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Three new species of the genus Paramesochra T. Scott, (Copepoda: Harpacticoida: Paramesochridae) from Yellow Sea, Korea with a redescription of Paramesochra similis Kunz, 1936

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Three new species of the genus *Paramesochra* T. Scott, 1892 (Copepoda: Harpacticoida: Paramesochridae) from Yellow Sea, Korea with a redescription of *Paramesochra similis* Kunz, 1936

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Three new species of Paramesochridae are described from the subtidal zone off Pungdo Island, west coast of Korea. *Paramesochra parasimilis* sp. nov. is closely related to *Paramesochra similis*. However, the new species is clearly distinguished by the characteristic seta IV of the caudal rami. *Paramesochra pungdoensis* sp. nov is characterized by five setae in antennary exopod and seta IV, which is longer than the caudal ramus. *Paramesochra mirabilis* sp. nov. has a laterally bent caudal seta V in the female. These three new species are placed in the *dubia*-group by the inner seta on the endopod of leg 3 and leg 4. Also, a redescription of *Paramesochra similis* Kunz, 1936 is provided, and an updated key to the species of *Paramesochra* is suggested.

http://www.zoobank.org/urn:lsid:zoobank.org:pub:F017D873-6A34-4976-A7EA-589038E1A9A3

Keywords: *Paramesochra*; Harpacticoida; Paramesochridae; Korea

Introduction

Back et al. (2009) found that interstitial harpacticoids that are specialized for living in sandy sediments dominate over nematodes in the Yellow Sea, off Taean, west coast of Korea, and that Ameiridae, Ectinosomatidae and Paramesochridae were the most diverse harpacticoid families in sandy sediments in their study area. Harpacticoid copepods living in interstitial habitats in Korea, including sandy sediments, are poorly known. The members of the family Paramesochridae are tiny, normally inhabit marine systems (apart from members of the genus *Remanea*, which consists of brackish-water species), and adapt to the interstitial spaces between sand grains. Although several species of the family Paramesochridae have been reported from the deep sea, the genus *Paramesochra* mainly occurs in sandy sediments of intertidal and shallow subtidal systems. Within the genus *Paramesochra* four different lineages, the *brevifurca*-, the *dubia*-, the *helgolandica*- and the *acutata*-groups have been recognized (Huys 1987). Recently two species, *Paramesochra marisalbi* Kornev and Chertoprud, 2008 of the *dubia*-group, and *Paramesochra taeana* Back and Lee, 2010 of the *acutata*-group have been described. As a result, the genus *Paramesochra* currently accommodates 17 species (Wells 2007; Huys 2009; Plum & George 2009; Back & Lee 2010).

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During the quantitative analysis of benthic harpacticoids, three new species of the genus *Paramesochra* T. Scott, 1892 were found from off Pungdo Island in the west coast of Korea. The present study aims to describe these three new species. We also provide a redescription of *Paramesochra similis* Kunz, 1936, and an amendment to the key of Back and Lee (2010) is provided.

Material and methods

The new species were collected from sandy sediments near Pungdo Island, in the Yellow sea of Korea. Sandy sediments were taken using a grab (surface area 0.1 m^2) and sub-samples were taken with acrylic corers (surface area 10 cm^2). The sediment samples were fixed with 5% buffered formalin. Copepods were extracted from the sediment samples through the Ludox method (Burgess 2001) and preserved in 70% ethanol. Dissected specimens were mounted on several slides separately using lactophenol as mounting medium. Slides were sealed with transparent nail varnish. Observations were made using an Olympus BX51 equipped with differential interference contrast and a drawing tube. The descriptive terminology was adopted from Huys et al. (1996). Abbreviations used in the text are: A1, antennule; A2, antenna; ae, aesthetasc; exp, exopod; enp, endopod; P1–P6, first to sixth thoracopod; exp (enp)-1 (2, 3) to denote the proximal (middle, distal) segment of a three-segmented ramus. Specimens were deposited in the National Institute of Biological Resources, Korea (NIBR), and in the Marine Biodiversity Institute of Korea (MABIK). A specimen of *P. similis* Kunz, 1936 was a loan from Natural History Museum, London which was arranged by Dr Rony Huys for the authors of the present study. Scale bars in figures are indicated in μm.

Systematics

Family **PARAMESOCHRIDAE** Lang, 1944
Genus ***Paramesochra*** T. Scott, 1892
Paramesochra parasimilis sp. nov.
(Figures 1–4)

Type locality

Off Pungdo Island, subtidal zone, west coast of Korea, Yellow sea (37°6′39″ N, 126°24′27″ E), depth 20–25 m, sand, salinity 31 psu.

Material examined

Holotype 1 ♀ (NIBRIV0000261347) dissected on five slides. Paratype 1 ♀ (CR00173700) preserved in 70% ethanol, 26 February 2008, Leg. J. Back.

Description of female

Body (Figure 1A,B). Cylindrical and depressed dorsoventrally; body length 300 μm ($n = 2$, mean = 295, measured from anterior tip of rostrum of cephalic shield to posterior margin of caudal rami); largest width measured at posterior margin of cephalic

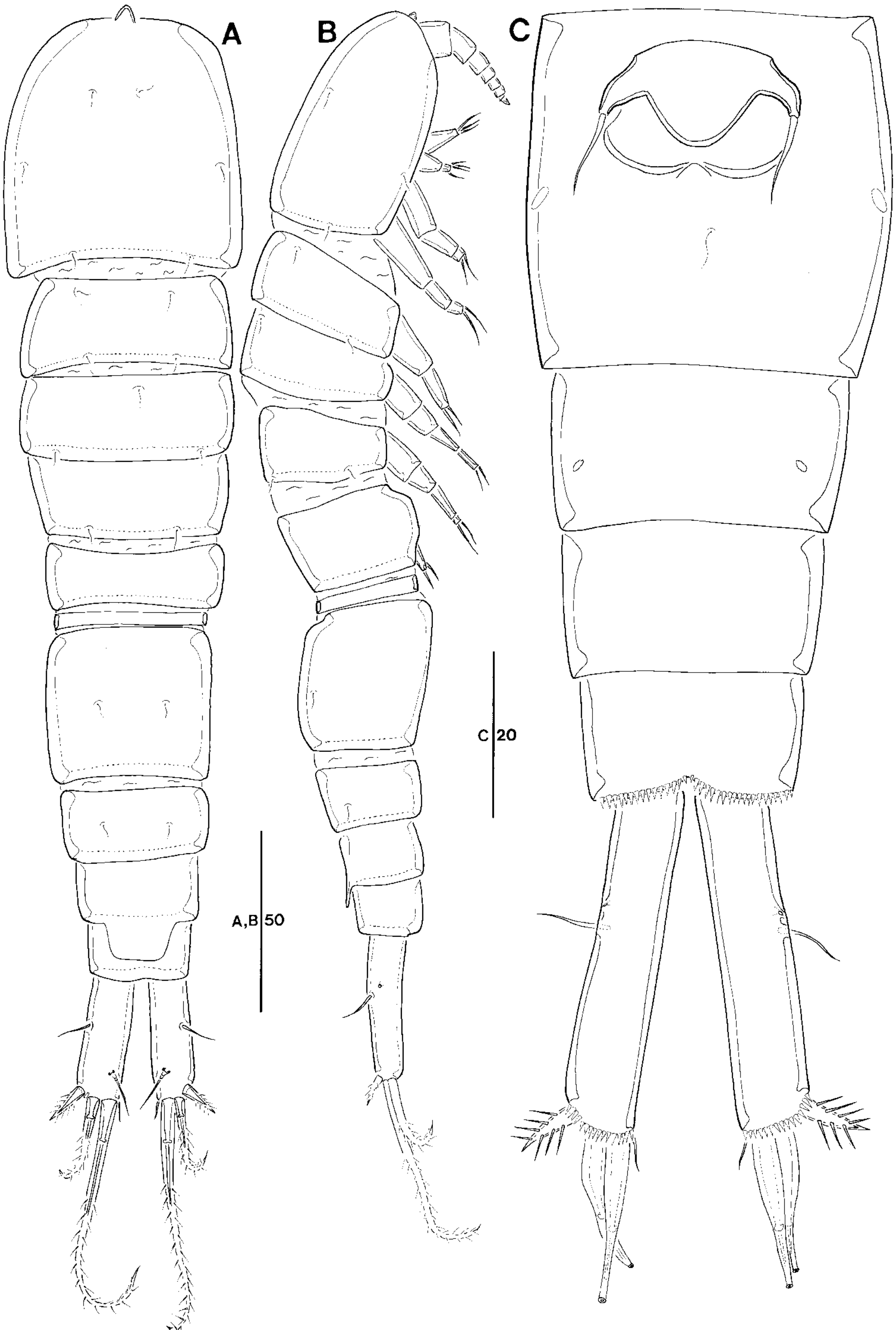

Figure 1. *Paramesochra parasimilis* sp. nov. (♀). (A) Habitus, dorsal; (B) habitus lateral; (C) urosome, ventral.

shield (65 μm); gradually tapering posteriorly; body somites connected by arthrodial membranes, sensilla on dorsal surface as in Figure 1A.

Rostrum. Diminutive, bare, fused with cephalosome (Figure 1A).

Prosome (Figure 1A). Four-segmented, comprising cephalothorax (bearing first pedigerous somite) and three free pedigerous somites; cephalothorax (Figure 1A,B) bell-shaped, with sensilla; pleural areas weakly developed and posterolateral angles rounded; posterior margin smooth; cuticula between cephalothorax and first free somite distinctly pursed; three free prosomites with sensilla as figured.

Urosome (Figure 1A–C). Five-segmented, comprising P5-bearing somite, genital double-somite, and three free abdominal somites; genital somite and first abdominal somite completely fused forming genital double-somite; gonopores fused medially forming single genital slit covered on both sides by opercula derived from P6; P6 represented by one plate, armed with one bare seta; middle of plate well developed and protruded. Anal somite (Figure 2A) small, occasionally, telescoped inside penultimate somite; anal operculum not present but pseudoperculum developed and trapezoid.

Caudal rami (Figures 1C, 2A). Juxtaposed, oblong and approximately four times as long as wide; with spinular row around ventral distal margin; each ramus armed with six setae; Seta I obscure, vestigial, probably presented by one small pore; seta II bare, situated in proximal half; seta III stout, spine-like bipinnate; seta IV shorter than caudal rami, slightly bulbous proximally pinnate distally; seta V longest, well developed, pinnate distally; seta VI bare and smallest; seta VII triarticulated at base.

Antennule (Figure 2C). Eight-segmented, short and robust; segment 1 with one small bare seta; segment 3 and segment 4 with sub-cylindrical pedestal; armature formula: 1–[1 bare], 2–[5 bare + 2 pinnate], 3–[6 bare + 1 pinnate], 4–[1 bare + 2 pinnate +(1+ae)], 5–[1 bare], 6–[3 bare], 7–[2 bare], 8–[5 bare + acrothek], apical acrothek consisting of cylindrical aesthetasc fused basally to two bare setae.

Antenna (Figure 3A). Four-segmented, comprising coxa, basis, one-segmented exopod, and free two-segmented endopod; coxa short and bare; basis approximately 2.2 times as long as wide; exopod one-segmented with four bare setae (apical element thick and modified); endopod two-segmented; enp-1 with one abexopodal bare seta; enp-2 with four bare setae laterally, one pinnate seta sub-apically, and five geniculate apical setae; outermost one fused basally to one bare seta.

Mandible (Figure $3B_1$,B_2). With well-developed gnathobase bearing seven cuspidate teeth distally and one bare seta at dorsal corner; mandibular palp biramous, well developed; basis widening distally, with two bare setae; exopod one-segmented, with two lateral and two distal bare setae, with spinular row sub-apically; endopod two-segmented, enp-1 longest, as long as exopod, with two bare distal setae, enp-2 approximately three times as long as wide, with five basally fused setae (note that the distal setae with fused bases are often misinterpreted as the third endopodal segment).

