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New Benthopelagic Calanoids (Copepoda: Clausocalanoidea) of the deep Japan Sea

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ABSTRACT

Two new species of benthopelagic calanoid copepod Bradfordian genera *Pseudophaenna japonica* sp. nov. and *Xantharus dubius* sp. nov. are described from collections of the Russian-German deep-sea expedition (SoJaBio) to the Sea of Japan onboard of the R/V Akademik Lavrentyev, 51st cruise taken close to the sea bed. The rare calanoid copepod genera *Pseudophaenna* Sars, 1902 and *Xantharus* Andronov, 1981 and a rare aetideid species *Bradyidius rakuma* (Zvereva, 1977) are recorded for the first time from the Japan Sea; the male of *B. rakuma* is described for the first time. *Pseudophaenna japonica* sp. nov. is the second species described for the genus *Pseudophaenna* and is distinguished by biramous rostrum, antennule ancestral segment XXII without seta, details of oral parts setation in females and in P5 structure in dimorphic males. *Xantharus dubius* sp. nov. is described from males and is distinguished from congeners in the antennule ancestral segments XXII and XXIII not comparatively small relative to the segment XXI and in the large and robust uniramous P5. In the collections of the expedition SoJaBio in 2010 from the Japan Sea the near-bottom benthopelgic fauna of Calanoida have been represented by these species only and they all belong to the calanoid superfamily Clausocalanoidea.

Key words: benthopelagic, *Bradyidius rakuma*, Copepoda, deep water, Japan Sea, new taxa, *Pseudophaenna japonica* sp. nov., *Xantharus dubius* sp. nov.

Новые бентопелагические веслоногие (Calanoida: Clausocalanoidea) из глубоководной части Японского моря

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РЕЗЮМЕ

Два новых вида бентопелагических веслоногих рачков копепод из отряда Calanoida, объединяемых в группу «Брэдфордовских» семейств, *Pseudophaenna japonica* sp. nov. и *Xantharus dubius* sp. nov. описаны из придонных проб, собранных Российско-Немецкой глубоководной экспедицией (SoJaBio). Коллекции, в которых были найдены новые виды, собраны в 51 рейсе научно-исследовательского судна «Академик Лаврентьев» в Японском море в непосредственной близости от морского дна. Редкие роды каланоид *Pseudophaenna* Sars, 1902 и *Xantharus* Andronov, 1981 впервые отмечены для Японского моря, а также впервые описан и отмечен в этом море самец редкого вида аетидэид *Bradyidius rakuma* (Zvereva, 1977). Вид *Pseudophaenna japonica* sp. nov. является вторым видом, который описан для рода *Pseudophaenna* и отличается от своего единственного сородича рострумом из двух ветвей и лишенным щетинки XXII анцестральным сегментом антеннулы, а также деталями вооружения ротовых частей самки и строением пятой пары ног (P5) у диморфоных самцов. Вид *Xantharus dubius* sp. nov. описан по самцам и отличается от других видов рода размером сегмента антеннулы XXI, который не уменьшен в сравнении с анцестральными сегментами XXII и XXIII и большой крепкой и одноветвистой P5. В изученной коллекции придонных проб собранных экспедицией SoJaBio в 2010 в Японском море бентопелагическая фауна Calanoida была представлена только этими видами и все эти виды принадлежат к надсемейству Calanoida Clausocalanoidea.

Ключевые слова: бентопелагические, *Bradyidius rakuma*, Copepoda, глубоководье, Японское море, новые таксоны, *Pseudophaenna japonica* sp. nov., *Xantharus dubius* sp. nov.

INTRODUCTION

Many new species of benthopelagic calanoid copepods were described during the recent decades from the different regions of the World Ocean (e.g., Ohtsuka and Boxshall 2004; Ohtsuka et al. 2003, 2005; Schulz 2006, Schulz and Kwasniewsky 2004; Bradford-Grieve 2005; Markhaseva et al. 2008, 2014, 2020, 2021, 2022; Soh et al. 2013; Bradford and Boxshall 2019; Bradford-Grieve et al. 2014; Markhaseva and Renz 2015, 2021; Renz and Markhaseva 2015; Renz et al. 2018; Komeda et al. 2021, etc.). However, most representatives of the demersal calanoid fauna of the World Ocean are still poorly known and this particularly true for our knowledge on the diversity and distribution of the near-bottom calanoids of the Japan Sea.

The genera *Pseudophaenna* Sars, 1902 and *Xantharus* Andronov, 1981 are the members of the copepod superfamily Clausocalanoidea united under the name "Bradfordian" calanoids, that are distinct in that they possess sensory setae on the maxilla and maxilliped. "Bradfordian" calanoids include seven families, viz. Diaixidae, Tharybidae, Scolecitrichidae, Parkiidae, Phaennidae, Kyphocalanidae and Rostrocalanidae and their name "Bradfordian" (Ferrari and Steinberg 1993) honors Janet Bradford-Grieve, who proposed a taxonomic significance for the sensory setae on the maxilla endopod (Bradford 1973). Benthopelagic "Bradfordian" genera *Xantharus* (Diaixidae) and *Pseudophaenna* (a monotypic genus whose family relationship is unresolved) are herein recorded first time from the Japan Sea. Representatives of these genera and the first discovery of the male of the aetideid *Bradyidius rakuma* (Zvereva, 1977) are presented below from the deep-water samples collected in the vicinity of bottom during the Russian-German expedition SoJaBio (Sea of Japan Biodiversity studies) on board R/V Akademik M.A. Lavrentyev.

METHODS AND TERMINOLOGY

Copepod specimens were collected during SoJaBio Expedition on the R/V Akademik M.A. Lavrentyev during cruise 51 in 2010. Sampling was carried out close to the sea bed (in total 14 samples) at depths between 455–3666 m with an epibenthic sledge (Brenke 2005). The herein described species were found in the samples from five stations at the depth interval from 455 to 2841 m. Specimens were fixed in 96% ethanol and later stained by adding a solution of chlorazol black E dissolved in 70% ethanol/30% water. Oral parts and swimming legs were dissected and figures were made in glycerin using a *camera lucida*.

The following abbreviations are used in the descriptions: P1–P5, swimming legs 1 to 5. Free segments of the antennule are designated by Arabic numerals, ancestral segments by Roman numerals; one seta and one aesthetasc on a segment of the antennule are designated as: 1s + 1ae.

Terminology and definitions for the antennule segmentation and setation, antenna exopod setation, maxilla and maxilliped segmentation and setation follows Huys and Bosxhall (1991), Markhaseva and Ferrari (2006), Markhaseva et al. (2014), Ferrari and Ivanenko (2008), and Ferrari and Markhaseva (2000a, b) respectively.

Type specimens are deposited at the Zoological Institute, Russian Academy of Sciences (ZIN), Saint Petersburg.

TAXONOMY

Superfamily Clausocalanoidea Giesbrecht, 1893
Family relationship unresolved
Genus *Pseudophaenna* Sars, 1902
***Pseudophaenna japonica* sp.nov.**
(Figs 1–7)

Holotype. Adult female, dissected, body length 1.90 mm (ZIN 91162); Japan Sea, 43°10'N, 135°00'E,

