a more precise definition to be made of the autapomorphies that define the genus *Kensakia*. A revised diagnosis for *Kensakia* is given. The argument for placing all three species in *Kensakia* will be given in the Discussion.

### Materials and Methods

Methods of collection, measurement and terminology follow Harris and Iwasaki (1996a) and Harris and Robertson (1994). Type specimens are deposited in the National Museum of Nature and Science, Tokyo (NSMT), Japan.

### Taxonomy

Family Porcellidiidae Boeck, 1865

Genus *Kensakia* Harris and Iwasaki, 1997

*Porcellidium*—Walker-Smith, 2001: 655 (part)

**Diagnosis.** Underside of cephalosome with lateral band of surface markings. Male antennule with large pad of hair-like setules (brush-pad) on compound segment; unique arrangement of coupling denticles on male antennule (triangular coupling denticle at base of  $\delta$  seta, large brush-like pad and bicuspid distal denticle on compound segment). Posterior end of female P5's falciform ridge ends in terminal notch. Terminal seta T2 absent from adult female caudal ramus; present on male caudal ramus.

**Description.** Anterior of female cephalosome not truncated, male cephalosome slightly

truncated. Hyaline border with sensilla at lateral edge of cephalosome, ducts of marginal glands open dorsal to border. No ridge plates on labrum. Female urosome plus caudal furca heart-shaped, urosome narrow, not clearly divided into anterior and posterior lobes, at least 1/2 caudal furca in arch of urosome. Female caudal rami trapezoid (sides not parallel), terminal seta T3 absent; adult male caudal rami rectangular, T3 absent. Terminal setae on caudal rami not pinnately clavate or evenly spaced. No anterior comb or large denticulate pad on male antennule. Maxillule endopod

with six setae. Coxae of maxillipeds meet in midline, fimbriate process on basis. Denticulate peg areas on P1 endopod very small or absent. Terminal pair of setae on P3 and P4 endopod plumose. Female P5 without ventral expansion, two non-pinnate dorsal setae present, P5s extend beyond urosome and caudal furca; male P5 with one lateral and five terminal setae. Spermatophore elongate, ephemeral on female.

*Species composition.* *Kensakia acuta* (Kim and Kim, 1997) comb. nov.; *K. shimodensis* sp. nov.; *K. parva* sp. nov.

#### Key to species of *Kensakia*

1. Large number (>400) of hair-like dorsal sensilla on cephalosome. Distal coupling denticle on male antennule large (10–15  $\mu\text{m}$ ) ..... *K. shimodensis*
- Not many dorsal sensilla (<50) on cephalosome. Distal coupling denticle on male antenna small (5  $\mu\text{m}$ ) ..... 2
2. Male P5 curved (not trapezoid). Male rostrum U-shaped (ventral). Aesthetasc on male antennule longer than antennule. Adult female very small (<0.55 mm long). Ventral band on cephalosome plain ..... *K. parva*
- Male P5 trapezoid. Male rostrum V or Y-shaped. Aesthetasc on male antennule <3/4 length of antennule. Adult female >0.75 mm in length. Ventral band on cephalosome with net-like pattern ..... *K. acuta*

#### *Kensakia shimodensis* sp. nov.

(Figs. 1–2)

*Type material examined.* Holotype: adult male, NSMT-Cr 19014, length 0.81 mm. Allotype: adult female, NSMT-Cr 19015, length 1.10 mm. Paratype: adult male, NSMT-Cr 19016. All type specimens were collected from a brown alga, *Undaria pinnatifida*, at Nabeta Bay, Shimoda, Shizuoka Prefecture, Japan (34°66.5'N, 138°93.8'E), by M. Aoki on 12 May 1998.

*Diagnosis.* Numerous dorsal sensilla (>400) on dorsal surface of cephalosome. Lateral band on ventral side of cephalosome with longitudinal ridges or wrinkles. Male rostrum U-shaped (length > width). Terminal setae T1 and  $\gamma$  on female caudal ramus lie parallel to beveled edge of ramus;  $\alpha$  and  $\beta$  seta on male caudal ramus short (<1/2 width of ramus). Distal coupling denticle on male antennule large (10–15  $\mu\text{m}$ ); aesthetasc

on male antennule about 1/2 length of antennule. No lateral rows of setules on maxilliped basis. Labrum without area of setules. Male P5 with more than 12 setules ventral to lateral seta.