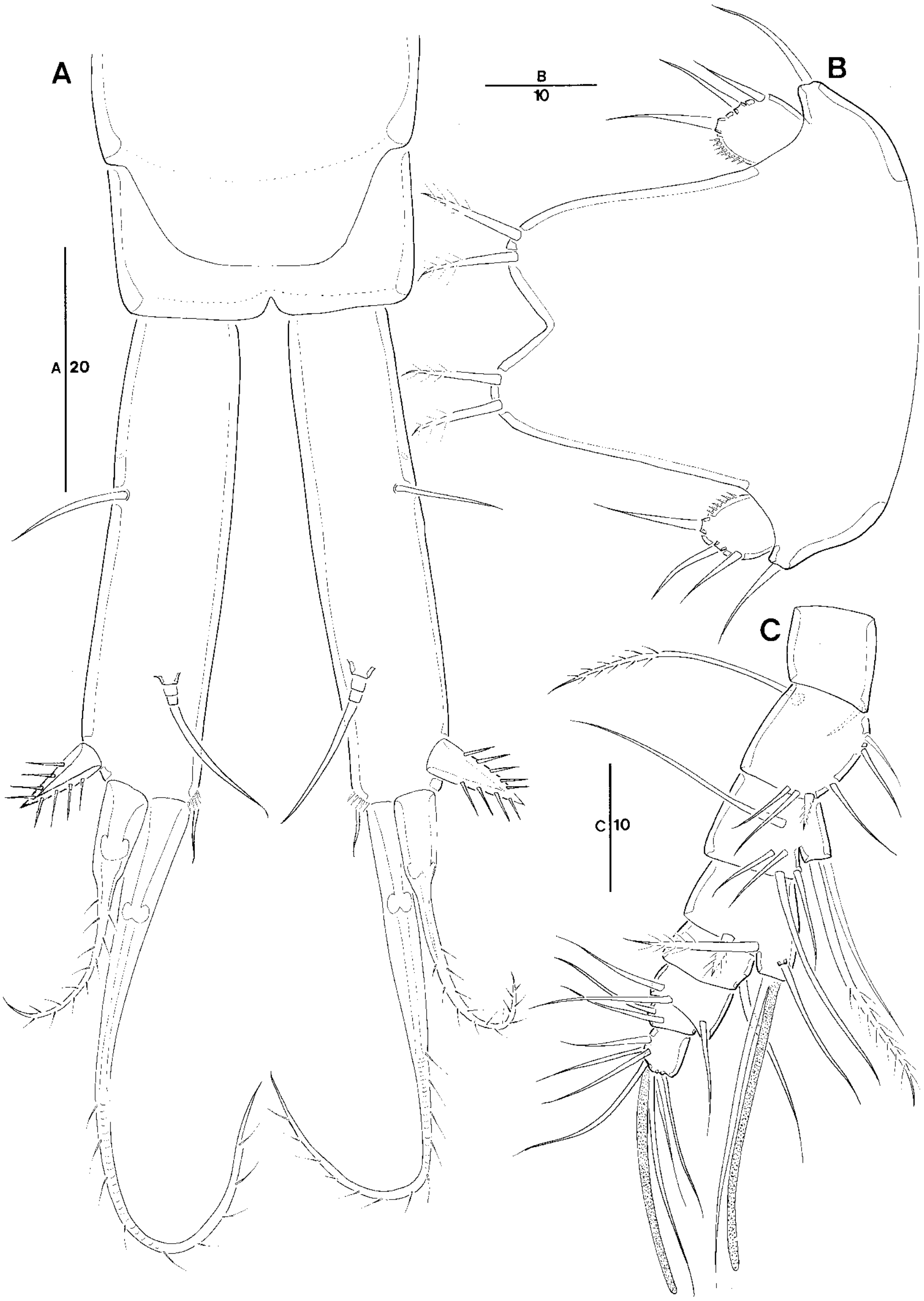

Figure 2. *Paramesochra parasimilis* sp. nov. (♀). (A) Caudal rami, dorsal; (B) P5, anterior; (C) antennule.

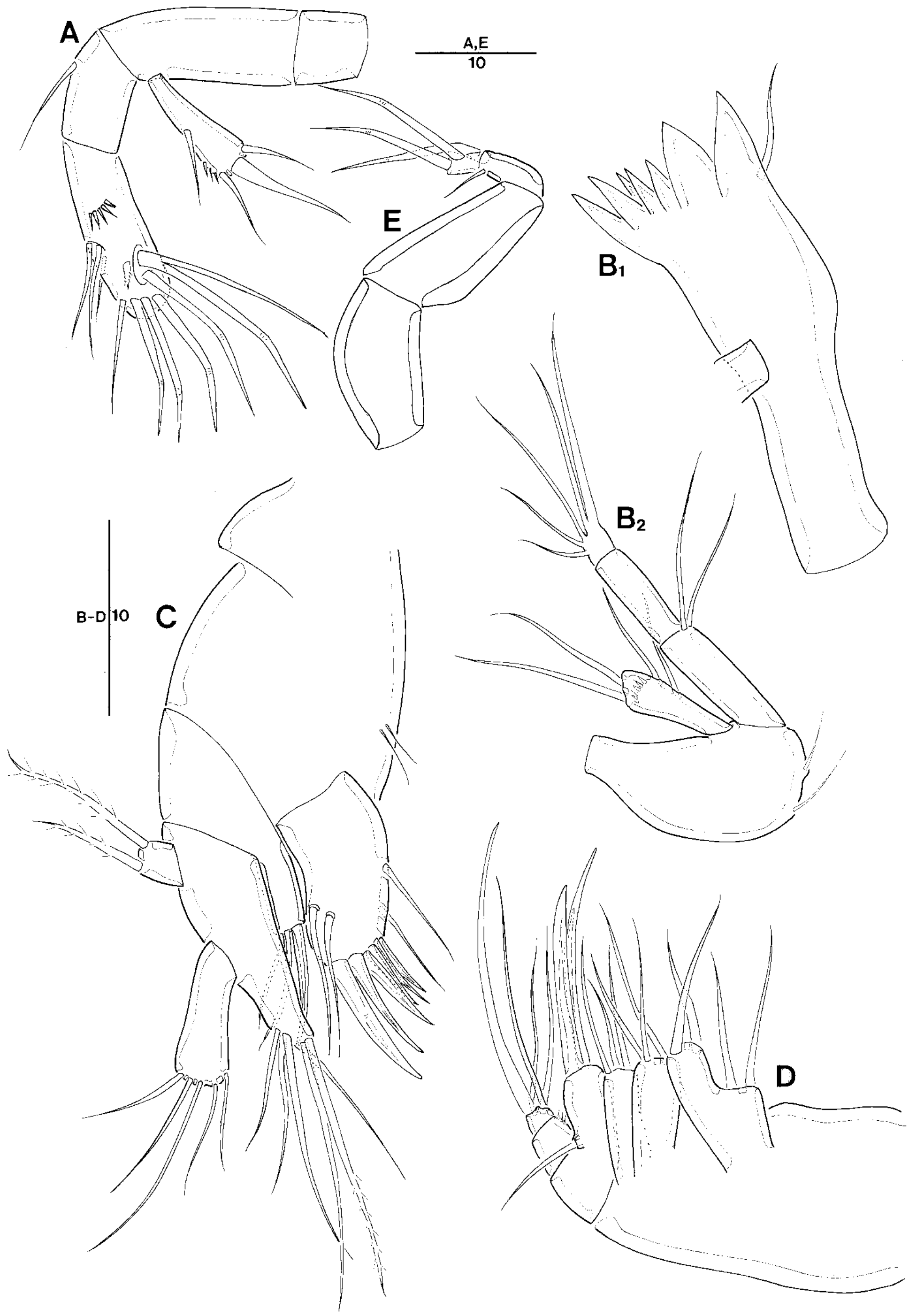

Figure 3. *Paramesochra parasimilis* sp. nov. (♀). (A) Antenna; (B) mandible (B_1, gnathobase; B_2, palp); (C) maxillule; (D) maxilla; (E) maxilliped.

Maxillule (Figure 3C). Praecoxa trapezoidal, and inner edge with two long spinules; arthrite well developed with two lateral bare setae, six curved distal spines, and two anterior bare setae; coxa with cylindrical process bearing one stout bare and two bare setae; basis cylindrical process with one pinnate and five bare setae; exopod one-segmented, squarish, with two pinnate setae; endopod one-segmented, elongate, rectangular, with five bare setae distally.

Maxilla (Figure 3D). Syncoxa with chitinous outer margin, and three cylindrical endites; proximal endite bilobed, with two bare setae on each lobe; second and third endites closed to each other, with three bare setae; allobasis with two terminal stout setae and one bare seta near insertion of endopodal base; endopod two-segmented; enp-1 with spinular row laterally; enp-2 squarish, minute, with one stout bare seta and three bare setae distally.

Maxilliped (Figure 3E). Four-segmented; syncoxa bare; basis elongate, approximately twice as long as wide, without ornamentation; endopod two-segmented; enp-1 twice as long as wide, with one small bare inner seta and one geniculate distal seta; enp-2 small with two geniculate setae distally.

Swimming legs P1–P4 (Figure 4A–D). Well-developed coxae and bases with long setular row on anterior surface as figured except for P1. Bases of P2–P4 with one outer bare seta; exopod three-segmented and endopod two-segmented; P2–P4 with spinular row along outer margin of exopod and endopod.

P1 (Figure 4A). Coxa bare; basis with one inner and one outer bare seta; exopod two-segmented and much shorter than enp-1; exp-1 with one outer bare seta at distal corner; exp-2 with four pinnate setae; endopod two-segmented; enp-1 bare, 1.6 times as long as exp; enp-2 small, squarish, with two geniculate setae on distal margin.

P2–P3 (Figure 4B,C). Exp-1 with one outer spine; exp-2 with one outer spine and inner corner forming small spinous projection; exp-3 with two pinnate spines, one apical bare seta and one pinnate seta; enp-1 without seta (P2) or with one inner bare seta (P3); enp-2 with one apical pinnate seta.

P4 (Figures 4D). Exp-1 with one outer spine; exp-2 with one outer spine and inner corner forming spinous projection; exp-3 with one outer spine and one stout bare seta apically; enp-1 with one inner seta; enp-2 with one stout unipinnate seta and acute inner corner. Armature formula of P1 to P4 is given in Table 1.

P5 (Figure 2B), baseoendopods confluent, forming large plate, furnished with one basal seta each; endopodal lobe expanding beyond exopod, and bilobed at distal edge, with two small pinnate setae; exopod discrete, small, with three bare setae, and with inner row of spinules.

Etymology

The specific name makes reference to the close relationship with *P. similis* Kunz, 1936.

Remarks

The new species is most closely related to *P. similis* Kunz, 1936 in the structure and armature formula of P1–P4, shape of P5, ratio of length to width in caudal rami,

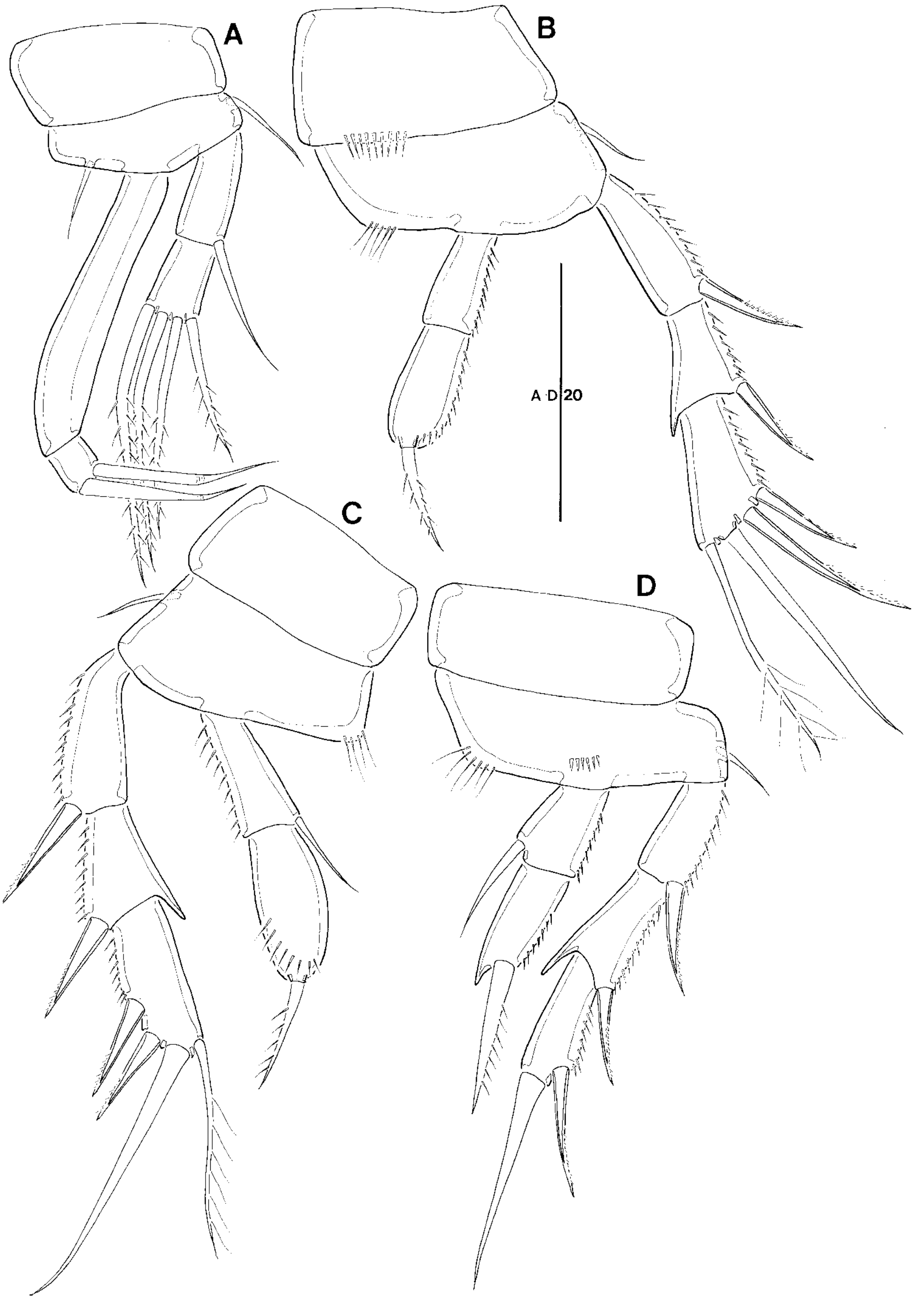

Figure 4. *Paramesochra parasimilis* sp. nov. (♀). (A) P1; (B) P2; (C) P3; (D) P4.

Table 1. Armature formula of P1 to P4 in *Paramesochra parasimilis* sp. nov.