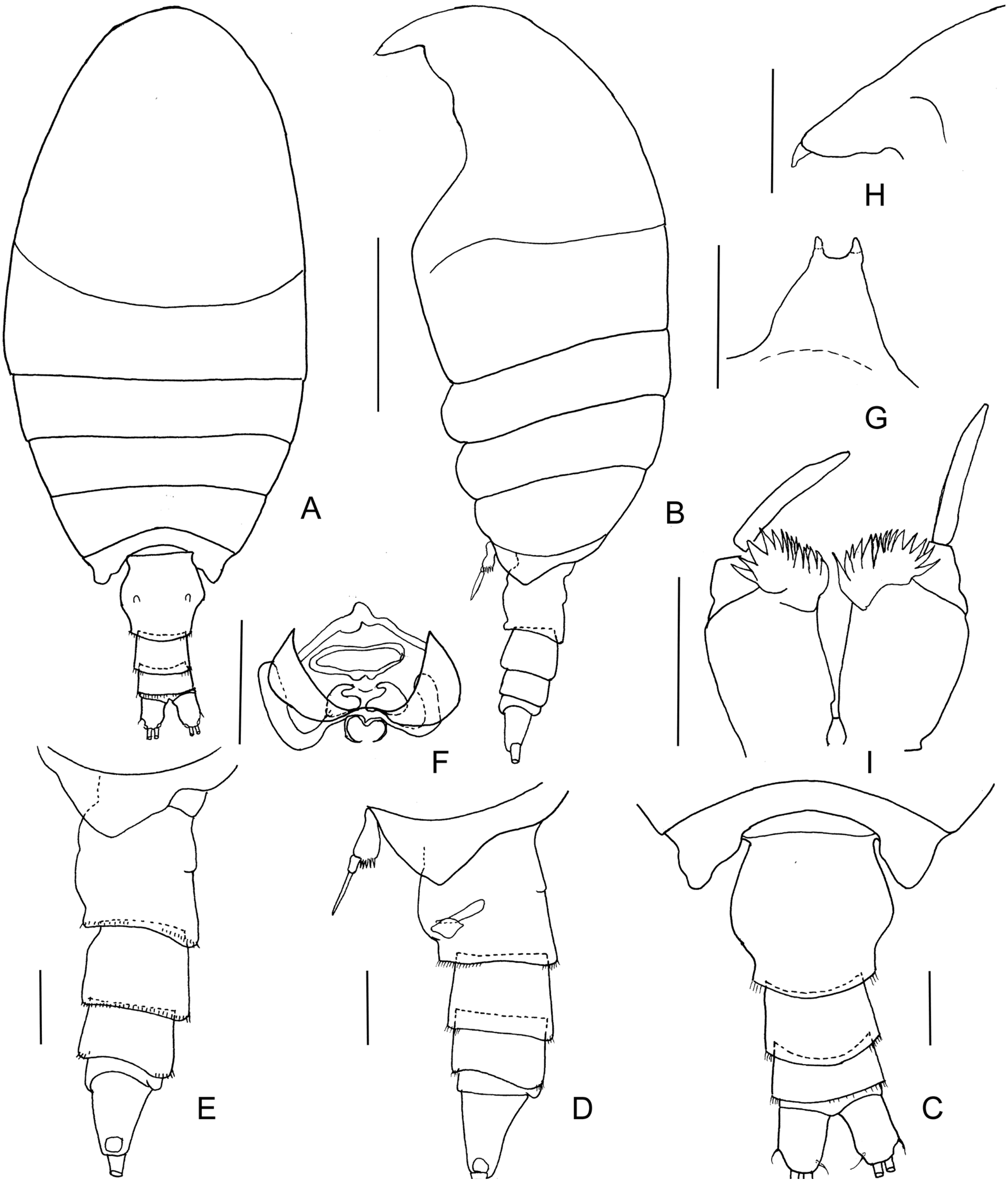

Fig. 1. *Pseudophaenna japonica* sp. nov., female, A, C–D, F–I, holotype, B, E, paratype 3; A – habitus, dorsal; B – habitus, lateral; C – posterior prosome and urosome, dorsal; D–E – posterior prosome and urosome, lateral; F – genital field, ventral; G – rostrum, dorsal; H – rostrum, lateral; I – P5. Scale bars: A – B, 0.5 mm; C – I, 0.1 mm.

station B6–6, 25 August 2010, above the sea bed at depth of 970–994 m.

Paratypes: 4 adult females (paratypes 1–4), dissected, or partly dissected, body length 1.85–1.90 mm and 3 males (paratypes 5–7), dissected, or partly dissected, body length 1.65–1.70 mm (ZIN 91163), same label data as for holotype.

Etymology. The specific name refers to the first record of the new species in the Japan Sea.

Differential diagnosis. The new species is separated from *Pseudophaenna typica* Sars, 1902 in: rostrum as a biramous plate (vs rostrum as a plate without rami in *P. typica*), antennule ancestral segment XXII without seta (vs seta present in *P. typica*), and coxa of antenna without seta (vs coxa with seta in *P. typica*). Females of the new species differ in: 1) maxillule, praecoxal arthrite with one posterior seta (vs posterior seta absent in *P. typica*); 2) maxillule, proximal basal endite with three setae (vs proximal basal endite with two setae in *P. typica*), and 3) maxilla endopod with seven setae, one worm-like, five brush-like and one sclerotized setae (vs endopod with seven setae, 2 worm-like and five brush-like setae in *P. typica*). Males are sexually dimorphic in reduction of oral parts and their armament. Males of *P. japonica* sp. nov. are also dimorphic in P1 endopod medial lobe of triangular configuration (vs rounded in female of this species). Males, however, share with females P2–P4 structure. Males of *P. japonica* sp. nov. are distinguished from males of *P. typica* in P5 longer than urosome, and right leg basis with proximal indentation.

Description. Adult female (after holotype and paratypes 1–3), total length 1.85–1.90 mm; prosome 3.4–3.5 times as long as urosome. Rostrum (Fig. 1G–H) as a plate with two rami. Cephalosome (Fig. 1A–B) and pediger 1, and pedigers 4 and 5 separate; posterior corners prolonged into obtuse-triangular lobes extending to the first third of genital double-somite (Fig. 1C–E). Genital double-somite slightly asymmetrical projecting more on the right; widest in the middle length in dorsal view (Fig. 1A, C). Genital double-somite and urosome somites 2 and 3 with fringe of spinules along posterior borders. Spermathecae oval, slightly asymmetrical with moderately narrow duct leading to the genital atrium (Fig. 1F). Caudal rami (Fig. 1C) with four terminal plus one small dorsolateral and one small ventral setae each.

Antennule (Fig. 2A–B) reaching to the middle of pediger 4, or to the posterior border of pediger 5, of 24 free segments; armature as follows: I – 3s, II–IV – 6? + 1ae, V–VI – 2s each, VII – 2s + 1ae, VIII – 2s, IX – 2s + 1ae; X–XI – 2s + 1? + 1ae, XII to XIII – 1? each; XIV – 1s + 1ae, XV – 1?, XVI – 1? + 1ae, XVII to XX – 1? each; XXI – 1ae, XXII – 0, XXIII – 1s, XXIV – 2s, XXV – 1s, XXVI – 2s, XXVII–XXVIII – 4s + 2ae.

Antenna (Fig. 2C–F), coxa without seta; basis with one seta; endopodal segment 1 without setae, endopodal segment 2 with 8 setae; exopod 8-segmented with 0, 0-0-0, 1, 1, 1, 1, 0 and 3 setae.

Mandible (Fig. 2G–H), gnathobase cutting edge with six teeth; exopod of five segments with 1, 1, 1, 1 and 1 setae; endopod segment 1 without setae, endopod segment 2 with seven setae; basis with two setae, small.

Maxillule (Fig. 2I–K), praecoxal arthrite with nine terminal spines and one posterior seta; coxal endite absent, coxal epipodite with seven setae; proximal basal endite with three setae, distal basal endite with three setae; endopod with six setae, exopod with two setae.

Maxilla (Fig. 3A), praecoxal endite bearing five setae, coxal with two setae; basal endites with two setae each; lobe of proximal endopodal segment with four setae, all sclerotized. Endopod with seven setae, one worm-like, five brush-like setae of different morphology and one sclerotized.

Maxilliped (Fig. 3B), syncoxa without seta on proximal praecoxal endite, two sclerotized setae on middle endite, and two setae on distal praecoxal endite, coxal endite with three setae. Basis with three medial setae plus two setae distally of incorporated endopod segment 1; endopod of five free segments with 4, 4, 3, 2+1 and 4 setae.

P1 (Fig. 3D–E), basis with medial distal seta curved; endopod one-segmented with three medial and two terminal setae, details of Von Vaupel Klein's organ (Forshell and Ferrari 2014) were not considered in this study; lateral lobe well developed, rounded; exopod three-segmented, segment 1 with lateral spine, segment 2 with lateral spine and medial seta, segment 3 with lateral spine, three medial setae and terminal spine.

P2 to P3 biramous with 3-segmented exopods, endopod 2-segmented in leg 2 and 3-segmented in legs 3 to 4. P2 to P3 with finely serrate terminal spine on exopod segment 3.