*Dimensions.* Adult females (N=2): maximum length (rostrum to end of caudal furca)  $L_{\text{max}}$  1.05 mm, 1.07 mm, length to end of urosome  $L_{\text{urs}}$  0.95 mm, 0.97 mm, width of cephalosome 0.68 mm, 0.71 mm, rostrum width 0.15 mm. Urosome length 0.24 mm, width 0.34 mm. Caudal ramus length 0.20 mm, width 0.088 mm. Female ratios  $L_{\text{urs}}/\text{width} = 1.4, 1.37$ , cephalosome width/rostrum = 4.53, 4.7, urosome w/l = 1.4, urosome arch 42% of urosome length, caudal ramus l/w = 2.3,  $\alpha$  seta 82% and  $\beta$  seta 70% of ramus length from posterior apex.

Adult male (N=1): Maximum length  $L_{\text{max}}$  0.81 mm,  $L_{\text{urs}}$  0.76 mm, cephalosome width 0.61 mm, rostrum length 0.082 mm, width 0.069 mm, caudal ramus length 0.085 mm, width 0.06 mm. Antennule length 0.185 mm. Spermatophore

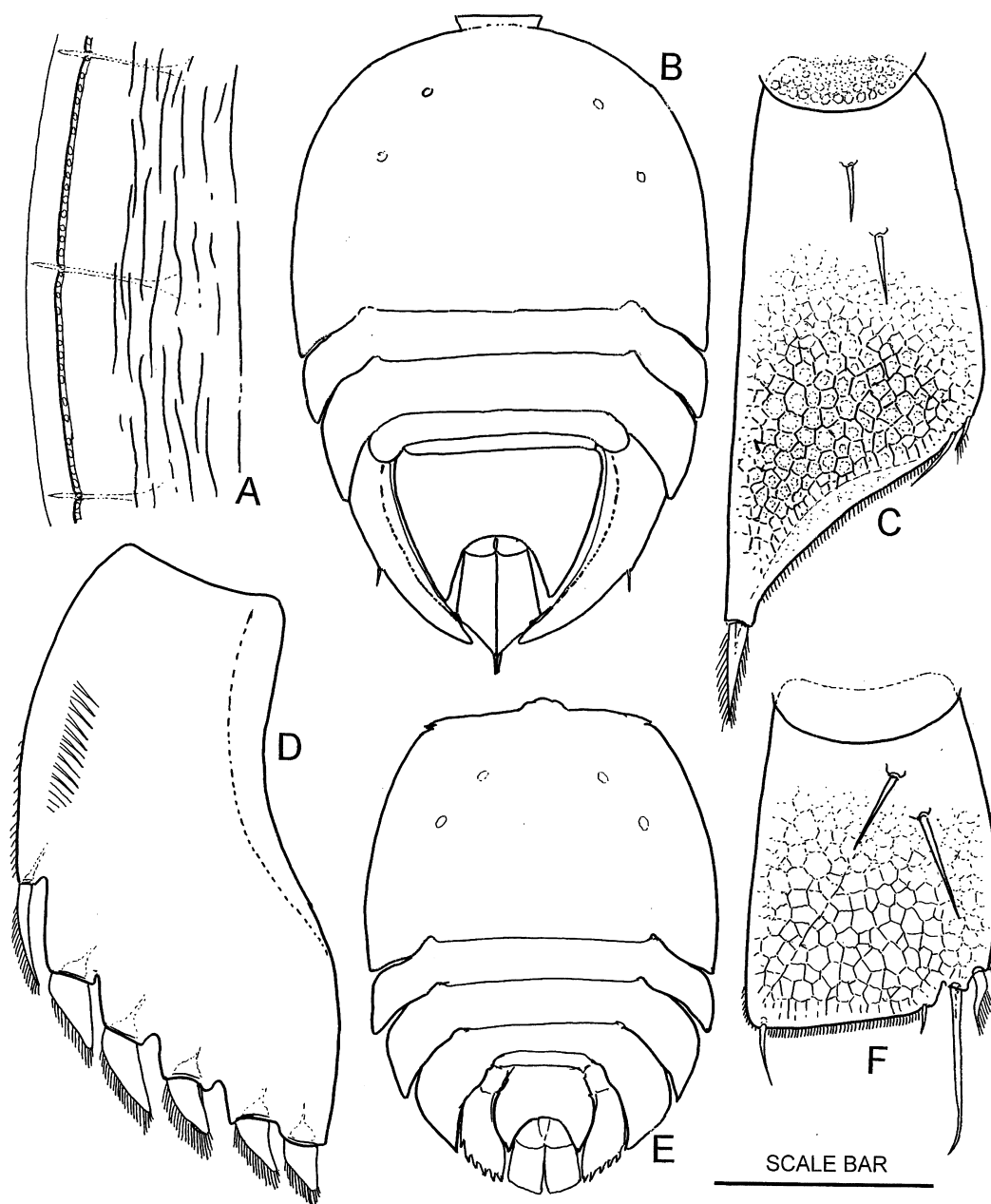


Fig. 1. *Kensakia shimodensis*. A, Lateral band on ventral side of cephalosome; B, Adult female; C, Female caudal ramus; D, Male P5, ventral view; E, Adult male; F, Male caudal ramus. Scale bar: A, D, F=0.055 mm; B, E=0.365 mm; C=0.075 mm.

0.11×0.02 mm. Male ratios  $L_{\max}/\text{width} = 1.3$ ,  $L_{\text{urs}}/\text{width} = 1.25$ , rostrum  $w/l = 0.84$ , caudal ramus  $l/w = 1.4$ , antennule 23% of  $L_{\max}$ , compound segment 38%, dactylus 27%, aesthetasc 60% of antennule length.

*Description.* Adult female (Fig. 1B) oviform (egg-shape), yellow with large red or purple dorsal area on cephalosome and posterior region. Dorsal pits small, conspicuous (3–5  $\mu\text{m}$ ), numerous dorsal sensilla (about 500) on cephalosome