	Exopod	Endopod
P1	0.121	0.011
P2	0.0.112	0.010
P3	0.0.112	1.010
P4	0.0.011	1.010

and short caudal rami seta VI. However, the new species is clearly distinguished from its congener by the combination of the following characters: (1) antennary exopod arms with four setae in *P. parasimilis* (Figure 3A), but five setae in *P. similis* (Figure 14C); (2) well-developed caudal rami seta IV somewhat bulbous in proximal third (Figures 1A–C, 2A), *P. parasimilis* is the only species within the genus with a modified caudal seta IV; (3) caudal seta III with spinules instead of setules (Figures 1C, 2A); (4) median posterior margin of P6 protruded in *P. parasimilis* (Figure 1C) but plain in *P. similis* (Figure 14A); and (5) trapezoidal pseudoperculum in *P. parasimilis* (Figure 1A).

Paramesochra pungdoensis sp. nov.
(Figures 5–8)

Type locality

Off Pungdo Island, subtidale zone, coast of Korea, Yellow sea (37°6′39″ N, 126°24′27″ E), depth 20–25 m, sand, salinity 31 psu.

Material examined

Holotype 1 ♀ dissected on seven slides (NIBRIV0000261348). Paratypes 3 ♀♀ (CR00173701) in 70% ethanol, 26 February 2008, Leg. J. Back.

Description of female

Body (Figure 5A,B). Cylindrical and depressed dorsoventrally; body length 325 μm ($n = 4$, mean = 320, measured from tip of rostrum of cephalic shield to posterior margin of caudal rami); largest width measured at posterior margin of cephalic shield (85 μm); gradually tapering posteriorly; entire surface covered with tiny denticles as illustrated (inserted in the rectangle of Figure 5A).

Rostrum. Diminutive (Figure 5A) bare, fused with cephalic shield.

Prosome. Four-segmented (Figure 5A,B), comprising cephalothorax (bearing first pedigerous somite) and three free pedigerous somites; cephalothorax bell-shaped with few sensilla and two pores laterally; pleural areas weakly developed and posterolateral angles rounded.

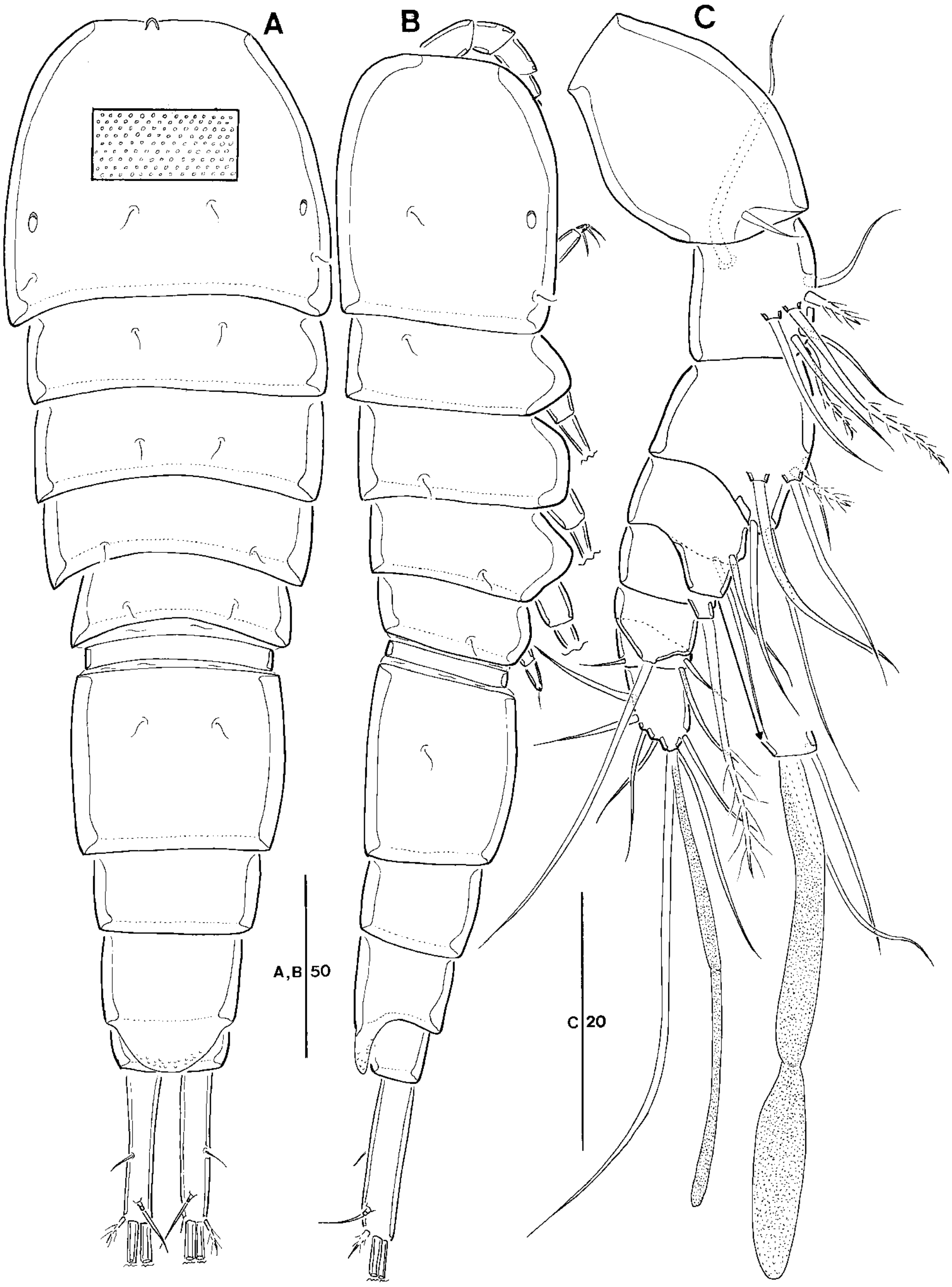

Figure 5. *Paramesochra pungdoensis* sp. nov. (♀). (A) Habitus, dorsal; (B) habitus lateral; (C) antennule.

Urosome. Five-segmented (Figures 5A, 6A), comprising P5-bearing somite, genital double-somite, and three free abdominal somites; genital somite and first abdominal somite completely fused forming genital double-somite; genital field with copulatory

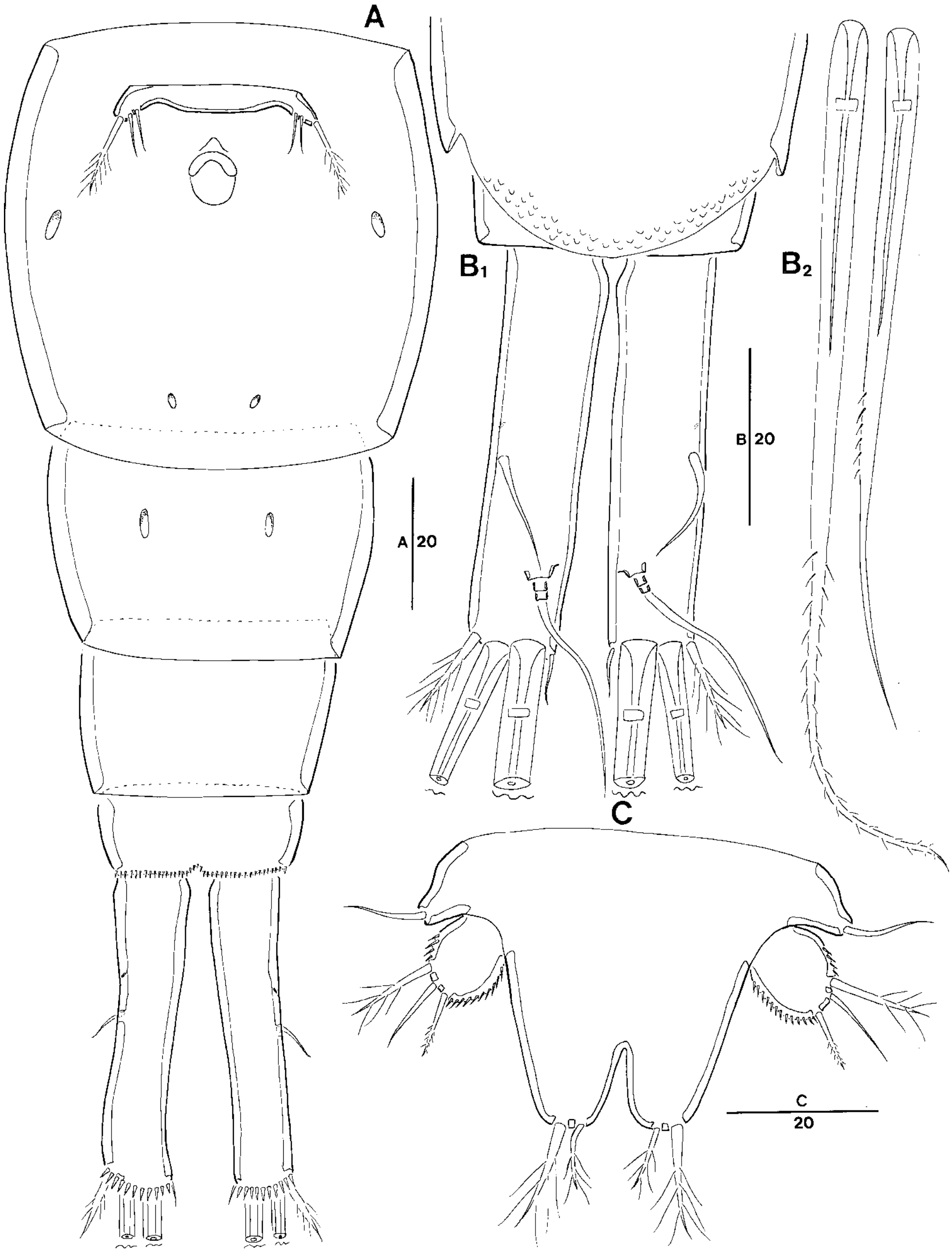

Figure 6. *Paramesochra pungdoensis* sp. nov. (♀). (A) Urosome, ventral; (B) caudal rami, dorsal (B_1, caudal rami; B_2 seta IV and V); (C) P5.

pore located in median depression; gonopores obscure, presumably single genital slit covered on both sides by opercula derived from P6; P6 represented by plate, each side with one long pinnate seta laterally and two inner, small, and bare setae; anal somite with row of spinules along ventral posterior margin; anal operculum not present, however, pseudoperculum well developed and multiple dimpled pattern on surface near posterior margin (Figure 6B_1).

Caudal rami (Figure 6A,B_1,B_2). Oblong, approximately 4.2 times as long as wide; with spinular row along distal margin ventrally; each ramus armed with six setae; seta I obscure, presumably represented by one lateral pore; seta II bare, situated on proximal half near outer edge; seta III plumose, situated at outer corner; seta IV well developed, with short row of small setules; seta V longest, pinnate; seta VI small, bare, situated at inner distal corner; dorsal seta VII triarticulated at base.

Antennule (Figure 5C). Eight-segmented, short, robust; segment 1 largest, with one short bare seta; segment 3 and segment 4 with sub-cylindrical pedestal; armature formula: 1–[1 bare], 2–[5 bare + 3 pinnate], 3–[5 bare + 1 pinnate], 4–[3 bare + (1+ae)], 5–[1 pinnate], 6–[1 bare], 7–[3 bare], 8–[5 bare + acrothek], apical acrothek consisting of small aesthetasc fused basally to two bare setae.

Antenna (Figure 7A). With basis approximately 2.5 times as long as wide; exopod one-segmented, with one bifurcate modified apical element, one bare seta distally at inner corner, and three lateral bare setae. Endopod two-segmented; enp-1 with one pinnate abexopodal seta; enp-2 with three bare lateral setae, one geniculate seta fused basally to one bare seta, and four geniculate apical elements.

Mandible (Figure 7B_1,B_2). With well-developed gnathobase bearing several cuspidate teeth distally and one pinnate seta at dorsal corner; mandibular palp biramous and well developed; basis widening distally, with two bare setae; exopod one-segmented, with one apical bare, and three lateral bare setae; endopod two-segmented, enp-1 twice as long as enp-2; enp-1 with two bare setae distally; enp-2 with five basally fused distal setae.

Maxillule (Figure 7C). With trapezoidal praecoxa; arthrite well developed with three lateral bare setae, six distal spines, and two long bare setae on anterior surface; coxa with cylindrical endite bearing one stout, and two bare setae; basis with five bare setae; exopod one-segmented with two bare setae; endopod one-segmented, rectangular, with five bare distal setae.

Maxilla (Figure 7D). Syncoxa with chitinous outer margin, and three cylindrical endites; proximal endite bilobed, with two bare setae on proximal lobe, and one bare and one pinnate seta on distal lobe; second and third endites closed to each other, each endite with three bare setae; allobasis with one claw-like pinnate spine and one stout bare seta; endopod one-segmented, square, with five bare setae distally.

Maxilliped (Figure 7E). Four-segmented; syncoxa bare; basis elongate, approximately three times as long as wide, without ornamentation; endopod two-segmented; enp-1 with one small bare seta laterally and one geniculate seta on distal margin; enp-2 small, with one small bare seta laterally and two geniculate setae distally.

P1–P4 (Figure 8A–D). Well-developed coxae and bases with setules and spinules row on anterior surface as illustrated; P2–P4 exopod three-segmented and endopod two-segmented; P2–P4 with spinular row along outer margin of exopod and endopod.