P2 (Fig. 4A), coxa with medial seta; basis without seta; endopod segment 1 with one medial seta; segment 2 with two medial, two terminal and one lateral

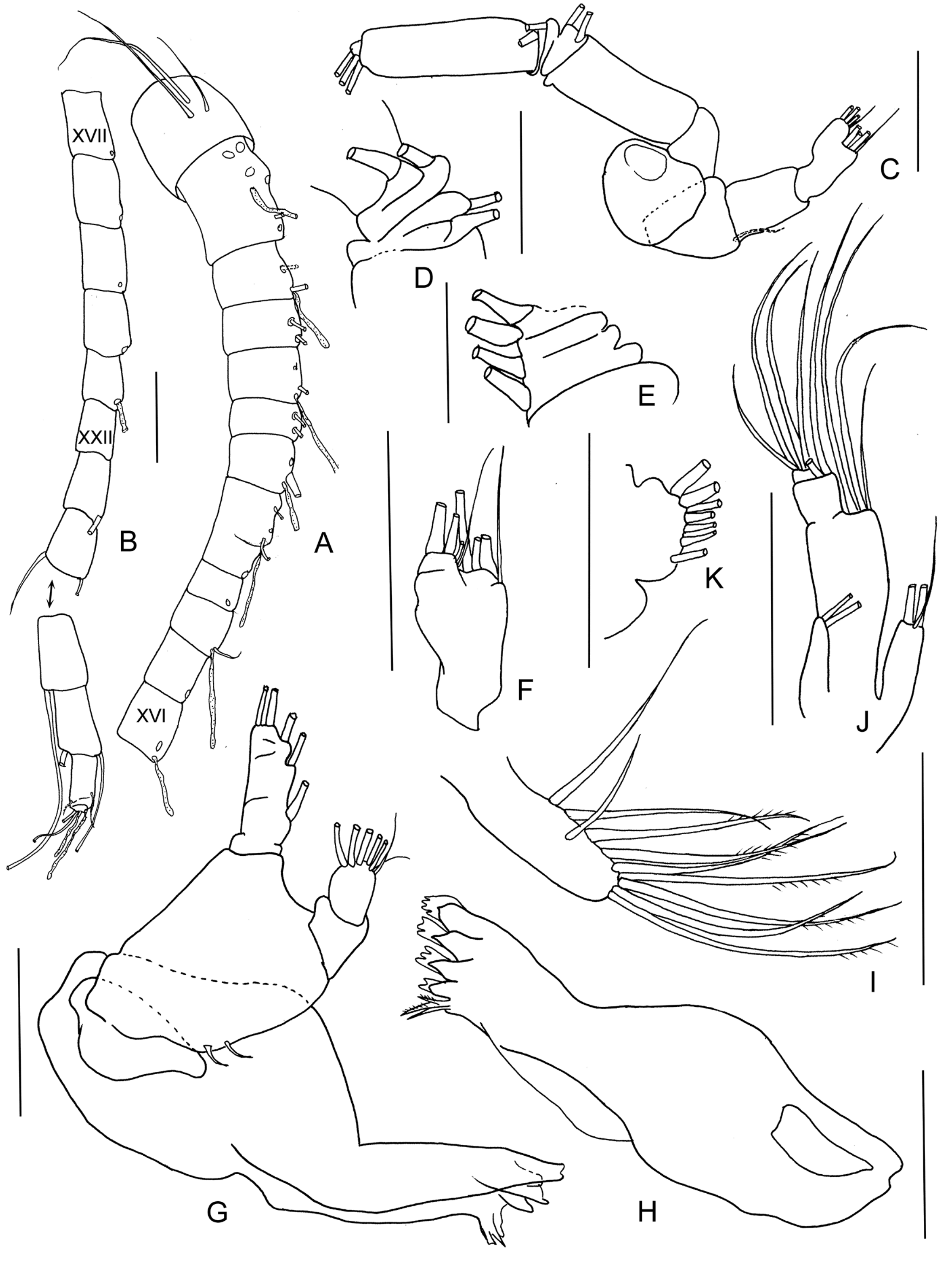

Fig. 2. *Pseudophaenna japonica* sp. nov., female, A – E, G–H, J, holotype; F, I, K, paratype 2; A – antennule, ancestral segments I–XVI; B – antennule, ancestral segments XVII–XXVIII; C – antenna (dotted line show additons after paratype 2); D–E, antenna, exopod segments V–VIII, different positions; F – antenna, endopod segment 2; G – mandible; H – mandible, gnathobase; I – maxillule, praecoxal arthrite; J – maxillule, basal endites, endopod and exopod; K – maxillule, epipodite. Scale bars: 0.1 mm.

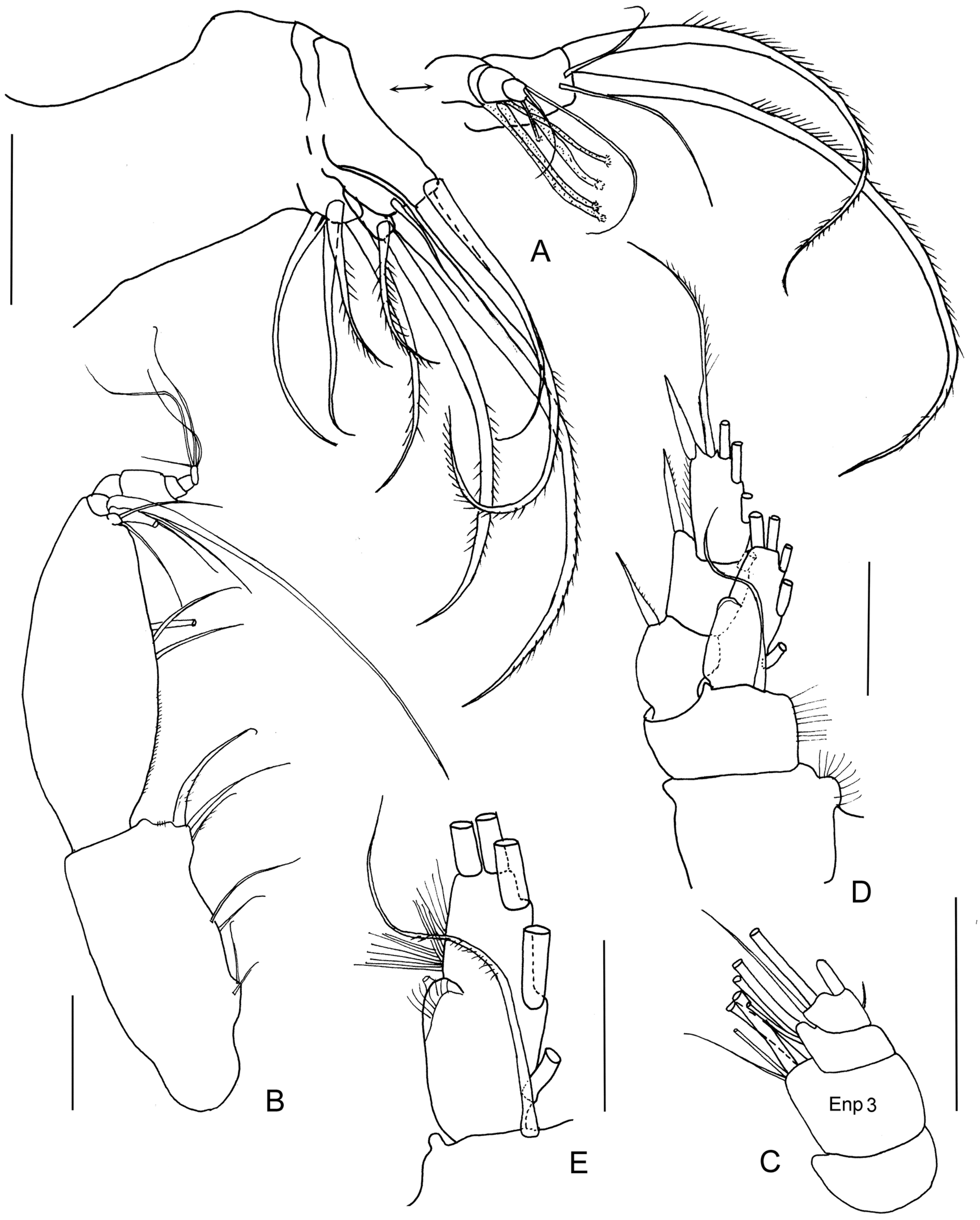

Fig. 3. *Pseudophaenna japonica* sp. nov., female, B, D, E, holotype, A, C, paratype 1; A – maxilla; B – maxilliped; C – maxilliped, endopod segments 2–6, armament of segments 2 and 6 is not figured; D – P1; E – P1, endopod. Scale bars: 0.1 mm.