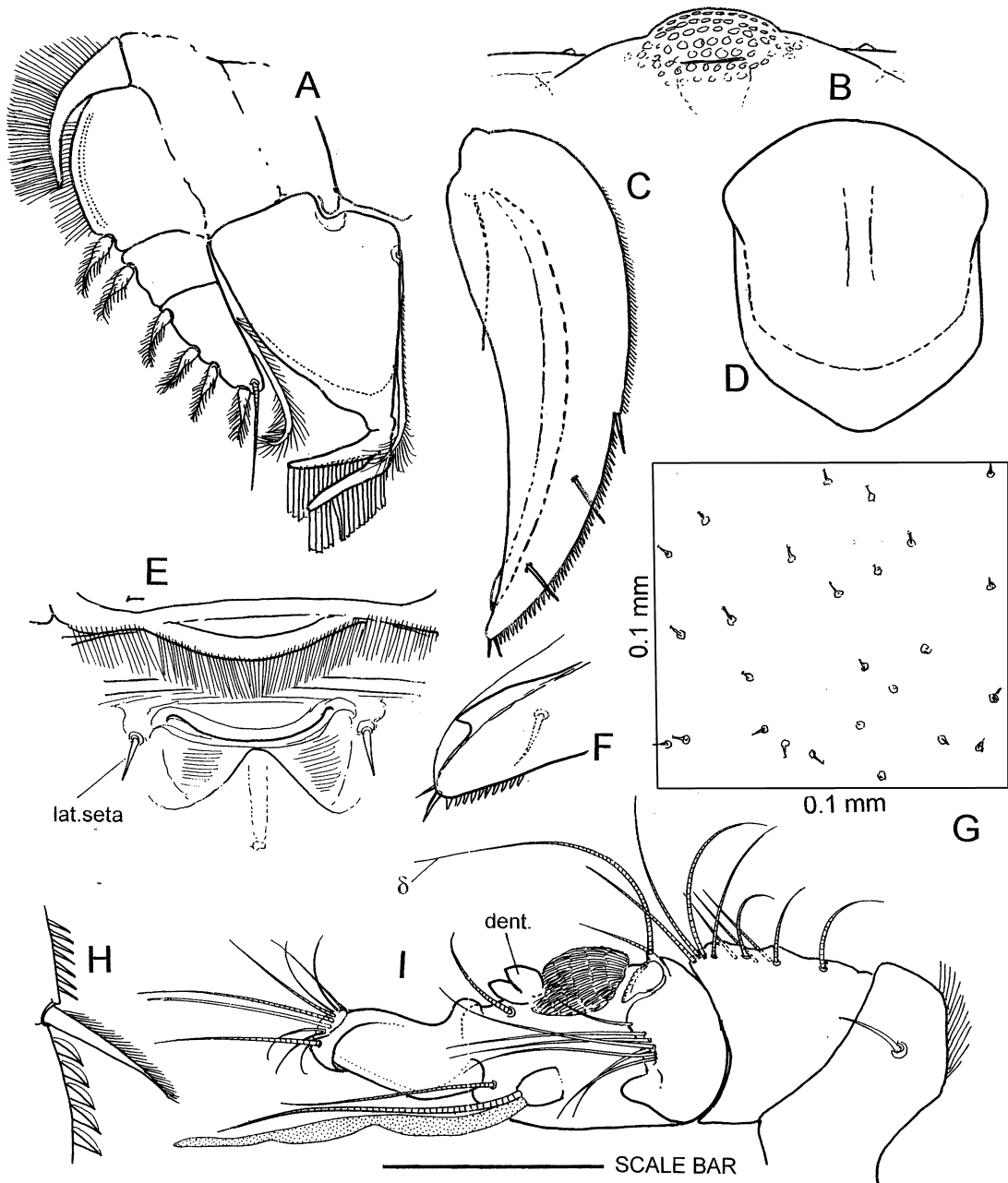


Fig. 2. *Kensakia shimodensis*. A, P1, ventral view; B, Anterior bulge of male cephalosome that obscures rostrum; C, Female P5, dorsal view; D, Male rostrum, ventral view; E, Female, ventral view of metasome segment 4 and genital opening, lat. seta: lateral seta; F, Apex of female P5 showing notch at end of falciform ridge, ventral view; G, Distribution of sensilla on dorsal surface of cephalosome, traced from photograph; H, Edge of female P5 showing lateral seta and border setules; I, Male antennule, ventral view, dent.: distal coupling denticle,  $\delta$ :  $\delta$  seta. Scale bar: A, D, E=0.055 mm; B, F=0.11 mm; C=0.18 mm; H=0.05 mm; I=0.065 mm.

(Fig. 2G). Hyaline border  $8\ \mu\text{m}$  wide. On the ventral side of cephalosome there is a lateral band of ridges or wrinkles (Fig. 1A).

Labrum without patch of short setules or striations.

Urosome conspicuously pitted dorsally, no notch to mark division between anterior and posterior lobes, arch less than  $1/2$  length. Sternal region of metasome segment 4 with fimbriate setules, genital opening with lateral seta (setule) at each corner (Fig. 2E).