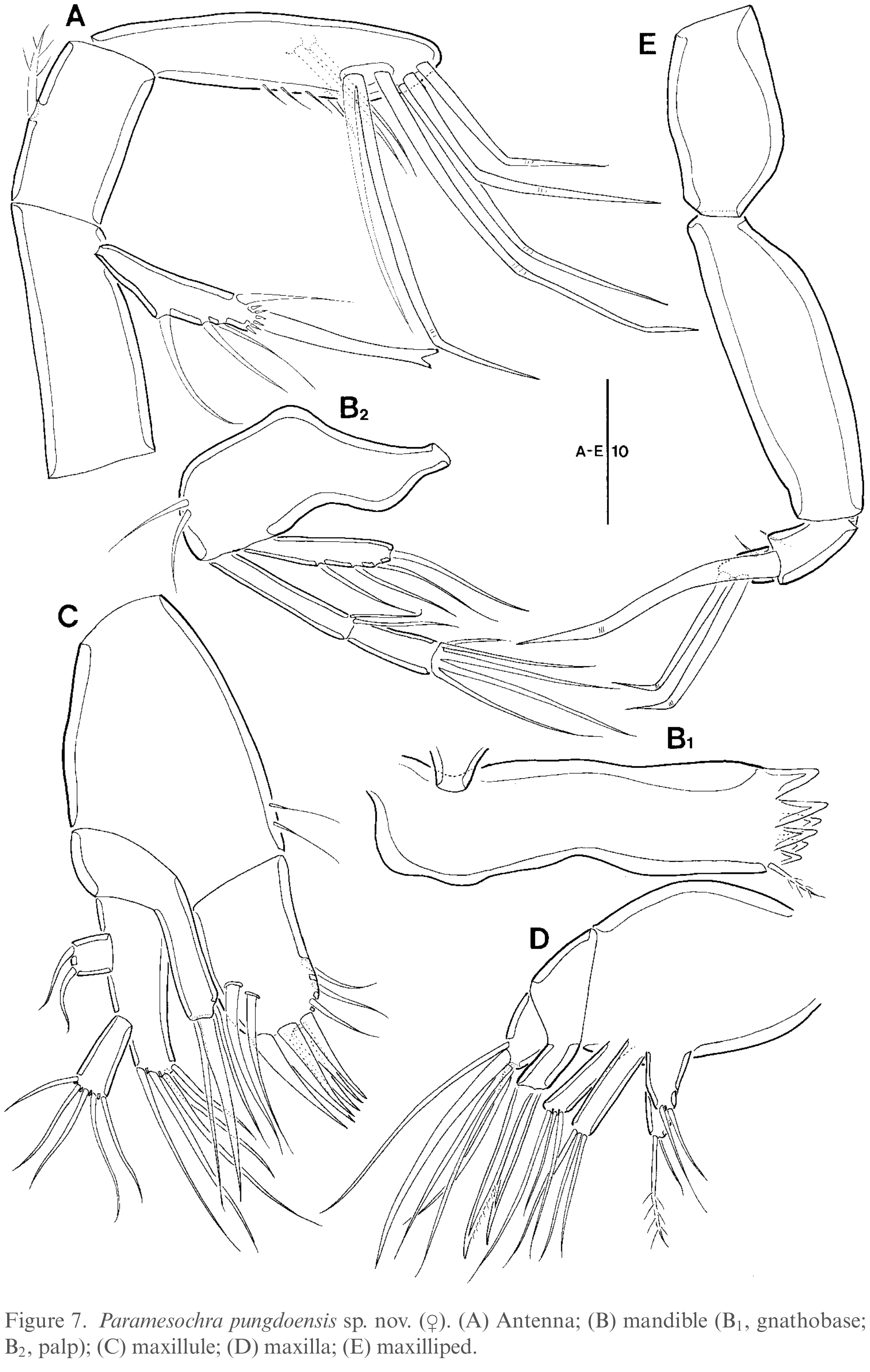

Figure 7. *Paramesochra pungdoensis* sp. nov. (♀). (A) Antenna; (B) mandible (B_1, gnathobase; B_2, palp); (C) maxillule; (D) maxilla; (E) maxilliped.

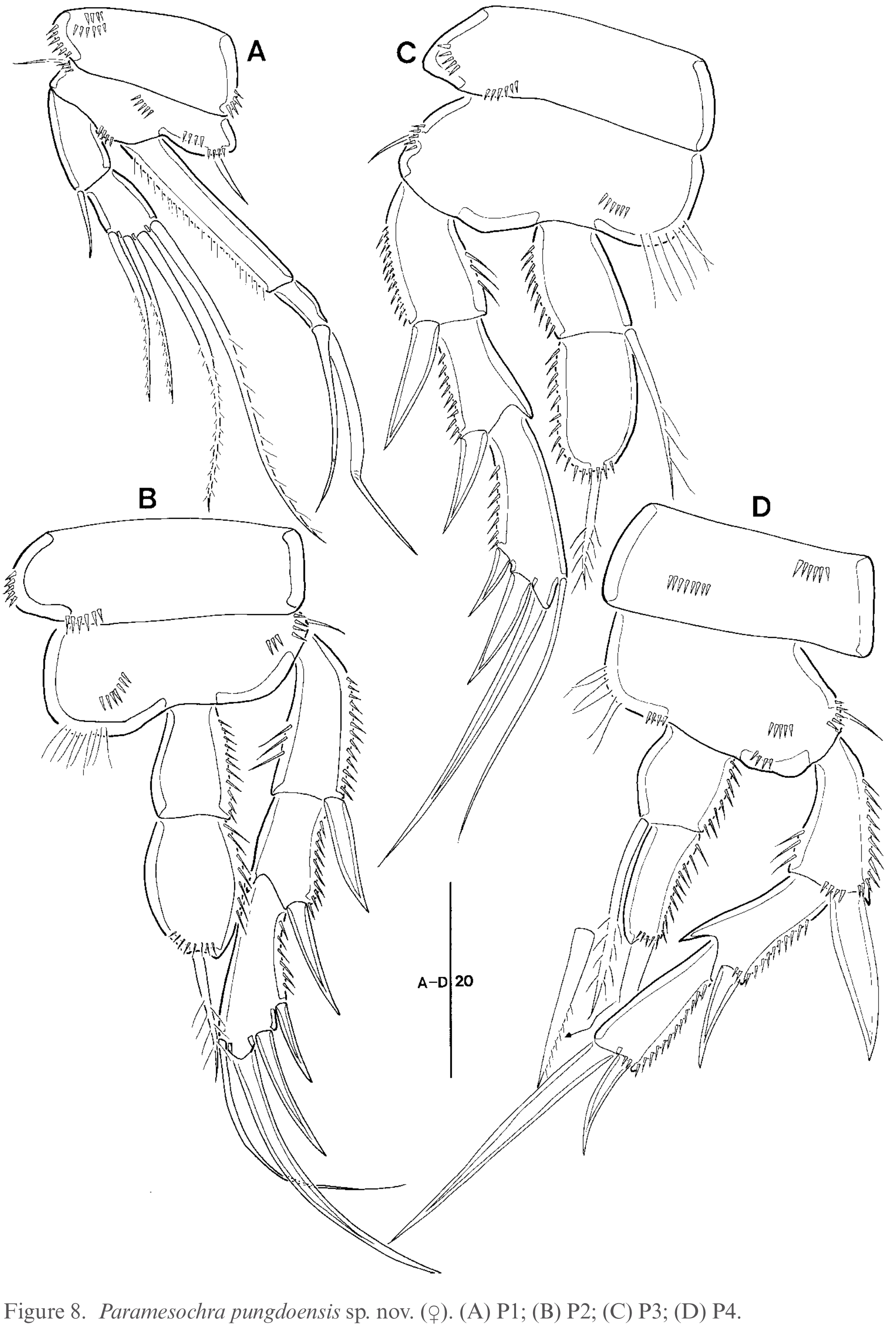

Figure 8. *Paramesochra pungdoensis* sp. nov. (♀). (A) P1; (B) P2; (C) P3; (D) P4.

Table 2. Armature formula of P1 to P4 in *Paramesochra pungdoensis* sp. nov.

	Exopod	Endopod
P1	0.121	0.011
P2	0.0.112	0.010
P3	0.0.112	1.010
P4	0.0.011	1.010

P1 (Figure 8A). Basis with one inner and one outer bare setae; exopod two-segmented and much shorter than endopod; exp-1 longer than exp-2, with one outer bare seta; exp-2 with four pinnate setae. Endopod two-segmented; enp-1 elongate, approximately six times as long as wide, with spinular row along outer margin; enp-2 small and squarish, with one bare seta and one geniculate seta on distal margin.

P2–P3 (Figure 8B,C). Basis with one outer small bare seta; exopod longer than endopod; exp-1 with one outer spine; exp-2 with one outer spine and inner corner forming spinous projection; exp-3 with two outer spines, one stout seta apically, and one thin bare seta at distal inner corner; enp-1 without seta (P2) or with one inner seta (P3); enp-2 with one apical, pinnate and small seta, and with row of spinules distally.

P4 (Figure 8D). Basis with one outer small bare seta; exp-1 with one strong outer spine; exp-2 with one outer spine, inner corner forming spinous projection; exp-3 with one outer spine and one stout bare seta apically; enp-1 with one pinnate inner seta; enp-2 with one stout unipinnate seta. Armature formula of P1 to P4 is shown in Table 2.

P5 (Figure 6C). Baseoendopods confluent, forming large plate, furnished with one basal bare seta each; endopodal lobe expanding beyond exopod, and bilobed along median distal margin, with one long outer pinnate and one shorter inner pinnate setae; exopod small, distinct, with one bare and two pinnate setae, with rows of spinules along inner and outer margin.

Etymology

The species is named after its type locality, off Pungdo Island, in the west coast Korea.

Remarks

This new species superficially resembles *P. similis* and *P. parasimilis* in the structure of shape of caudal rami and armature formula of P1–P5. However *P. pungdoensis* is clearly distinguishable from its congeners by the combination of the following characters: (1) antennary exopod with five setae; (2) it possesses the longest caudal seta IV among the congeners, the caudal setae IV of *P. similis* and *P. parasimilis* are shorter than their supporting ramus, and, the caudal seta IV of *P. pungdoensis* is approximately 1.8 times as long as the length of caudal ramus; (3) both sides of P6 fused forming a thin plate, and represented by one long outer pinnate seta and two small inner naked setae at each side (Figure 6A), *P. similis* and *P. parasimilis* have only one long outer seta on the female P6; and (4) the inner seta of P5 baseoendopod is shorter than the outer one in *P. pungdoensis*, whereas it is sub-equal in length in the two other congeners (Figures 2B, 13D).

Paramesochra mirabilis sp. nov.
(Figures 9–12)

Type locality

Off Pungdo Island, subtidale zone, west coast of Korea, Yellow sea (37°5′21″ N, 126°27′10″ E), depth 10–15 m, sand, salinity 32 psu.

Material examined

Holotype 1 ♀ dissected on five slides (NIBRIV0000261349). Paratypes. 1 ♂ dissected on five slides (NIBRIV0000261350). 1 ♀ on one slide (CR00173704). 1 ♂ on one slide (CR00173705). 6 ♀♀ (CR00173702) and 5 ♂♂ (CR00173703) in 70% ethanol in vials, 26 February 2008, Leg. J. Back.

Description of female

Body (Figure 9A,B). Cylindrical and depressed dorsoventrally; body length 370 μm (n = 8, mean = 345; measured from tip of rostrum of cephalic shield to posterior margin of caudal rami); largest width measured at posterior margin of cephalic shield (65 μm); gradually tapering posteriorly.

Rostrum (Figure 9A). Diminutive, bare, triangular, and fused with cephalic shield.

Prosome (Figure 9A,B). Four-segmented, comprising cephalothorax (bearing first pedigerous somite) and three free pedigerous somites; cephalothorax bell-shaped, with few sensilla as illustrated in Figure 9A,B; pleural areas weakly developed and posterolateral angles rounded.

Urosome (Figures 9A, 10E). Five-segmented, comprising P5-bearing somite, genital double-somite, and three free abdominal somites; genital somite and first abdominal somite completely fused forming genital double-somite; genital field with copulatory pore located in median depression; gonopores obscure; P6 (Figure 10E,F) represented by one plate, bilaterally armed with one longer, outer pinnate seta and two shorter, inner bare setae; anal operculum (Figure 9A,D) not present; however, pseudoperculum well developed and rounded without ornamentation.

Caudal rami (Figure 9D). Approximately 2.2 times as long as wide, each ramus with seven setae; seta I bare; seta II bare and close to seta I; seta III spine-like and pinnate, situated at outer distal corner; seta IV well developed and pinnate; seta V longest, distal half bent laterally and pinnate; seta VI small and bare situated at inner distal corner; seta VII triarticulated at base located on dorsal surface forming chitinous out growth.