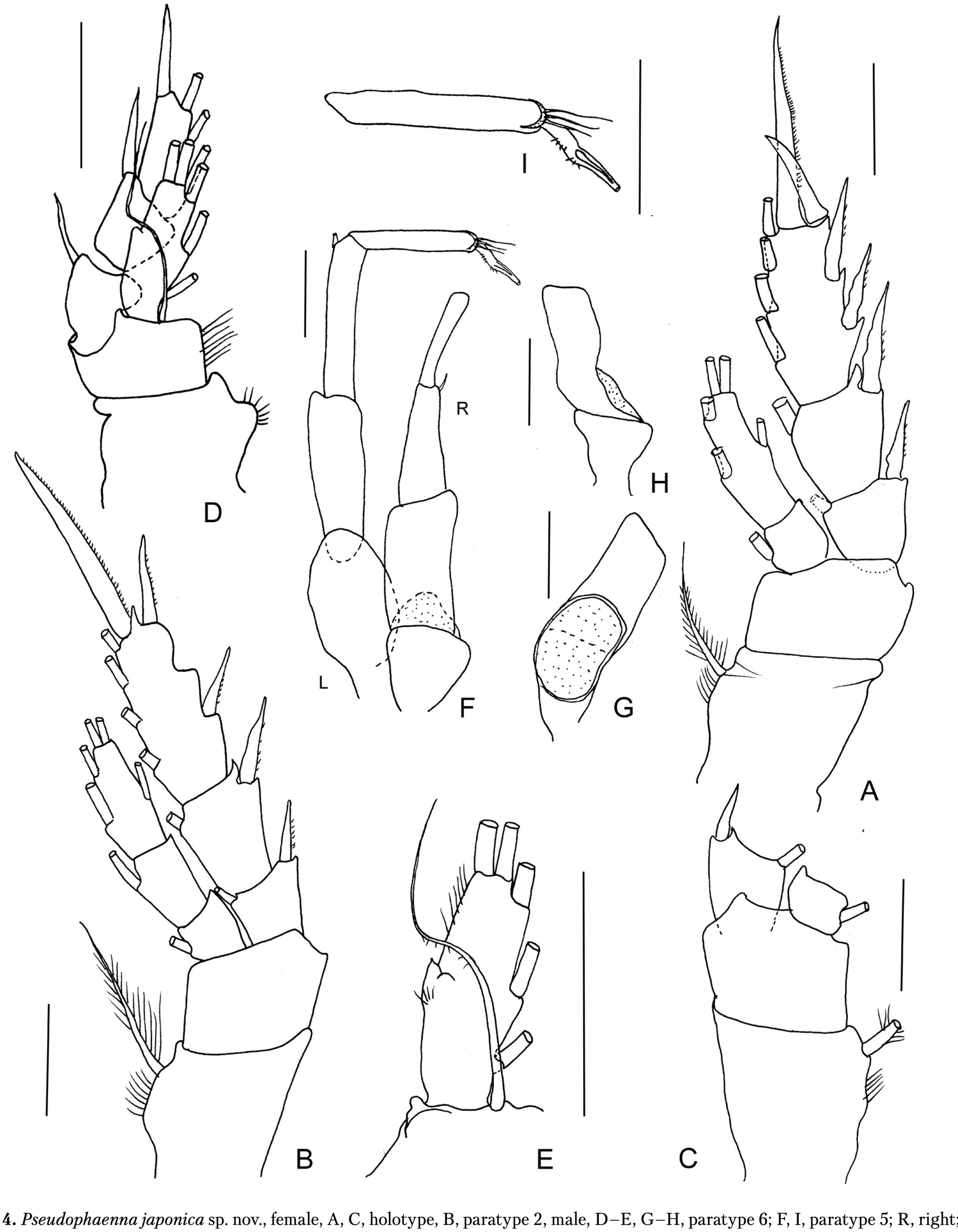

Fig. 4. *Pseudophaenna japonica* sp. nov., female, A, C, holotype, B, paratype 2, male, D–E, G–H, paratype 6; F, I, paratype 5; R, right; L, left; A – P2; B – P3; C – P4, exopod and endopod segments 2–3 broken; male, D – P1; E – P1, endopod; F – P5; G–H – P5, coxa and basis, different positions; I – P5, exopod segments 2–3. Scale bars: 0.1 mm.

setae. Exopod segment 1 with lateral spine, and medial seta, segment 2 with lateral spine and medial seta, segment 3 with three lateral spines, four medial setae and terminal spine.

P3 (Fig. 4B), coxa with medial seta; basis without seta; endopod segment 1 with medial seta, segment 2 with one medial seta, segment 3 with two medial, two terminal and one lateral setae; exopod segment 1 with lateral spine and medial seta, segment 2 with lateral spine and medial seta, segment 3 with three lateral spines, four medial setae and terminal spine.

P4 (Fig. 4C), coxa with medial seta; basis without seta; endopod segment 1 with medial seta and exopod segment 1 with lateral spine and medial seta, other segments lost.

P5 (Fig. 1I) uniramous, symmetrical, 2-segmented with one thick terminal spine each, each coxa with 14–15 spines fused at their base.

Adult male (after paratypes 5–7), total length 1.65–1.70 mm, prosome 2.70–3.25 times as long as urosome. Rostrum (Fig. 5B, E–F) as a plate with two short rami. Cephalosome (Fig. 5A–B) and pediger 1, and pedigers 4 and 5 separate; posterior corners prolonged into obtuse-triangular lobes extending to posterior border of urosomite 1 (Fig. 5A–B, C–D). Caudal rami (Fig. 5C–D) with four terminal plus one small ventral setae each.

Antennule (Fig. 6A–B, after paratype 5 and 6) right reaching to anterior part of pediger 5, of 22 free segments; armature as follows: I – 1s + 1ae, II–IV – 2s + 4? + 2ae, V – 1s + 1ae+ 1?, VI – 3?, VII – 2? + 1 ae, VIII – 3?, IX – 2? + 1ae; X–XI – 2s + 2ae + 1?, XII – XIV – 3s + 2?; XV to XIX – 2? each; XX – 1s, XXI – 1? + 1ae, XXII – 0, XXIII – 1?, XXIV – 1s + 1?, XXV to XXVI – 2s each, XXVII–XXVIII, armament broken. Left antennule of 22 free segments; armature as follows: I – 1s + 1ae, II – IV as in the right, V – 2s + 1?, VI – 2?, VII – 1s + 1 ae + 1?, VIII – 1s + 1?, IX – 1s + 2?; X–XI – 2s + 1ae +2?, XII – XIV – 2s + 3?; XV – 2?, XVI as in the right, XVII to XVIII, no setae or scar observed, XIX – 1?; XX – 1s, XXI – 1?, XXII – 0, XXIII – 1s, XXIV to XXV – 1s + 1 each?, XXVI – 2s, XXVII–XXVIII – only 3 setae were observed.

Antenna (Fig. 6E), coxa without seta; basis with one seta; endopodal segment 1 without setae, endopodal segment 2 with 8 setae; exopod 8-segmented with 0, 0-0-0, 1, 1, 1, 1, 0 and 3 setae.

Mandible (Fig. 6F), gnathobase cutting edge with teeth reduced; exopod of five segments with 1, 1, 1, 1 and 1 setae; endopod segment 1 without setae, endopod segment 2 with eight setae; basis with one seta, small.

Maxillule (Fig. 7A), praecoxal arthrite rudimentary, without setae; coxal endite absent, coxal epipodite with seven setae; proximal basal endite with one setae and tiny attenuation, distal basal endite with one seta; endopod with six setae, exopod with two setae.

Maxilla (Fig. 7B), praecoxal endite bearing two setae, coxal with one seta; basal endites with two setae each; lobe of proximal endopodal segment with three setae, all sclerotized. Endopod with seven setae, one worm-like, four brush-like setae and two sclerotized.

Maxilliped (Fig. 7C), syncoxa without seta on proximal praecoxal endite, one sclerotized setae on middle endite and distal praecoxal endite each, coxal endite with two setae. Basis with one medial setae plus two setae distally of incorporated endopod segment 1; endopod of five free segments with 4, 4, 3, 2+1 and 4 setae.

P1 (Fig. 4D–E), basis with medial distal seta curved; endopod one-segmented with three medial and two terminal setae, lateral lobe well developed, triangular, details of Von Vaupel Klein's organ were not considered in this study; exopod three-segmented, segment 1 with lateral spine, segment 2 with lateral spine and medial seta, segment 3 with lateral spine, three medial setae and terminal spine.

P2 to P4 as in female.

P5 (Fig. 4F–I, 5D) longer than urosome. Right leg coxa shorter than basis, basis of complicate shape with proximal indentation (Fig. 4 G–H); exopod segment 1 with distal lateral spine, exopod segment 2 without armament, exopod segment 3 broken. Left leg coxa and basis of nearly the same length, exopod segment 1 with distal terminal spine broken at its tip; exopod segment 2 with 3 setae arising from the distal crescent like chitinous thickening; exopod segment 3 with patch of sparse setae and lateral spine-like attenuation; terminal part of the segment broken.