Caudal ramus trapezoid (proximal width 65% of maximum width), bevelled posterior edge slightly concave with very fine border setules, dorsal surface with conspicuous network of ridges (Fig. 1C),  $\alpha$  seta close to proximal end of ramus (82% from posterior apex), T1 and  $\gamma$  setae lie parallel to posterior border, T1 small pinnate, T4 larger, pinnate at posterior apex.

Limb structure and setation typical of family. Antenna with single row of surface setules on basis. Claw on maxilla endopod not comb-like. Maxilliped without rows of fine setules on side of basis. Large serrate spinous seta on P3 endopod segment 3 much longer than endopod (1.5:1). Spinous seta on P4 endopod segments 2 and 3 finely serrulate. P5 lanceolate (Fig. 2C) with deep notch at apical end of ventral falciform ridge (Fig. 2F), dorsal surface conspicuously pitted, border setules of unusual appearance (Fig. 2H), first dorsal seta 70% of distance from apex to lateral seta.

Adult male (Fig. 1E), cephalosome slightly truncated with small medial bulge that obscures lateral angle of antennule sockets (Fig. 2B), colouration, dorsal pits, dorsal sensilla and ridged ventral band on cephalosome same as for female, rostrum U-shaped in ventral view (Fig. 2D), slightly longer than wide ( $w/l=0.87$ ).

Caudal ramus rectangular ( $l/w=1.4$ ), conspicuous network of ridges on dorsal surface, length of  $\alpha$  and  $\beta$  setae  $1/2$  width of ramus, T1 small, pinnate, T2 minute, T4 small plain (Fig. 1F).