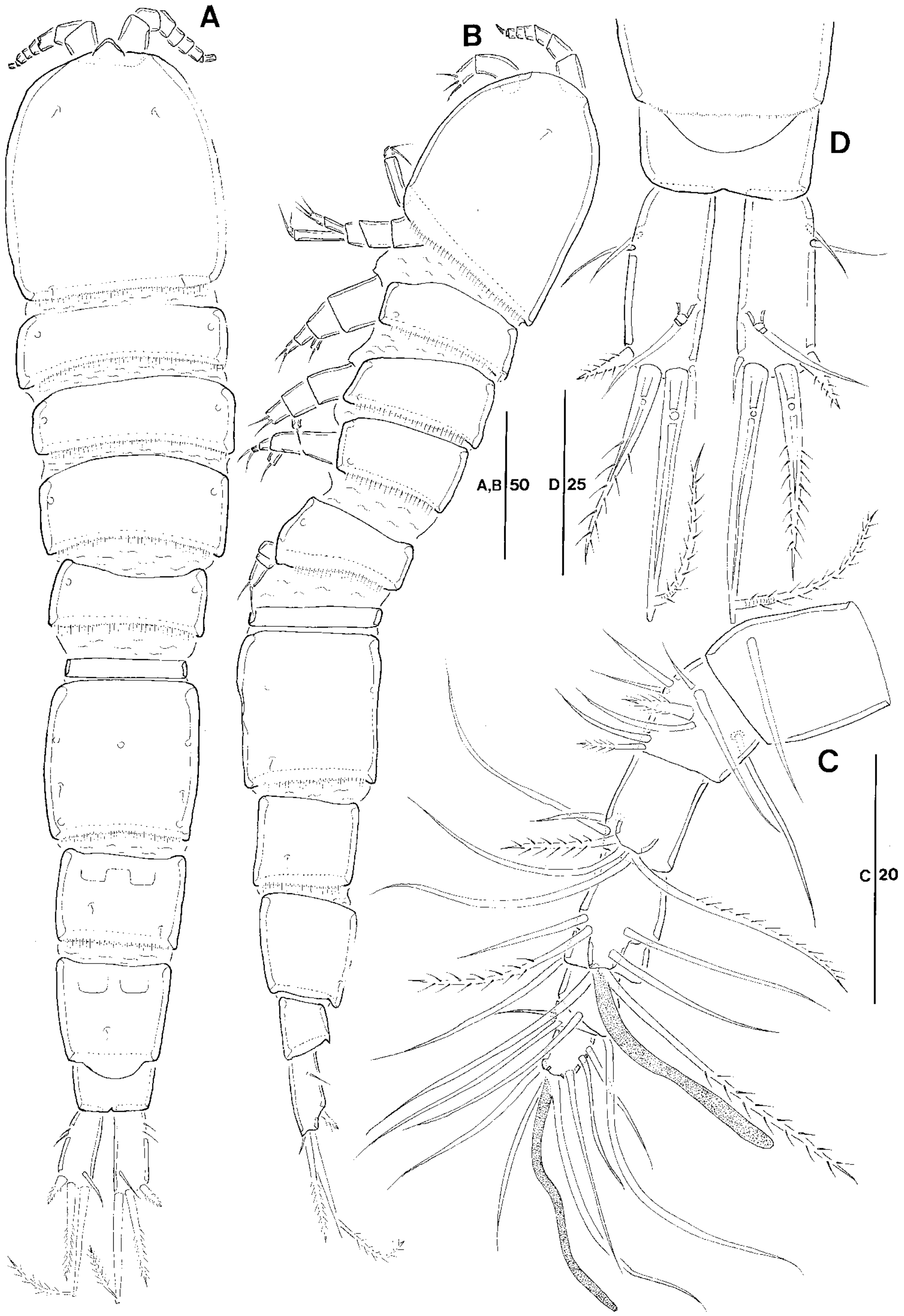

Figure 9. *Paramesochra mirabilis* sp. nov. (♀). (A) Habitus, dorsal; (B) habitus, lateral; (C) antennule; (D) caudal rami, dorsal.

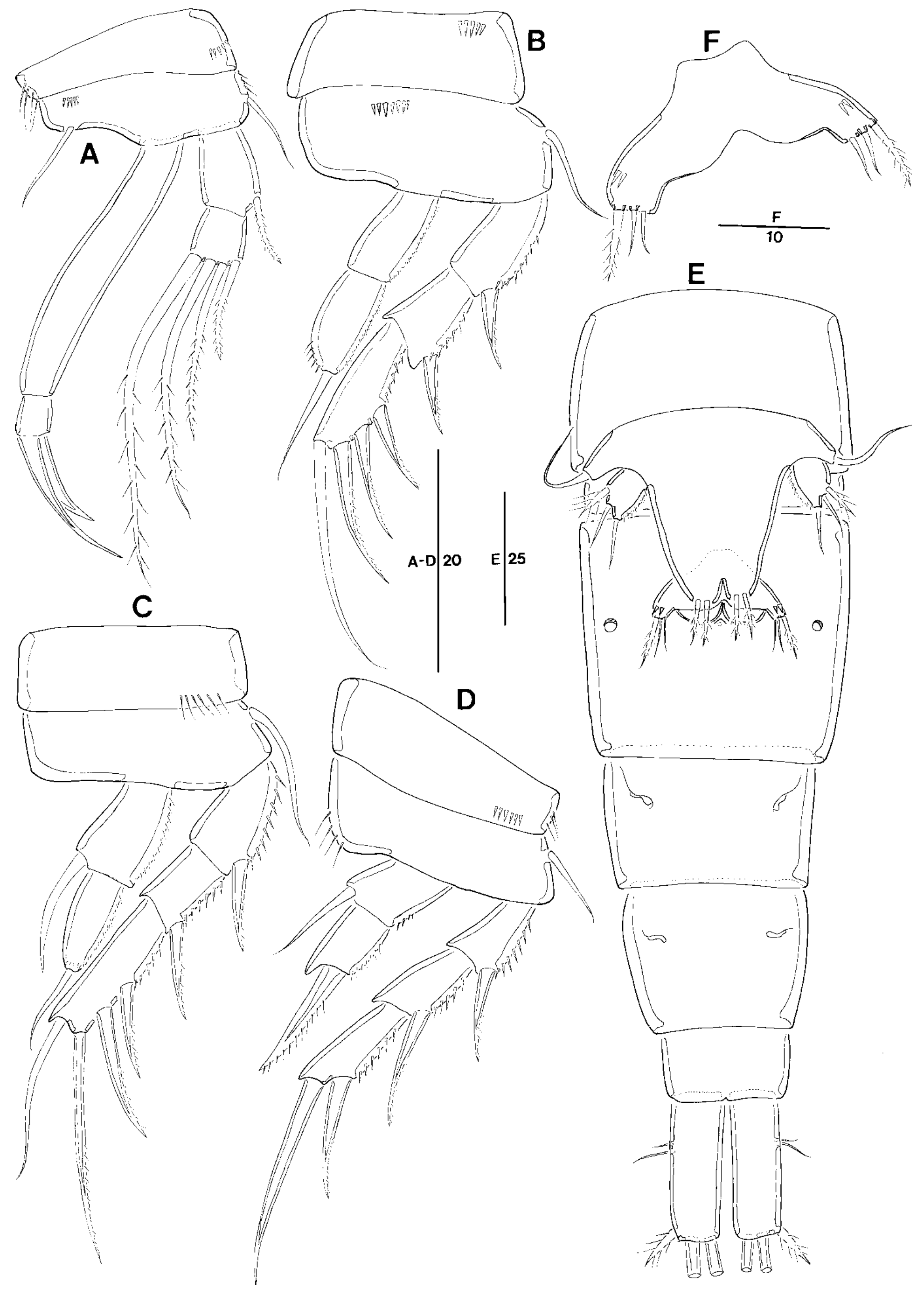

Figure 10. *Paramesochra mirabilis* sp. nov. (♀). (A) P1; (B) P2; (C) P3; (D) P4; (E) urosome, ventral; (F) P6.

Antennule (Figure 9C). Eight-segmented, short, and robust; segment 1 largest armed with one bare seta; segment 3 and segment 4 with sub-cylindrical pedestal; armature formula: 1–[1 bare], 2–[7 bare + 2 pinnate], 3–[4 bare + 2 pinnate], 4–[4 bare + 1 pinnate + (1+ae)], 5–[1 bare], 6–[2 bare], 7–[2 bare], 8–[4 bare + acrothek], apical acrothek consisting of small aesthetasc fused basally to two bare setae.

Antenna (Figure 11A). Coxa bare; basis approximately twice as long as wide. Exopod one-segmented with three lateral bare setae, one strong apical seta, and one bare seta on distal corner. Endopod 2-segmented; enp-1 with one bare abexopodal seta; enp-2 with four bare setae, three geniculate setae apically, and one long geniculate seta fused basally to one bare seta, and with row of spinules sub-apically.

Mandible (Figure 11B_1,B_2). Gnathobase (Figure 11B_1) well developed, bearing several cuspidate teeth distally and one bare seta; mandibular palp (Figure 11B_2) biramous and well developed; basis widening distally, with one small bare seta; exopod one-segmented with three lateral bare setae and one apical bare seta; endopod two-segmented; enp-1 with two bare distal setae; enp-2 with five basally fused setae at apex.

Maxillule (Figure 11C). With trapezoidal praecoxa; arthrite well developed, with two bare setae laterally, six apical spines, and two juxtaposed bare setae on anterior surface; coxa with cylindrical endite bearing four bare setae; basis cylindrical, with six bare setae; exopod one-segmented, small, squarish with two naked setae; endopod one-segmented with six bare setae near distal margin.

Maxilla (Figure 11D). Syncoxa with chitinous outer rim, and with three cylindrical endites; first endite bilobed, with two bare setae on each lobe; second and third endites with three bare setae distally; allobasis with two claw-like setae; endopod one-segmented, indistinctly subdivided, squarish and with five bare setae.

Maxilliped (Figure 11E). Four-segmented; syncoxa bare; basis elongate approximately three times as long as wide, without ornamentation; endopod two-segmented; enp-1 with one geniculate seta on distal margin and one small bare seta laterally; enp-2 with two geniculate setae distally and one small bare seta on lateral margin.

P1–P4 (Figure 10A–D). Well-developed coxae and bases with spinules rows as illustrated; P2–P4 basis with one outer bare seta; P2–P4 exopod three-segmented and endopod two-segmented; P2–P4 with row of spinules along outer margin of exopod and endopod.

P1 (Figure 10A). Basis with one outer and one inner bare seta; exopod two-segmented; exp-1 longer than exp-2; exp-1 with one pinnate outer seta; exp-2 with four pinnate setae; endopod two-segmented; enp-1 bare and elongate approximately twice as long as exopod; enp-2 small, squarish, and with two stout distal setae.

P2–P3 (Figure 10B,C). Exopod longer than endopod; exp-1 with outer spine; exp-2 with one outer spine, and inner corner forming small spinous projection; exp-3 with two outer spines, one apical strong seta and one bare distal seta at inner corner; enp-1 without seta (P2) or with one inner bare seta (P3); enp-2 with one apical cylindrical bare seta.

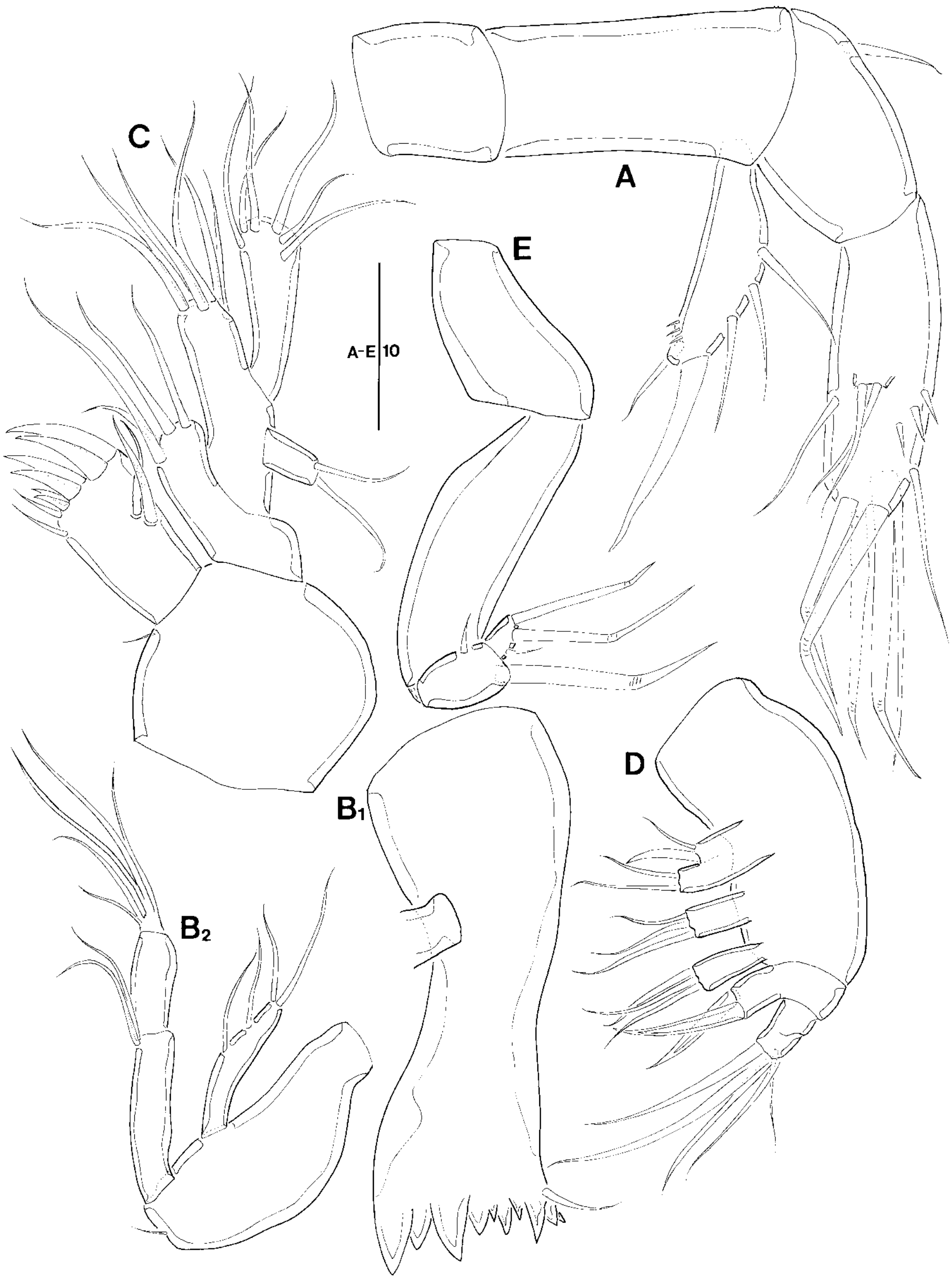

Figure 11. *Paramesochra mirabilis* sp. nov. (♀). (A) Antenna; (B) mandible (B_1, gnathobase; B_2, palp); (C) maxillule; (D) maxilla; (E) maxilliped.