Remarks. The monotypic genus *Pseudophaenna* is considered taxonomically unresolved. *Pseudophaenna* is a member of the group of the clausocalanoidean copepods united under the name “Bradfordian” calanoids (viz. Diaixidae, Tharybidae, Scolecitrichidae, Parkiidae, Phaennidae, Kyphocalanidae and Rostrocalanidae), however, there are characters, that prevent this genus from being placed in any of these families (Markhaseva et al. 2014).

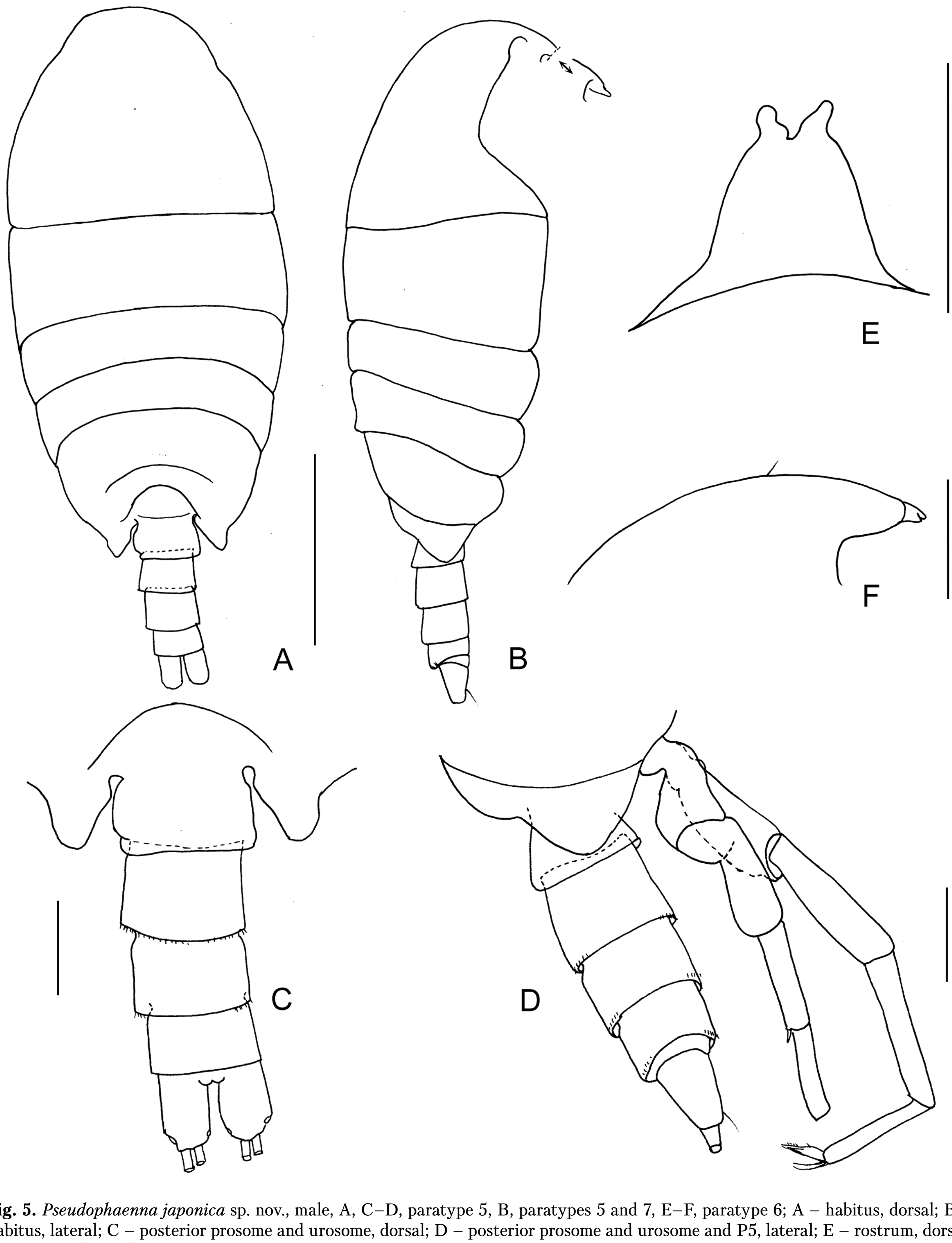

Fig. 5. *Pseudophaenna japonica* sp. nov., male, A, C–D, paratype 5, B, paratypes 5 and 7, E–F, paratype 6; A – habitus, dorsal; B – habitus, lateral; C – posterior prosome and urosome, dorsal; D – posterior prosome and urosome and P5, lateral; E – rostrum, dorsal; F – rostrum, lateral. Scale bars: A – B, 0.5 mm, C – F, 0.1 mm.

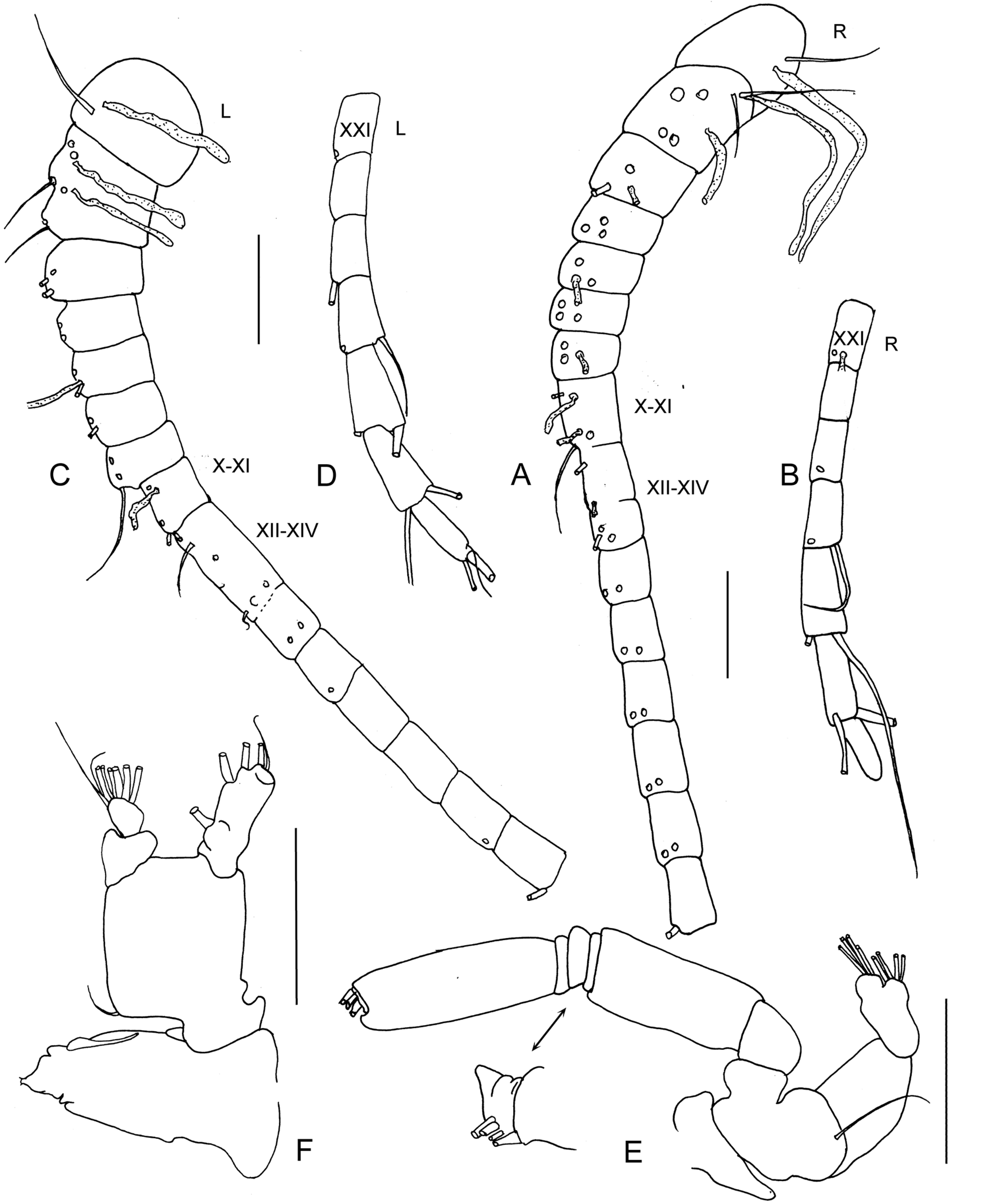

Fig. 6. *Pseudophaenna japonica* sp. nov., male, paratype, A–D, paratype 5, E–F, paratype 6; R, right; L, left; A – right antennule, segments I–XX; B – right antennule, segments XXI –XXVIII (armament of segments XXVII–XXVIII not figured); C – left antennule, segments I–XX, D – left antennule, segments XXI–XXVIII; E, antenna; F, mandible. Scale bars: 0.1 mm.