Antennule dactylus  $2/3$  length of compound segment, hooked distally, distal coupling denticle large ( $10\text{--}15\ \mu\text{m}$ ) close to brush pad (Fig. 2I),

aesthetasc about  $1/2$  length of antennule. P2 with two terminal setae on endopod. P5 trapezoid, but with concave medial edge, lateral edge slightly convex (Fig. 1D), dorsal surface with network of fine ridges, lateral seta of different shape to terminal setae, inserted  $2/3$  way down lateral edge, ventral row of 14–15 setules. Spermatophore small, about  $1/8$  body length.

*Remarks.* *Kensakia shimodensis* is the largest member of the genus. The type specimens are covered with foreign material (algae, bacteria and mucus-like substance) that makes observation of fine detail on the cephalosome and caudal rami difficult.

*Etymology.* The specific epithet is named after the place where this species was found.

### ***Kensakia parva* sp. nov.**

(Figs. 3–4)

*Type material examined.* Holotype: adult male, dissected mounted on microscope slide, NSMT-Cr 19017, length 0.45 mm. Allotype: adult female, dissected mounted on microscope slide, NSMT-Cr 19018, length 0.54 mm. Paratype: two adult males, NSMT-Cr 19019. All type specimens were collected from a brown alga, *Colpomenia* sp. at Cape Gelabir, Tioman Island, Malaysia, ( $2^{\circ}50'N$ ,  $104^{\circ}10'E$ ), by N. Iwasaki on 5 August 1999.

*Diagnosis.* Lateral band on ventral side of cephalosome plain (no wrinkles or net-like marking); very few dorsal sensilla. Rostrum U-shaped (width = length).  $\alpha$  and  $\beta$  setae on male caudal ramus long ( $>3/4$  width of ramus). Distal coupling denticle on male antennule small ( $5\ \mu\text{m}$ ); aesthetasc on male antennule very long ( $>$ antennule length). Labrum without area of setules. No lateral rows of setules on maxilliped basis. Apex of female P5 truncated, rounded; male P5 with less than 8 setules ventral to the lateral seta.

*Dimensions.* Adult female (N=1): Maximum length  $L_{\text{max}}$  0.54 mm, length to end of urosome  $L_{\text{urs}}$  0.50 mm, width of cephalosome 0.35 mm, rostrum width 0.07 mm. Urosome length 0.145 mm, width 0.19 mm. Caudal ramus