P4 (Figure 10D). Exp-1 with one outer spine; exp-2 with one outer spine and inner corner forming small spinous projection; exp-3 with one outer spine and one stout bare seta apically. Enp-1 with one inner bare seta; enp-2 with one modified unipinnate seta. Armature formula of P1 to P4 is shown in Table 3.

Table 3. Armature formula of P1 to P4 in *Paramesochra mirabilis* sp. nov.

	Exopod	endopod
P1	0.121	0.011
P2	0.0.112	0.010
P3	0.0.112	1.010
P4	0.0.011	1.010

P5 (Figure 10E). Baseoendopods confluent, forming large plate, and with one basal bare seta each; endopodal lobe reaching genital field, bilobed at median distal margin, and with two small pinnate setae; exopod small, clearly distinct, with one pinnate and two bare setae, and with row of spinules along outer distal margin.

Description of male

Body (Figure 12A). Slightly smaller and more slender than female, body length 290 μm ($n = 7$, mean = 291; measured from tip of rostrum of cephalic shield to posterior margin of caudal rami), largest width measured at posterior margin of cephalic shield: 55 μm; general body shape and ornamentation as in female except for double-genital somite; additional sexual dimorphism in A1, P5, and P6.

Antennule (Figure 12B_1–B_3). Seven-segmented, subchirocer; segment 2 formed from fusion of two ancestral segments indicated by incomplete surface hinge, with triangular process along distal posterior margin. Segment 5 swollen, largest. Aesthetascs on fifth and seventh segments. Armature formula: 1–[1 bare], 2–[11 bare + 3 pinnate], 3–[6 bare + 1 pinnate], 4–[2 bare], 5–[10 bare + 1 pinnate + 1 modified stout + (1 + ae)], 6–[3 bare], 7–[7 bare + acrothek], apical acrothek consisting of small aesthetasc fused basally to two bare setae.

P5 (Figure 12C). Baseoendopod confluent, each side with one slender pinnate basal seta; endopodal lobe bilobed and bare; exopod subcircular and discrete, ornamented with row of long spinules along inner margin, armed with two outer pinnate setae laterally, two apical naked setae; innermost one longest; one large pore in median surface.

P6 (Figure 12C). Pair of P6 asymmetrical, not confluent; each P6 with one naked outer and two pinnate setae.

Etymology

The specific name, "*mirabilis*" refers to characteristic shape, laterally bent distal half of caudal seta V in the female.

Remarks

This new species is most closely related to *P. mielkei* in the armature formula of P1–P5, shape of P5 baseoendopod, and presence of seven setae in the caudal ramus. However,

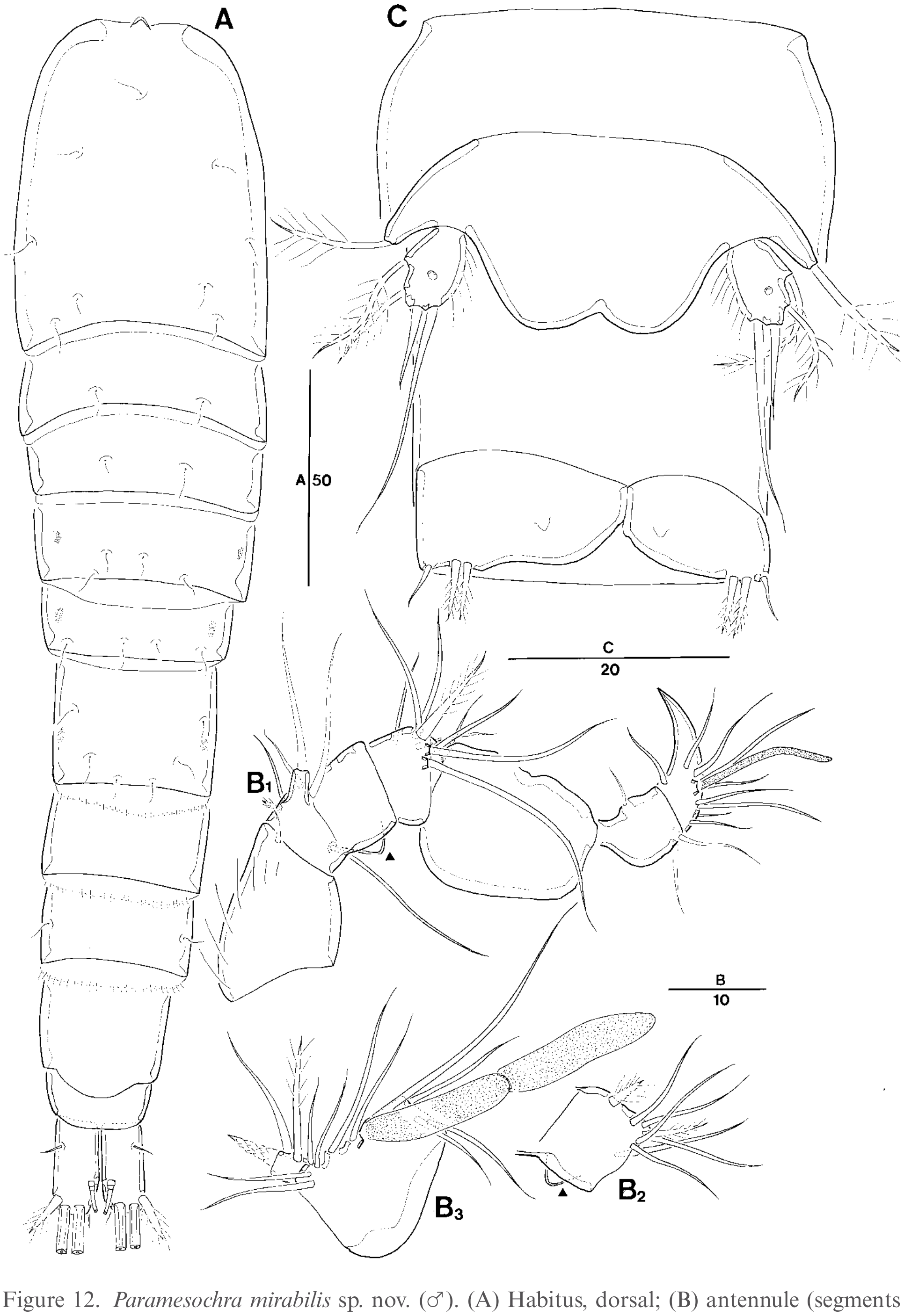

Figure 12. *Paramesochra mirabilis* sp. nov. (♂). (A) Habitus, dorsal; (B) antennule (segments 2 and 5 shown as separate inserts B_2 and B_3); (C) P5 and P6.

the new species is clearly distinguished from *P. mielkei* by the combination of the following characters: (1) the modified, laterally bent caudal seta V as illustrated in Figure 9D, *P. mirabilis* sp. nov. is the only species in the genus female having modified caudal seta V (*Wellsopsyllus* (*Intermedopsyllus*) *intermedius* (Scott and Scott, 1895) and *Emertonia miguelensis* (Kunz, 1983) share the modified seta V with the new species); (2) P5 baseoendopodal lobe with two setae of almost the same length (Figure 10E), the outer seta is longer than inner one in *P. mielkei*; (3) smooth median margin of confluent P6 plate in the female (Figure 10E,F), whereas it is crenated in *P. mielkei* (see fig. 5A in Huys 1987); (4) the bilobed median margin of male P5 baseoendopod (Figure 12C), *P. mielkei* has plain median distal margin, and show no distinct median depression between both plates of baseoendopod of male P5; and (5) asymmetrical and quadrilateral shape of P6 in the male (Figure 12C), trianglar shape of P6 in *P. mielkei*.

Paramesochra similis Kunz, 1936
(Figures 13, 14)

Material examined

One ♀ (a loan from the Natural History Museum London) dissected on three slides and sealed with transparent nail varnish, from type locality, collected by Kunz on 22 May 1985.

Description of female

Body (Figure 13A,B). Cylindrical and depressed dorsoventrally; body length 400 μm ($n = 1$, measured from tip of rostrum of cephalic shield to posterior margin of caudal rami); largest width measured at posterior margin of cephalic shield (75 μm); gradually tapering posteriorly; body somites connected by arthrodial membranes, several sensilla on dorsal surface.

Rostrum. Diminutive, bare, and fused to cephalosome (Figure 13A).

Prosome (Figure 13A,B). Four-segmented, comprising cephalothorax (bearing first pedigerous somite) and three free pedigerous somites; cephalothorax bell-shaped, with few sensilla, and one pair of pores; pleural areas weakly developed and posterolateral angles rounded; posterior margin smooth; three prosomites with one pair of pores located each lateral side.

Urosome (Figures 13A,B, 14A). Five-segmented, comprising P5-bearing somite, genital double-somite, and three free abdominal somites; genital somite and first abdominal somite completely fused forming genital double-somite with one large median pore dorsally; gonopores covered on both sides by P6; P6 represented by plate, with one pinnate seta each; middle of plate flattened. Anal operculum not present, pseudoperculum well developed, round and bare.

Caudal rami (Figure 13C). Oblong and approximately 3.8 times as long as wide; each ramus armed with six setae and one dorsal pore; seta I obscure; seta II bare at proximal

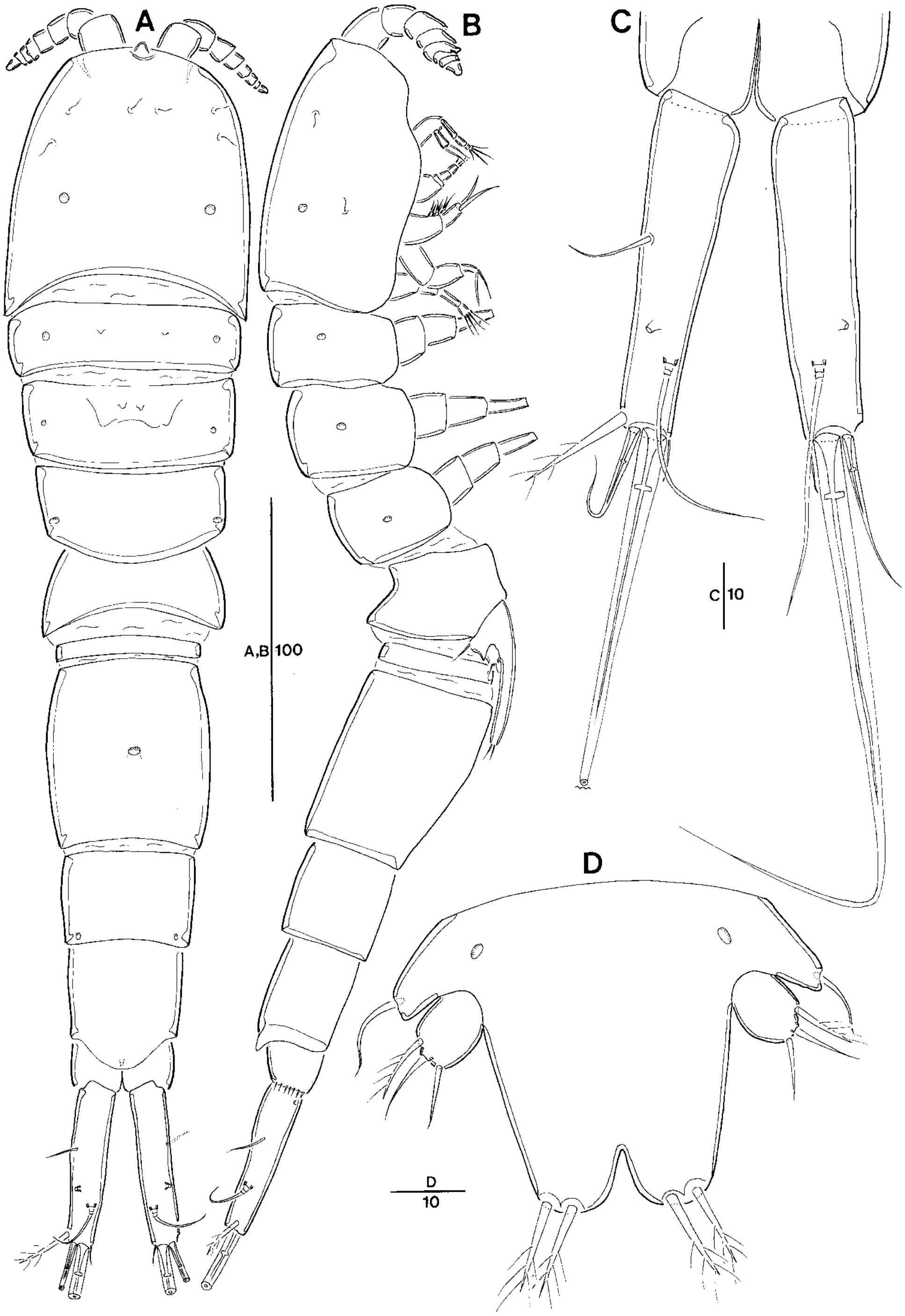

Figure 13. *Paramesochra similis* Kunz, (♀). (A) Habitus, dorsal; (B) habitus, lateral; (C) caudal rami, dorsal; (D) P5.