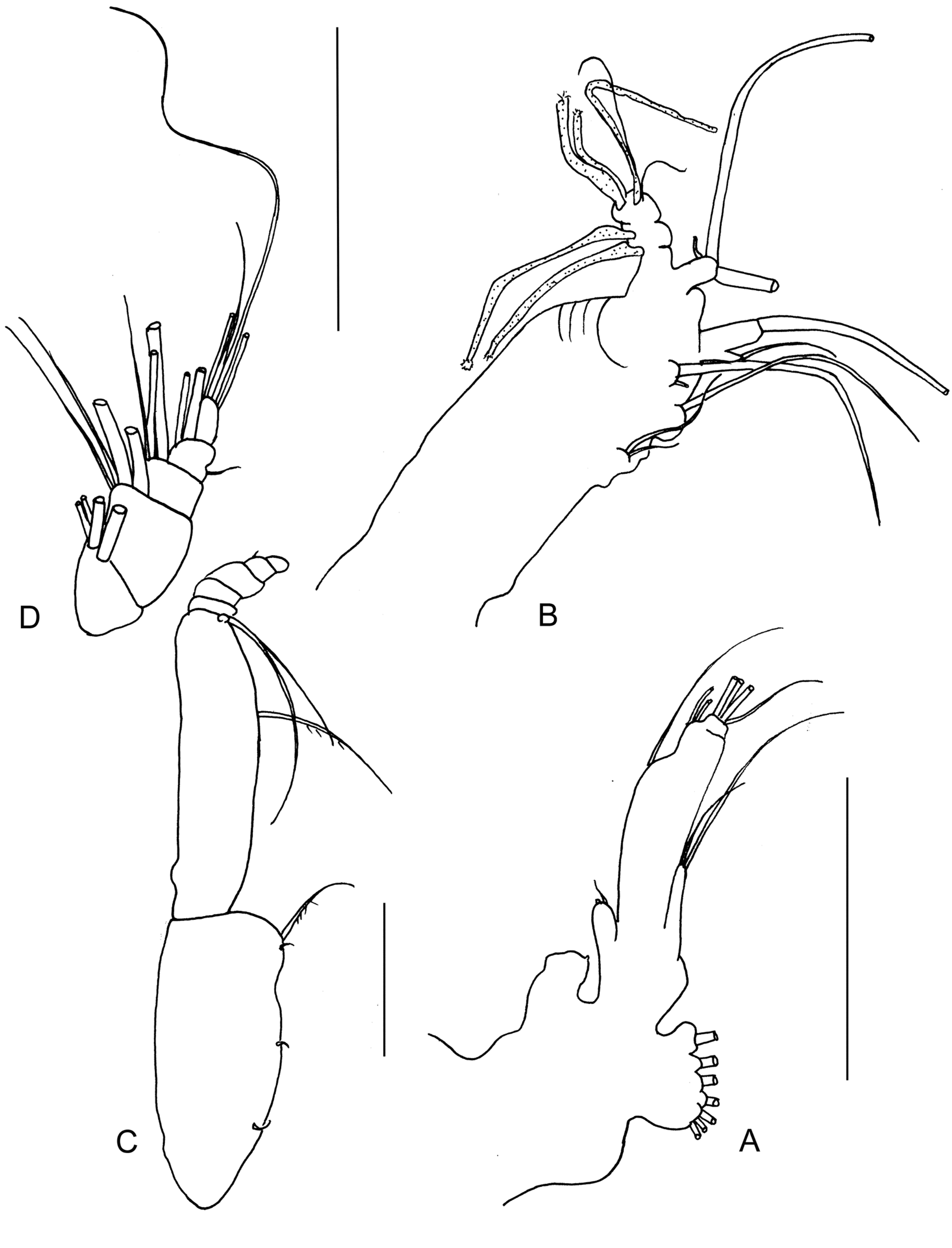

Fig. 7. *Pseudophaenna japonica* sp. nov., male, A–C, paratype 6; A – maxillule; B – maxilla; C – maxilliped; D – endopod segments 2–6. Scale bars: 0.1 mm.

Pseudophaenna was established by Sars (1902) from the Norwegian near-bottom shallow waters (up to 100 m) and has more recently been found in waters above the bottom from the Norwegian coast by Matthews (1967) at depths up to 240 m. Sars's report of *P. typica* is the only record of the genus supplied by illustrated description. In the later references *P. typica* is only mentioned in the taxonomic lists, e.g., list of species found from the vertical hauls in the Bering Sea (Wilson 1950), in the Bay of Biscay Albaina and Irigoien (2007), in the Barents Sea (Dvoretsky and Dvoretsky 2010), and in the Iceland Sea (Gislason and Silva 2012). The species was predominantly found in shallow waters, and here is given the first documented deep-water, near-bottom occurrence (970–994 m).

Xantharus dubius sp.nov.

(Figs 8D–G, 9–11)

Holotype. Adult male, partly dissected, body length 0.86 mm (ZIN 91164); Japan Sea, 44°50'N, 137°14'E, station A3–10, 14 August 2010, above the sea bed at depth of 1354–1356 m.

Paratypes: 3 adult males (paratypes 1–3), dissected, or partly dissected, body length 0.80–0.86 mm, (ZIN 91165), same lable data as for holotype.

Etymology. The specific name *dubius* refers the uncertain placement of the species in the genus *Xantharus.*

Differential diagnosis. The male of the new species differs from congeners in the antennule ancestral segments XXII and XXIII not comparatively small relative to the segment XXI. The male of *X. dubius* sp. nov. is disingushed from congeners by the robust P5, reaching beyond urosome by nearly its distal two thirds (2/3) of exopod segment 2 plus exopod segment 3 (vs P5 is slim and shorter in congeners: reaching urosome segment 4 in *X. formosus* Andronov, 1981, caudal rami in *X. renatehaassae* Schulz, 1998, or in *X. siedleckii* Schulz et Kwasniewski, 2004 slightly exceeding caudal rami by P5 exopod segment 3). The male of *X. dubius* sp. nov. shares a small size (< 0.86 mm) with *X. formosus* Andronov, 1981 (vs size of other congeners, *X. renatehaassae* Schulz, 1998 and *X. siedleckii* Schulz et Kwasniewski, 2004 > 1.00 mm), however, it differs from *X. formosus* in the leg P5 uniramous (vs P5 biramous in *X. formosus*).

Description. Adult male (described after type series), total length 0.80–0.86 mm, prosome 3.0–3.1 times as long as urosome. Rostrum (Fig. 8 F) as a plate with two filaments. Cephalosome and pediger 1, and pedigers 4 and 5 fused (Fig. 8D–E); posterior corners prolonged into obtuse in lateral view lobes, triangular in dorsal view extending to posterior border of urosomite 1 (Fig. 8D–E). Caudal rami (Fig. 8G) with four terminal plus one lateral and one ventral setae each.

Antennule reaching to anterior part of pediger 4 (Fig. 9A–C); left of 24 free segments armature as follows: I – 1s, II–IV – 5s + 4ae + 1?, V – 2s + 2ae, VI – 1s + 1ae, VII – 1s + 2ae, VIII – 2s + 1ae, IX – 2s + 1ae; X–XI – 4s + 1ae, XII – 1ae, XIII – 0s, XIV – 2s + 1ae; XV – 1s + 1ae, XVI – 2s + 1ae, XVII – 1s + 1ae, XVIII – 2s + 1ae, XIX – 2s, XX and XXI – 1s + 1ae, each, XXII – 0s, XXIII – 1s, XXIV and XXV – 2s + 1ae each, XXVI – 2s, XXVII–XXVIII – 5s + 1ae; right, of 23 free segments, segments XXII and XXIII fused with 1 seta; other segments identical.

Antenna (Fig. 9D), coxa with one seta; basis with two setae (one seta in holotype); endopodal segment 1 with one seta, endopodal segment 2 with 13 setae; exopod 7-segmented with 0, 0-0-1, 1, 1, 1, 1, 0 and 3 setae.