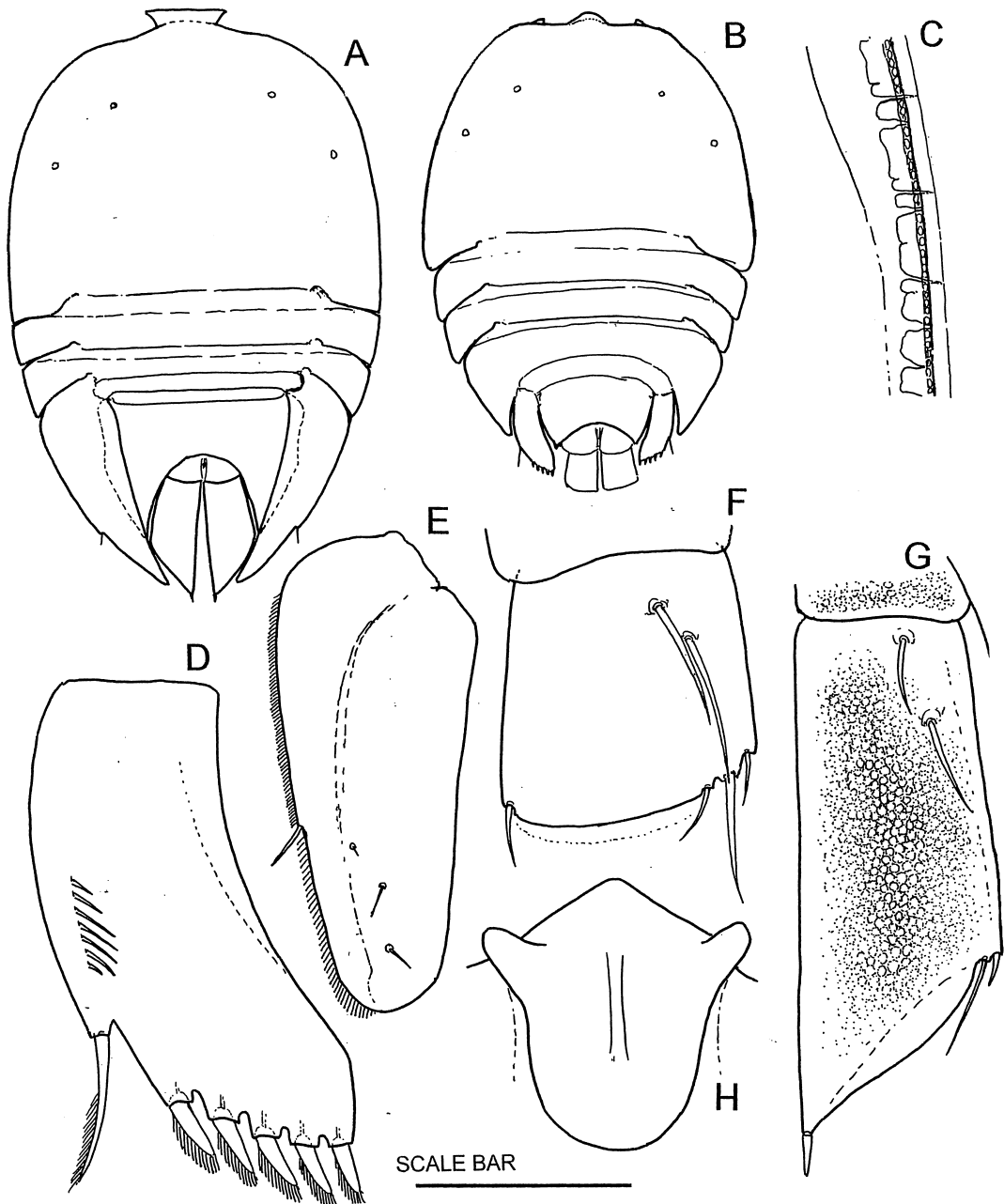


Fig. 3. *Kensakia parva*. A, Adult female; B, Adult male; C, Lateral band on ventral side of cephalosome; D, Male P5, ventral view; E, Female P5, dorsal view; F, Male caudal ramus; G, Female caudal ramus; H, Male rostrum, ventral view. Scale bar: A, B=0.2 mm; C=0.06 mm; D=0.025 mm; E=0.1 mm; G=0.05 mm; F, H=0.032 mm.