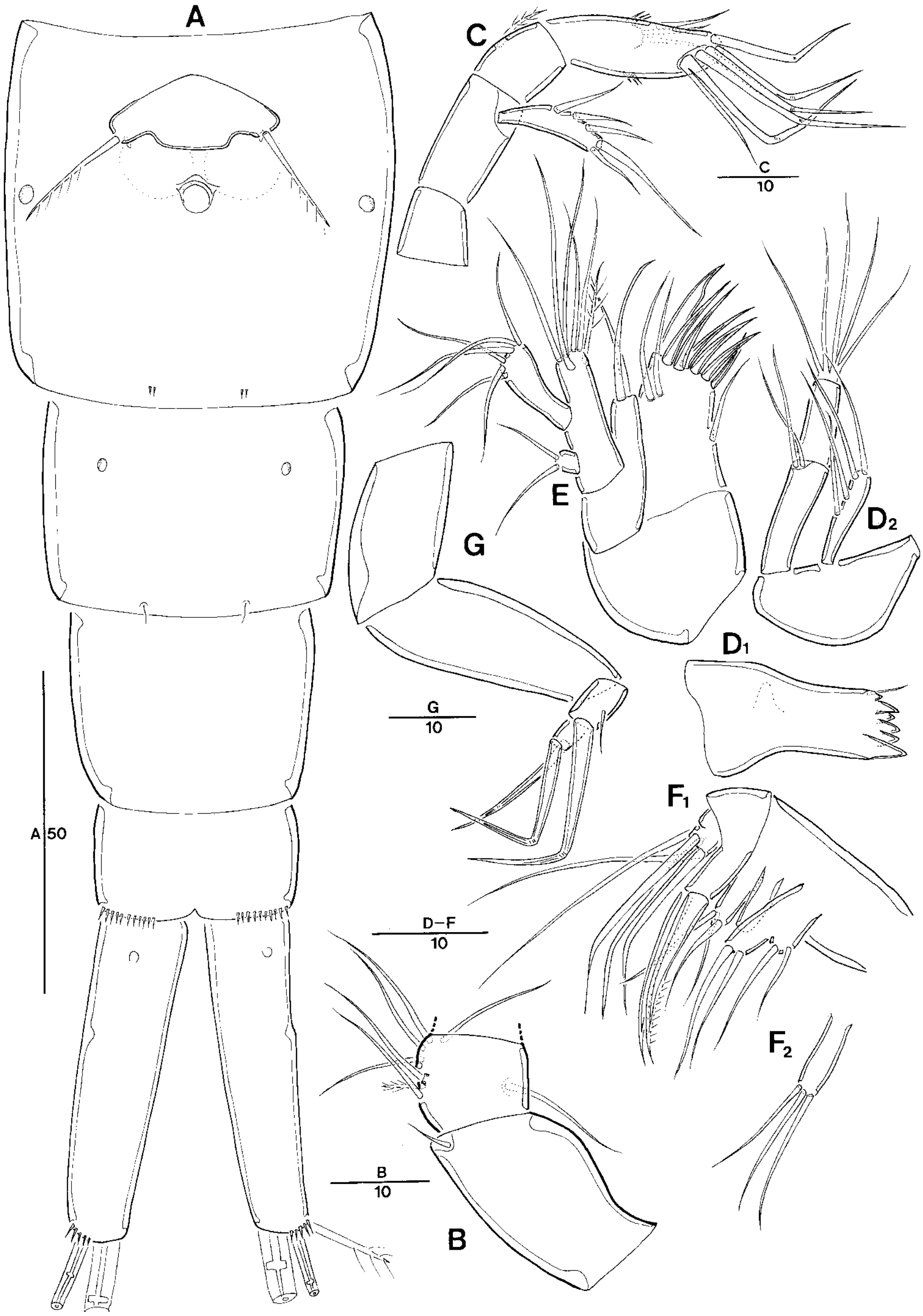

Figure 14. *Paramesochra similis* Kunz, (♀). (A) Urosome, ventral; (B) segment-1 and –2 of antennule; (C) antenna; (D) mandible (D_1, gnathobase; D_2, palp); (E) maxillule; (F) maxilla (F_1, maxilla except for second endite; F_2, second endite); (G) maxilliped.

half; seta III pinnate on outer lateral corner; seta IV bare; seta V longest and bare; seta VI smallest and bare; seta VII triarticulated at base on dorsal surface.

Antennule. Damaged during observation (Figure 14B), however clearly eight-segmented, short; segment 1 with one small bare seta; segment 2 with seven bare and one pinnate; other segments damaged.

Antenna (Figure 14C). Four-segmented, comprising coxa, basis, and free two-segmented endopod. Exopod one-segmented with five bare setae. Endopod two-segmented; enp-1 with one abexopodal pinnate seta; enp-2 armed with three bare setae, four geniculate setae, and one geniculate seta fused basally to one bare seta.

Mandible (Figure 14D_1,D_2). Gnathobase well developed, bearing several teeth overlapping each other around distal margin and one bare seta at distal corner; mandibular palp biramous: basis widening distally. Exopod one-segmented, with two lateral and two distal bare setae. Endopod two-segmented, enp-1 longest as long as exopod, with two bare setae at distal margin, enp-2 with five basally fused setae.

Maxillule (Figure 14E). Praecoxa trapezoidal; arthrite well developed with one bare seta on lateral margin, seven curved distal spines, and two juxtaposed bare setae on anterior surface; coxa with cylindrical process bearing two bare setae; basis bearing cylindrical process with one pinnate and five bare setae; exopod one-segmented, square, and with two pinnate setae; endopod one-segmented, elongate, rectangular and with six distal bare setae.

Maxilla (Figure 14F_1,F_2). Syncoxa with chitinous outer margin, and three cylindrical endites; proximal endite bilobed, with two bare setae on each lobe; second and third endites close to each other, with three bare setae, respectively; allobasis with two stout setae; endopod one-segmented, indistinctly subdivided, square, and with five bare setae.

Maxilliped (Figure 14G). Four-segmented; syncoxa bare; basis elongate approximately 2.3 times as long as width without ornamentation; endopod two-segmented; enp-1 with one small bare seta laterally and one geniculate seta distally; enp-2 small with two geniculate distal setae.

Remarks

There are several discrepancies between Kunz's original description (Kunz 1936) and the observations presented in the present study: (1) A2 exopod armed with five setae; (2) endopod of maxilliped two-segmented; (3) P6 armed with one unipinnate seta; and (4) segment-1 of A1 with one small bare seta (Figure 14B). All these characters were confirmed from observation of the specimens collected by Kunz from the type locality.

Discussion

The family Paramesochridae currently contains 13 valid genera (Wells 2007; Huys 2009): *Paramesochra* T. Scott, 1892; *Leptopsyllus* T. Scott, 1894; *Remanea* Klie, 1929; *Emertonia* Wilson, 1932; *Diarthrodella* Klie, 1949; *Tisbisoma* Božić, 1964; *Kunzia*

Wells, 1967; *Caligopsyllus* Kunz, 1975; *Rossopsyllus* Soyer, 1975; *Wellsopsyllus* Kunz, 1981; *Meiopsyllus* Cottarelli and Forniz, 1994; *Biuncus* Huys, 1996; and *Apodopsyllus* Huys, 2009). Both Kunz (1981) and Huys (1987) analysed the relationships between the genera proposed at that time. Kunz (1981) recognized a *Paramesochra*-group encompassing the type genus, *Kliopsyllus* (= *Emertonia*), *Kunzia* and *Caligopsyllus*. Huys (1987) largely retained this taxonomic concept but excluded *Caligopsyllus*, which he believed was more closely related to *Apodopsyllus* (Huys 1988). One of the problems highlighted in Huys' (1987) phylogenetic tree is the striking absence of autapomorphies for the two most speciose genera, *Paramesochra* and *Emertonia* (as *Kliopsyllus*), suggesting that both genera are paraphyletic and not "true evolutionary units" as claimed by Wells et al. (1975). In particular, there is accumulating evidence that at least some lineages of the genus *Emertonia* are nested within *Paramesochra*. The primary difference between both genera is expressed in the endopodal segmentation of P2–P4 which is one-segmented in the former and two-segmented in the latter. However, this discrepancy is not clear-cut because some *Emertonia* species have an incision [*E. atlantica* (Kunz, 1983)], a surface suture [*E. acutifurcata* (Mielke, 1985)], or internal chitinous rib [*E. chilensis* (Mielke, 1985)] near the outer margin of the one-segmented endopods, marking the original segmentation (or the failure of both segments to separate completely). Lee and Huys (2002) remarked that endopodal segmentation patterns can be potentially misleading when defining generic boundaries in derived harpacticoid lineages such as groundwater Ameiridae because overweighing such characters at the expense of others may result in assigning species to the wrong genus. For example, it is highly conceivable that *E. furcavaricatus* (Kunz, 1974) (P2–P4 endopods one-segmented) and *P. pterocaudata* Kunz, 1936 (P2–P4 endopods two-segmented) are more closely related to each other than to any of their respective congeners because both share paired posteriorly directed, spinous projections on the anal somite and a similar mechanism for movement of the caudal rami (Wells et al. 1975). This view has recently gathered further credence by the discovery in the deep sea of another species with anal projections, displaying an intermediate endopodal segmentation pattern. *Emertonia andeep* (Veit-Köhler, 2004) is similar to *E. furcavaricatus* in the one-segmented endopods of P2–P3 and resembles *P. pterocaudata* in the two-segmented P4 endopod and the presence of an inner seta on the endopods of P3–P4. We concur with Veit-Köhler (2004, 2005) that a proper phylogenetic analysis at species level of the *Paramesochra*-group is long overdue and will undoubtedly alter the taxonomic concepts of and relationships between the genera included in it. In addition, Vasconcelos et al. (2009) found the new species, *E. minor*, to have an intermediate endopodal segmentation pattern of P4 without anal projections in the deep sea. However, not all of these characters are apomorphic states and at least some of them have evolved convergently in other genera and consequently are not autapomorphic for *Paramesochra*.

The subfamily Paramesochrinae consists of the *Wellsopsyllus*-group, the *Paramesochra*-group, and the genus *Remanea* as suggested by Huys (1987). Furthermore in the genus *Paramesochra*, he recognized four lineages: the *brevifurca*-, the *dubia*-, the *helgolandica*- and the *acutata*-groups.

The three new species are placed in the genus *Paramesochra* on account of the two-segmented P2–P4, only one seta on the enp-2 of P2–P4, diminutive rostrum, one-segmented A2-exopod, and pattern of sexual dimorphism in A1, P5, P6 and genital segmentation. These species belongs to the *dubia*-group by the presence of the inner seta on the endopod of P3 and P4. At present seven species are comprised in this species-group: *P. dubia* T. Scott, 1892; *P. similis* Kunz, 1936; *P. pterocaudata* Kunz, 1936; *P. borealis* Geddes, 1981; *P. helgolandica* Kunz, 1936; *P. kunzi* Mielke, 1985; *P. mielkei* Huys, 1987 (Table 4). Though Huys' (1987) mentioned that the two-segmented mandibular endopod is considered as an autapomorphy for the *brevifurca*-group (Huys, 1987), the distal setae with fused bases in the mandibular endopod-2 are often misinterpreted as a third endopodal segment in other groups. For example, *P. marisalbi* Kornev and Chertoprud, 2008 is another species to be included within the *dubia*-group, having a two-segmented mandibular endopod. In addition, we updated the two-segmented mandibular endopod in *P. similis*. Furthermore, *E. andeep* being regarded as an intermediate species also has a two-segmented mandibular endopod armed with four setae fused together at the base of the second segment.

There is some discrepancy in the diagnostic characters between *P. parasimilis* sp. nov. and other congeners. The maxillary endopod is single-segmented in the amended generic diagnosis by Huys (1987). However the maxillary endopod of *P. parasimilis* is two-segmented and this character is also shown in four other species in *Paramesochra*, *P. brevifurca*, *P. dubia*, *P. longicaudata* and *P. marisalbi*. Kornev and Chertoprud (2008) described the two-segmented maxilla endopod as low noticeable separation. In addition, *P. similis* and *P. mirabilis* have intermediate maxilla endopodal shape subdividing the segment indistinctly. In other cases, some genera of the family Paramesochridiae include many types of maxillary endopods, for example, the genus *Wellsopsyllus* contains *W*. (*Intermedopsyllus*) *antoniae* (Plum and George, 2009) with a vestigial maxillary endopod with four setae and *W*. (*Scottopsyllus*) *praecipuus* (Veit-Köhler, 2000) with a two-segmented maxillary endopod. Presumably the presence of various segments of maxillular endopod in the same genus implies that this variation of segment numbers on the maxillary endopod evolved several times independently in each genus. As a result, the diagnosis of the genus *Paramesochra* needs to be amended for the segments of the maxilla endopod, which is one- or two-segmented.

So far the members of *Paramesochra* have been reported mainly from European coasts including Helgoland, Southern Bight and Schilksee in Germany, Firth of Forth in Scotland, Francelos in Portugal, Grindöy in Norway, and Gulf of Kandalaksha in Russia, and also from Cooum River and Palm beach in India, from Central America including Galapagos in Ecuador and gulf of Panama, and from Cottesloe beach in Australia, Hawaii, USA, and Korea in the North Western Pacific area (Table 4). This is the second report for the genus *Paramesochra* in the North Western Pacific area.