Mandible (Fig. 9E–F), gnathobase cutting edge with 8 teeth; exopod of five segments with 1,1,1,1 and 2 setae; endopod segment 1 with three setae, endopod segment 2 with nine long and 2 short setae; basis with 3 setae (in one specimen with 2 setae).

Maxillule (Fig. 9G–H), praecoxal arthrite with nine terminal, three posterior and one anterior setae; coxal endite with 2 setae, coxal epipodite with nine setae; basal endites with four setae each; endopod with 10 setae, exopod with eight setae.

Maxilla (Fig. 10A–B), praecoxal endite bearing four setae, coxal and basal endites with three setae each; lobe of proximal endopodal segment with four setae, all sclerotized. Endopod with eight setae, three worm-like and five brush-like.

Maxilliped (Fig. 10C–D), syncoxa with one seta on proximal praecoxal endite, one well developed and one vestigial sclerotized setae on middle endite and distal praecoxal endite with two well developed and one vestigial sclerotized setae, coxal endite with three setae. Basis with three medial setae. Endopod of six free segments with 2, 4, 2, 3, 3+1 and 4 setae.

P1 (Fig. 11A), basis with medial distal seta curved; endopod one-segmented with three medial

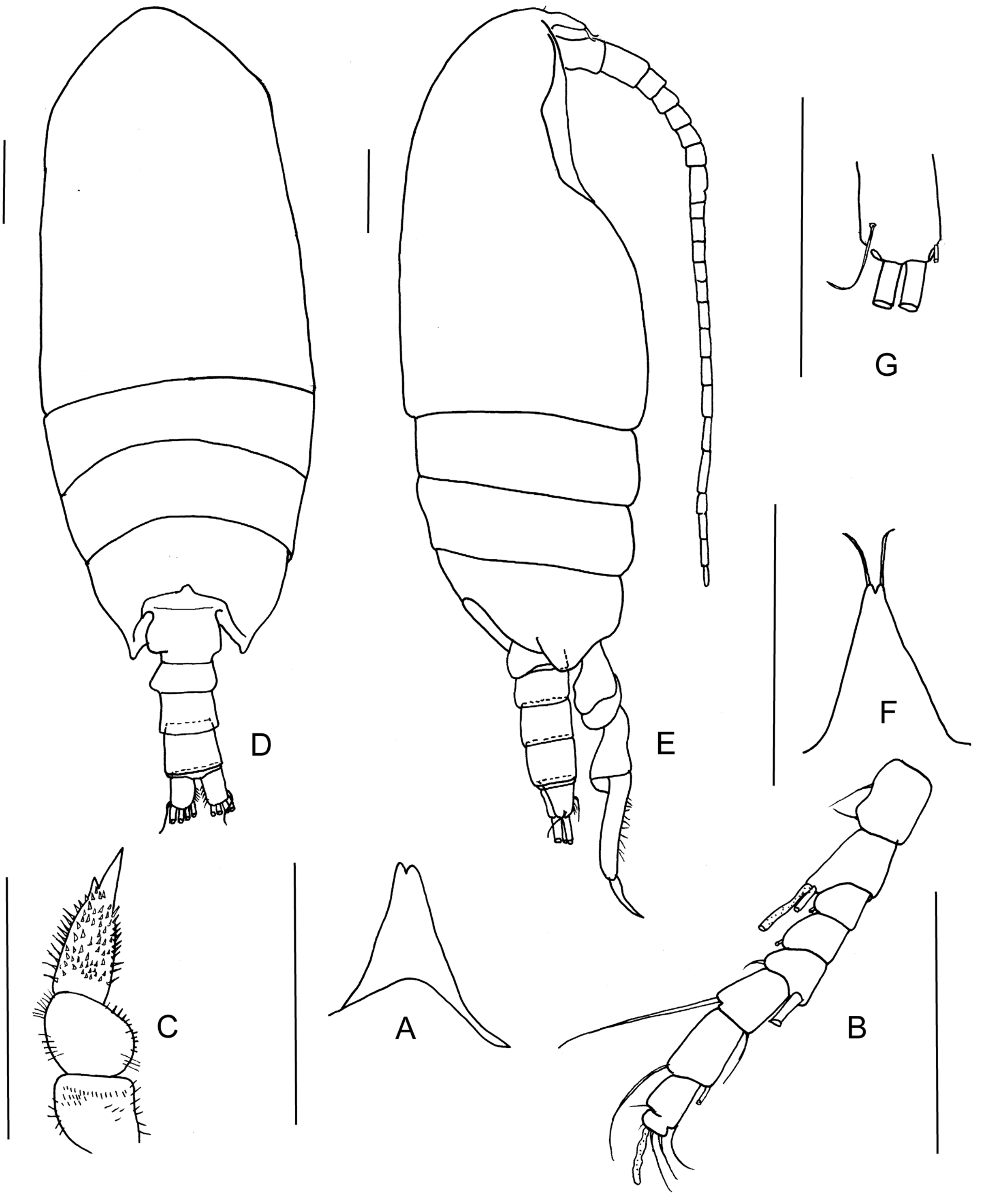

Fig. 8. *Xantharus* sp., female CV, A–C, CV female, male, D–E, G, holotype, F, paratype 1; A – rostrum, filaments broken; B – antennule, ancestral segments XX – XXVIII; C – P5; *Xantharus dubius* sp. nov., male, D – habitus, dorsal; E – habitus, lateral; F – rostrum, dorsal; G – caudal ramus, ventral. Scale bars: 0.1 mm.

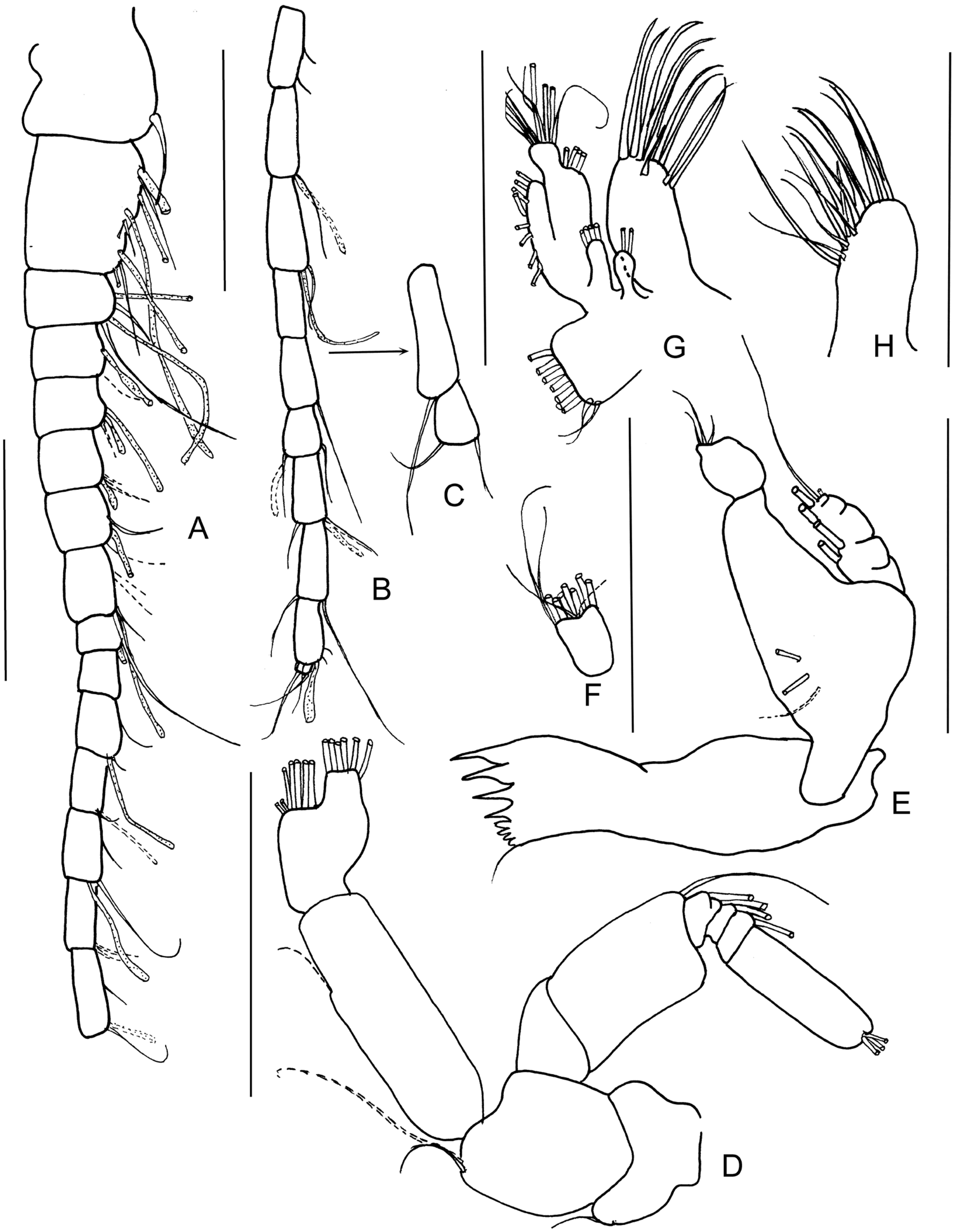

Fig. 9. *Xantharus dubius* sp. nov., male, A–C, F paratype 1, D–E, holotype, G–H, paratype 2; A – left antennule, ancestral segments I–XVIII; B – left antennule, ancestral segments XIX–XXVIII; C – right antennule, fused ancestral segments XXII–XXIII and segment XXIV; D – antenna (dotted line show additons after paratype 1); E – mandible, endopod segment 2 is not figured; F – mandible, endopod segment 2; G – maxillule; H – maxillule, praecoxal arthrite. Scale bars: 0.1 mm.