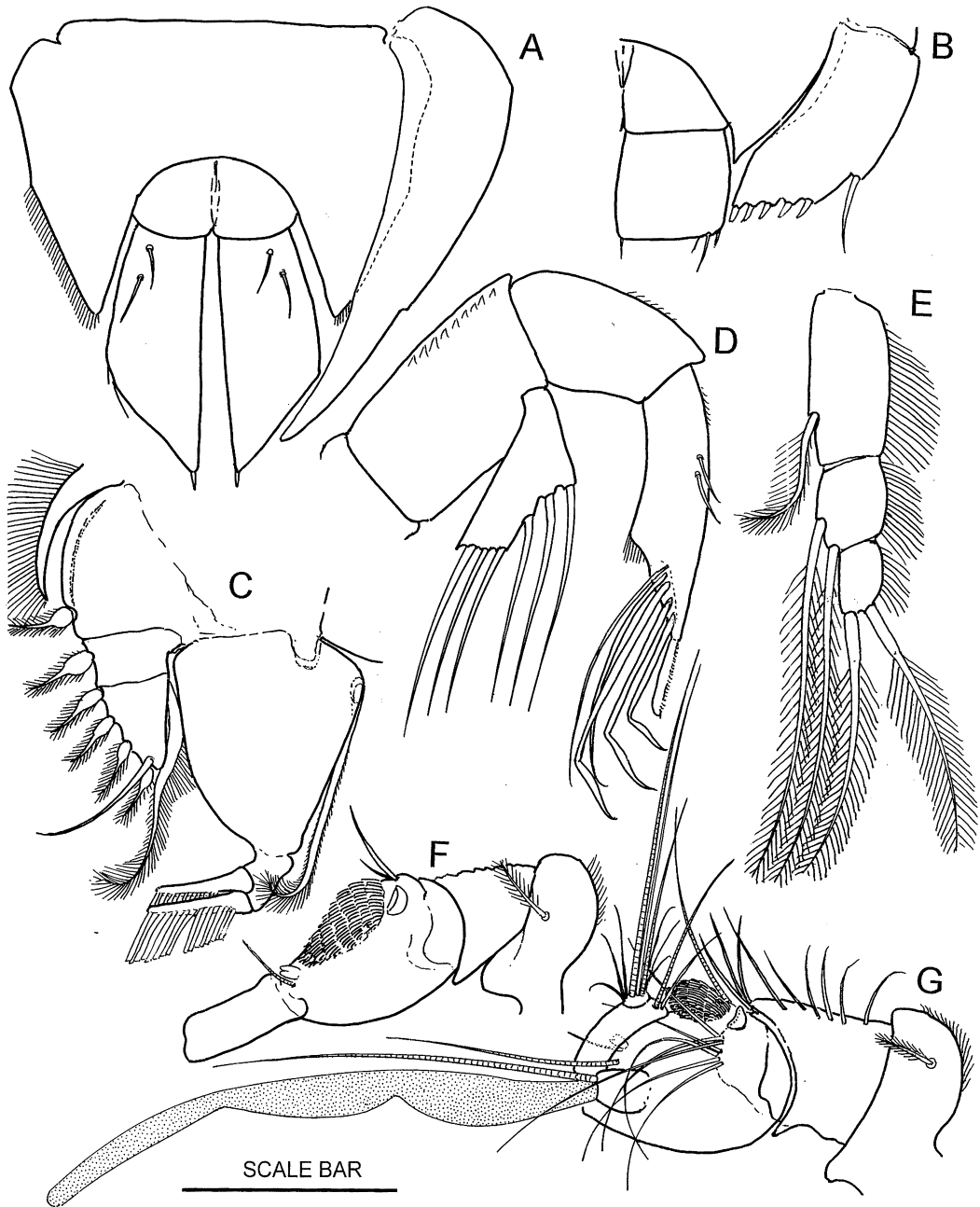


Fig. 4. *Kensakia parva*. A, Female urosome with caudal furca and P5; B, Male caudal ramus and P5; C, P1, ventral view; D, Antenna; E, Male P2 endopod; F, Male antennule showing distal coupling denticle; G, Male antennule, ventral view. Scale bar: A=0.1 mm; B, C, E=0.065 mm; D=0.032 mm; F=0.055 mm; G=0.05 mm.

length 0.11 mm, width 0.045 mm. Female ratios  $L_{\text{urs}}/\text{width}=1.43$ , cephalosome width/rostrum =5, urosome  $w/l=1.3$ , urosome arch 45% of urosome length, caudal ramus  $l/w=2.5$ ,  $\alpha$  seta 95% and  $\beta$  seta 80% of ramus length from poste-

rior apex.

Adult male (N=1): Maximum length  $L_{\text{max}}$  0.45 mm,  $L_{\text{urs}}$  0.43 mm, cephalosome width 0.29, rostrum width 0.04 mm, length 0.04 mm, caudal ramus length 0.036 mm, width 0.033 mm. Anten-

nule length 0.112 mm. Spermatophore  $0.11 \times 0.03$  mm. Male ratios.  $L_{\max}/\text{width} = 1.55$ , rostrum  $l/w = 1$ , caudal ramus  $l/w = 1.1$ , antennule 25% of body length ( $L_{\max}$ ), compound segment 44%, dactylus 20% and aesthetasc 110% of antennule length. Spermatophore 24% of  $L_{\max}$ .

*Description.* Adult female (Fig. 3A), colourless. Dorsal pits, very small (1.5–2.0 mm), hyaline border narrow ( $4 \mu\text{m}$ ), very few dorsal sensilla, lateral band on underside of cephalosome plain (no wrinkles or net-like markings) (Fig. 3C). Labrum without area of fine setules.

No notch on urosome to indicate boundary between anterior and posterior lobes, anterior half of border slightly concave (Fig. 4A), dorsal surface pitted, border setules unusually long on posterior half of border, caudal arch  $1/2$  urosome length.