Key to the species of the genus *Paramesochra* T. Scott, 1892

With the description of the three new species, the number of valid species and subspecies of the genus *Paramesochra* has risen to 21. The latest updated key by Back and Lee (2010) used significantly unacceptable and fallible characters like number of antennule segments. On the other hand, the dichotomous key by Huys (1987) also contains errors in the couplets leading to *P. denticulata* Rao and Ganapati, 1969 (P4 exp-3 has four setae/spines, not two), *P. acutata acutata* Klie, 1934 and *P. acutata hawaiiensis* Kunz, 1981 (antennary exopod with four and two setae, respectively, not three), and *P. kunzi* Mielke, 1984 (antennary exopod with five setae, not three). The subspecies *P. brevifurca mediterranea* Huys, 1987 was omitted by Wells (2007) but

Table 4. Distinguishing morphological features of the species of *Paramesochra* T. Scott, 1892.

Species	A1♀ segments	P3 enp-1 inner seta	P4 enp-1 inner seta	P5♀ setal no. exp	P5♀ setal no. benp	P5♀ benp type	P5♂ setal no. exp	P5♂ setal no. benp	CR L:W	CR shape	Type locality
dubia-group											
dubia T. Scott, 1892[1]	7	+	+	3	2	A	3	0	6.0	cylindrical	Firth of Forth (Scotland)
similis Kunz, 1936	7	+	+	3	2	A	4	0	4.0	cylindrical	Helgoland (Germany)
pterocaudata Kunz, 1936	8	+	+	3	2	A	?	?	7.0	cylindrical	Helgoland (Germany)
helgolandica sensu Mielke (1975)	7(or 8?)	+	+	3	2	A	?	?	3.7	cylindrical	Isle of Sylt (Germany)
borealis Geddes, 1981	7	+	+	3	2	A	4	2	1.75	cylindrical	Grindöy (Norway)
kunzi Mielke, 1984b	8	+	+	3	2	A	3	0	3.5	cylindrical	Isla Naos (Panama)
mielkei Huys, 1987	8	+	+	3	2	A	4	0	2.2–2.5	cylindrical	Southern Bight of North Sea (SW Dutch coast)
marisalbi Kornev & Chertoprud, 2008	8	+	+	3	2	A	4	0	2.5	cylindrical	Gulf of Kandalaksha (Russia)
***parasimilis* sp. nov.**	8	+	+	3	2	A	?	?	4.0	cylindrical	Yellow Sea (Korea)
***bisegmenta* sp. nov.**	8	+	+	3	2	A	?	?	4.5	cylindrical	Yellow Sea (Korea)
***mirabilis* sp. nov.**	8	+	+	3	2	A	4	0	2.2	cylindrical	Yellow Sea (Korea)
brevifurca-group											
brevifurca brevifurca Galhano, 1970	8	–	–	3	2	B	?	?	1.5	cylindrical	Francelos (Portugal)
brevifurca mediterranea Huys, 1987	?	–	–	3	2	B	?	?	1.1	cylindrical	Sardinia (Italy)
helgolandica-group											
helgolandica helgolandica Kunz, 1936	7	–	+	3	2	A	3	0	3.0	cylindrical	Helgoland (Germany)
helgolandica galapagoensis Mielke, 1984a	8 (or 9?)	–	+	3	2	A	3	0	3.0	cylindrical	Galápagos (Ecuador)

(*Continued*)

Table 4. (Continued).

Species	A1♀ segments	P3 enp-1 inner seta	P4 enp-1 inner seta	P5♀ setal no. exp	P5♀ setal no. benp	P5♀ benp type	P5♂ setal no. exp	P5♂ setal no. benp	CR L:W	CR shape	Type locality
longicaudata Nicholls, 1945	7	–	+	4	2	A	2	0	3.0	cylindrical	Cottesloe Beach (Australia)
acutata-group											
acutata Klie, 1934	7	–	–	3	1	C	3	0	3.0	conical	Schilksee (Germany)
ornata Krishnaswamy, 1957	8	–	–	3	0	D	3	0	2.0	cylindrical	Cooum River (India)
denticulata Rao and Ganapati, 1969	7	–	–	3	0	D	3	0	2.0	cylindrical	Palm Beach (India)
hawaiiensis Kunz, 1981	7	–	–	3	1	C	4	0	2.7	conical	Barking Sand Beach (Hawaii)
unaspina Mielke 1984a	8	–	–	3	2	A	4	0	3.0	cylindrical	Galápagos (Ecuador)
taeana Back and Lee, 2010	8	–	–	3	1	C	3	0	2.7–3.0	conical	Yellow Sea (Korea)

[1]T. Scott's (1892) original description illustrated four setae on the P5 baseoendopod of both sexes but Sars (1911) and Kunz (1938) reported only three setae for the female and male, respectively, which is here accepted as the correct number.

benp type = shape of medially fused endopodal lobes of ♀ baseoendopods (A: endopodal lobes forming strongly developed median extension projecting well beyond distal margin of exopods and with weakly to moderately developed incision separating left and right endopodal lobes; B: endopodal lobes forming moderately developed bilobate extension not projecting beyond distal margin of exopods and with moderately developed median incision separating left and right endopodal lobes; C: lobes represented by strongly developed, narrow, triangular extensions projecting well beyond distal margin of exopods and separated by deep cleft originating at the insertion level of the exopods; D: endopodal lobes vestigial, forming single midventral plate not extending beyond distal margins of exopod, with or without small median incision); L = length; W = width. Species-groups after Huys (1987).

is (as well as *P. helgolandica* Kunz, 1936 *sensu* Mielke, 1975) included in the key below. Note that in the tabular keys of Wells (2007: 580) *P. acutata hawaiiensis* Kunz, 1981 erroneously keys out to codon KG2/1 because of an incorrect coding of the number of inner setae on P2–P4 enp-1. The subspecies has exactly the same coding for the characters listed under codon KG1 as its nominal subspecies *P. acutata acutata* Klie, 1934 except for the number of exopodal setae on the male P5.

Paramesochra mielkei Huys, 1987 and the recently described *P. marisalbi* Kornev and Chertoprud, 2008 are extremely similar and potentially conspecific. In fact, the differences between them are less significant than those between the geographically widely separated subspecies *P. helgolandica helgolandica* and *P. helgolandica galapagoensis*. The caudal ramus is marginally shorter in *P. mielkei* (Table 4) although some variability in the length : width ratio was reported by Huys (1987), and seta II inserts in the proximal half of the ramus rather than in the distal one as in *P. marisalbi*. The terminal spine on P4 exp-3 is nearly as long as the entire exopod in *P. mielkei* but only as long as exp-2 and exp-3 combined in *P. marisalbi*. The endopodal lobe of the male P5 baseoendopod is less well developed in *P. marisalbi*, not reaching beyond the distal margins of the exopods; the latter have two pinnate and two naked elements whereas in *P. mielkei* all four elements are pinnate. Both species are retained as separate entries in the key below pending the arrival of molecular sequence data.

Mielke (1994) described the monotypic genus *Psammoleptomesochra* (type species: *Psammoleptomesochra australis* Mielke, 1994) and placed it in the family Ameiridae. Bodin (1997) listed this species as "*Paramesochra australis*" in the Paramesochridae as well as under its correct original combination in the Ameiridae. Seifried (2003) remarked that there is no evidence for assigning *Psammoleptomesochra australis* to the Paramesochridae and that it should be maintained in the Ameiridae as long as its position is not resolved. Within the latter family, *Psammoleptomesochra* appears most closely related to the genus *Paraleptomesochra* Wells, 1967 (type species: *Paraleptomesochra minima* Wells, 1967). Both genera differ from the typical ameirid condition in the combination of the morphology of the rostrum, antennary exopod, mouthparts, P1 (position of inner seta on enp-1) and the presence of extensive hyaline frills on the body somites. This combination of characters strongly suggests that both *Psammoleptomesochra* and *Paraleptomesochra* are members of the family Parastenheliidae, and consequently they are here formally removed from Ameiridae and assigned to this family.

1. P1 exp-2 with five setae/spines; P4 exp-3 with four setae/spines .... 2.
   P1 exp-2 with four setae/spines; P4 exp-3 with two setae/spines .... 3.
2. Endopod of mandibular palp two-segmented; caudal rami 1.5 times as long as wide .... *brevifurca brevifurca* Galhano, 1970.
   Endopod of mandibular palp one-segmented; caudal rami 1.1 times as long as wide .... *brevifurca mediterranea* Huys, 1987.
3. P3–P4 enp-1 with inner seta .... 4.
   P3 enp-1 without inner seta, P4 enp-1 with inner seta .... 14.
   P3–P4 enp-1 without inner seta .... 16.

4. Cephalothorax with lateral, backwardly produced, spinous projections; first segment of antennule with spinous process at anteriodistal corner .... *dubia* T. Scott, 1892.
These characters not present .... 5.

5. Anal somite with paired posteriorly directed, spinous extensions .... *pterocaudata* Kunz, 1936.
Anal somite without such extensions .... 6.

6. Distal seta on P2–P3 enp-1 accompanied by a spinose lobe; baseoendopod with two setae in ♂; caudal ramus shorter than twice the width .... *borealis* Geddes, 1981.
Distal seta on P2–P3 enp-1 not accompanied by a spinose lobe; baseoendopod without setae in ♂ [unknown in *P. helgolandica sensu* Mielke (1975)]; caudal ramus at least twice as long as wide .... 7.

7. Caudal ramus seta IV shorter than ramus .... 8.
Caudal ramus seta IV longer than ramus. .... 9.

8. A2 exopod with four setae; P6 middle of plate protruded; caudal ramus seta III stout; pseudoperculum developed and trapezoid ...... *parasimilis* sp. nov.
A2 exopod with four or five setae; flatten P6 plate; caudal ramus seta III cylindrical; pseudoperculum rounded..................... *similis* Kunz 1936.

9. Caudal ramus three times as long as wide at most .... 10.
Caudal ramus three times as long as wide at least .... 12.

10. Caudal ramus seta V twisted; median weakly depression in P6 .... *mirabilis* sp. nov.
Caudal ramus seta V normal; P6 protruded .... 11.

11. Terminal spine of P4 exp-3 almost as long as entire exopod; caudal ramus usually about 2.2 times as long as wide with seta II inserting in proximal half of ramus; P5 endopodal lobe ♂ extending beyond distal margin of exopods.. .... *mielkei* Huys, 1987.
Terminal spine of P4 exp-3 as long as exp-2 and exp-3 combined; caudal ramus 2.5 times as long as wide with seta II inserting in distal half or at halfway the ramus length; P5 endopodal lobe ♂ not extending beyond distal margin of exopods.......................... *marisalbi* Kornev and Chertoprud, 2008.

12. Caudal ramus 4.2 times as long as wide .... *pungdoensis* sp. nov.
Caudal ramus four times as long as wide at most .... 13.

13. Caudal ramus 3.5 times as long as wide; P1 enp-2 with two non-geniculate, short claws; P2–P3 enp-2 apical seta at least as long as segment; P3–P4 enp-1 inner seta reaching beyond distal margin of segment; P5 exopod ♂ with three setae/spines .... *kunzi* Mielke, 1984b.
Caudal ramus 3.7 times as long as wide; P2–P3 enp-2 apical seta distinctly shorter than segment; P3–P4 enp-1 inner seta not reaching beyond distal margin of segment; P1 and P5 exopod ♂ unknown .... *helgolandica sensu* Mielke (1975).

14. P5 exopod with four setae/spines in ♀ and two setae/spines in ♂ .... *longicaudata* Nicholls, 1945.
    P5 exopod with three setae/spines in both sexes .... 15.

15. P2–P3 enp-2 bulbiform and broader than enp-1; inner element of P5 exopod ♀ spiniform; inner endopodal element of P5 baseoendopod ♀ shorter than outer one; body length 340–360 μ (♀), 330 μm (♂) .... *helgolandica helgolandica* Kunz, 1936.
    P2–P3 enp-2 not bulbiform and about as wide as enp-1; inner element of P5 exopod ♀ spiniform; inner endopodal element of P5 baseoendopod ♀ as long as outer one; body length 220–250 μ (♀), 210 μm (♂) .... *helgolandica galapagoensis* Mielke, 1984a.

16. P1 enp-2 with one claw; P5 baseoendopod ♀ with 2 endopodal setae .... *unaspina* Mielke, 1984a.
    P1 enp-2 with two claws or setae; P5 baseoendopod ♀ with 0–1 endopodal setae .... 17.

17. Caudal rami conical, produced into distal spinous process; P5 endopodal lobes of ♀ represented by strongly developed, narrow, triangular extensions projecting well beyond distal margin of exopods and separated by deep cleft originating at around the insertion level of the exopods .... 18.
    Caudal rami cylindrical without conspicuous distal spinous process; P5 endopodal lobes of ♀ vestigial and asetose, forming single midventral plate not extending beyond distal margins of exopod ....20.

18. Antennary exopod with four setae; P3 exp-3 with three setae/spines .... *acutata* Klie, 1934.
    Antennary exopod with two setae; P3 exp-3 with four setae/spines .... 19.

19. Free body somites (except penultimate and anal) with distinct hyaline lappets around posterior margin; antennule ♀ eight-segmented; base of baseoendopodal median cleft of ♀ P5 slightly distal to insertion level of exopods .... *taeana* Back and Lee, 2010.
    Free body somites without distinct hyaline lappets around posterior margin; antennule ♀ seven-segmented; base of baseoendopodal median cleft of ♀ P5 clearly proximal to insertion level of exopods .... *hawaiiensis* Kunz, 1981, new rank.

20. P2–P3 exp-3 with four setae/spines; body length about 320 μm .... *denticulata* Rao and Ganapati, 1969.
    P2–P3 exp-3 with two setae/spines; body length exceeding 900 μm .... *ornata* Krishnaswamy, 1957.

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