Caudal ramus (Fig. 3G) trapezoid, proximal width 85% of maximum width, dorsal surface with feint network of ridges and pits,  $\alpha$  seta very close to proximal end of ramus (95% from posterior apex), T1 small, plain, T4 small plain, at posterior apex.

Limb structure and setation typical of family. Claw on endopod of antenna almost as long as adjacent geniculate seta. Spinous setae on P4 endopod plain. Apex of P5 truncated, broadly rounded when laid flat, medial edge overlaps urosome (Fig. 4A), slight indentation at apical end of ventral falciform ridge. Lateral seta of P5 plain, first dorsal seta about  $1/2$  way between lateral seta and posterior edge (Fig. 3E), fine setules along lateral border, dorsal surface pitted.

Adult male (Fig. 3B) colourless. Dorsal pits, sensilla and ventral lateral band on cephalosome as for female. Rostrum U-shaped in ventral view, keeled, width equal to length (Fig. 3H).

Caudal ramus quadrate ( $l/w = 1.1$ ), T1, T2 and T4 plain, very small,  $\alpha$  and  $\beta$  setae long ( $> 3/4$  width of ramus, Fig. 3F).

Antennule (Fig. 4G) with unusually long aesthetasc (=or>length of antennule), distal coupling denticle on compound segment small ( $5 \mu\text{m}$ ), close to base of dactylus (Fig. 4F), dactylus short (about  $1/2$  length of compound seg-

ment), not hooked terminally. Endopod of P2 with two plumose terminal setae. P5 exopod elongate curved (not obviously trapezoid) with concave medial and convex lateral edge, lateral seta  $3/4$  down lateral edge, different shape to terminal setae (Fig. 3D), seven setules ventral to lateral seta.

*Remarks.* *Kensakia parva* is one of the smallest members of the Porcellidiidae. The diagnostic features listed above clearly distinguish this species from other members of the genus. Fine details of the posterior border of the caudal rami on the type specimens cannot be seen because of mucus-like foreign material, but it is assumed fine setules line the border (Fig. 3F).

The specimens are colourless, but it is not known if they might have lost colour in preservation. All the other species in the genus are coloured.

*Etymology.* The specific epithet *parva* refer to the small body.

## Discussion

Kim and Kim (1997) followed the long held view that the Porcellidiidae has only one genus, *Porcellidium*. But the discovery of new species that do not fit the diagnosis of *Porcellidium*, as given by Huys *et al.* (1996), has resulted in the erection of several new genera including *Kensakia*. Walker-Smith (2001) in a review of the family pointed out that genera should be based on autapomorphic characters. She accepted four of the new genera but rejected *Kensakia* because the original diagnosis did not define which characters were considered autapomorphic (*i.e.*, derived or apomorphic characters unique to a particular group of species). The revised diagnosis for *Kensakia* given above rectifies this omission.

A problem arises here because Claus, who described *Porcellidium tenuicauda* in 1860, did not state which characters define the genus *Porcellidium*. Not one of the diagnoses given since 1860 (including Walker-Smith's) state which characters of *Porcellidium* are autapomorphic. To overcome this problem a detailed study of male and female *P. tenuicauda* and *P. scutatatum* Claus, 1889



was made by the senior author (unpub.). It was found that the type of spermatophore and the pattern of insemination, as well as the unique structure and arrangement of the coupling denticles on the male antennule are different from all other known members of the family. These features are considered true autapomorphic characters that define the genus *Porcellidium*.

As already described, the most important autapomorphic characters of *Kensakia* are the brush-pad and arrangement of coupling denticles on the male antennule. It follows from this that *acutum*, *shimodensis* and *parva* cannot belong to *Porcellidium*, nor can *tenuicauda* belong to *Kensakia*. The correct name for the Korean animals is, therefore, *Kensakia acuta* (Kim and Kim, 1997).

The inclusion of male characters in the diagnosis emphasizes the importance of the male antennule in taxonomy of the Porcellidiidae. Most of these characters are specific to a particular species and can be used to identify an animal with certainty, but a few (like the brush pad or the anterior comb of *Kushia*) are considered autapomorphic and can be used to define genera. Because characters of the male antennule are so important the male animal has been designated holotype and the female allotype in this study.

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