Fig. 10. *Xantharus dubius* sp. nov., male, A, E, paratype 1, B, paratype 3, C, D, paratypes 1 and 3; R, right; L, left; A – maxilla, brush-like setae of endopod not figured; B – maxilla, endopod; C – maxilliped, syncoxa and basis; D – maxilliped, endopod; E – P5 (dotted line show additons after paratype 2). Scale bars: 0.1 mm.

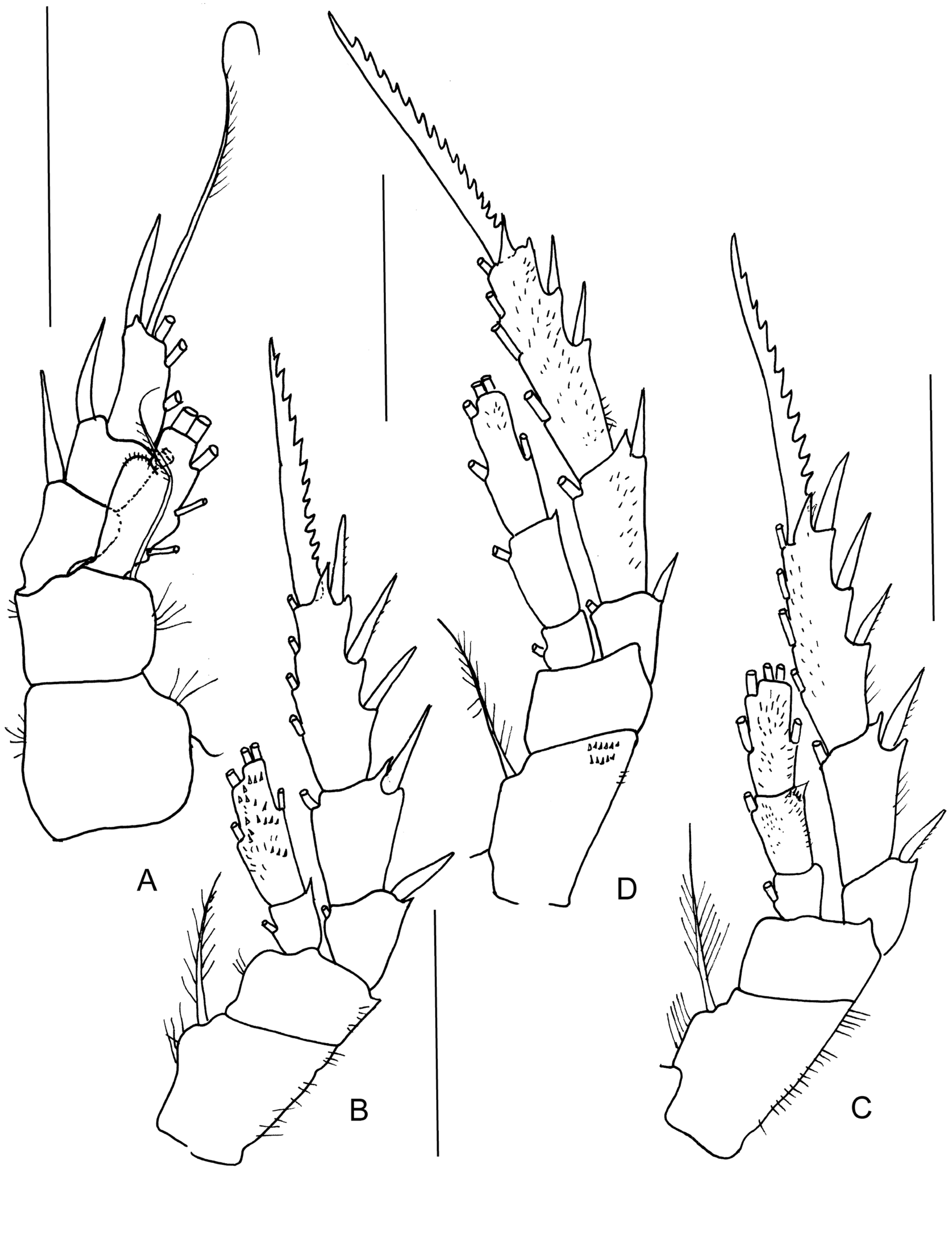

Fig. 11. *Xantharus dubius* sp. nov., male, A, holotype, B–D, paratype 1; A – P1; B – P2; C – P3; D – P4. Scale bars: 0.1 mm.

and two terminal setae, details of Von Vaupel Klein's organ (Forshell and Ferrari 2014) were not considered in this study; lateral lobe well developed, rounded; exopod three-segmented, segment 1 with lateral spine, segment 2 with lateral spine and medial seta, segment 3 with lateral spine, three medial setae and terminal spine.

P2 (Fig. 11B), coxa with medial seta and lateral tiny spinules; basis without seta and with lateral tiny spinules; endopod segment 1 with one medial seta; segment 2 with two medial, two terminal and one lateral setae and posterior spinules. Exopod segment 1 with lateral spine, and medial seta, segment 2 with lateral spine and medial seta, segment 3 with three lateral spines, four medial setae and terminal spine.

P3–P4 (Fig. 11 C–D), coxa with medial seta and in P4 with 2 rows of posterior denticles, in P3 with lateral spinules; basis without seta; endopod segment 1 with medial seta, segment 2 with one medial seta and in P3 with posterior denticles, segment 3 with two medial, two terminal and one lateral setae and posterior denticles; exopod segment 1 with lateral spine and medial seta, segment 2 with lateral spine and medial seta and in P4 with posterior denticles, segment 3 with three lateral spines, four medial setae and terminal spine and posterior denticles.

P5 (Fig. 8E, 10E) longer than urosome. Coxae of nearly same length, right basis is smaller than left, suture of separation between right coxa and basis is not well pronounced. Both leg exopods of three segments; right exopod segment 1 of irregular configuration, segment 2 with armament of medial spinules, exopod segment 3 with two small medial spines and one small lateral spine. Left exopod segment 1 with row of four small denticles distally; exopod segment 2 with armament of medial spinules, and exopod segment 3 with sparse medial spinules in its distal part.

Remarks. Genus *Xantharus* now includes three species described after females and males (*X. formosus*, *X. renatehaassae* and *X. siedleckii*). *Xantharus cryeri* Bradford-Grieve, 2005 is known after female only and the herein described *X. dubius* sp. nov. is represented by adult males only.

Genus *Xantharus* is a close relative of *Paraxantharus* Schulz, 2006 (Schulz 2006, Markhaseva 2010) and even the name given to the later genus refers the species as "near to imply a superficially similar taxon", i.e., *Xantharus* (Schulz 2006: 48). These two genera are distinguished mostly by the antennule ancestral segments XXII and XXIII comparatively small (*Xantharus*), or not small (*Paraxantharus*) relative to the antennule segment XXI. The other character to differentiate between these genera is the size of antenna endopod segment 1: endopod segment 1 is distinctly longer than terminal antenna exopod compound segment (*Xantharus*), or nearly equal in length, or shorter than terminal exopod compound segment (*Paraxantharus*). The new species possess antenna endopod segment 1 distinctly longer than antenna terminal exopod compound segment and share this character with Xantharus. The male of the new species, however, differs from *Xantharus* in the antennule ancestral segments XXII and XXIII not comparatively small relative to the segment XXI, and in this character shows similarity to the genus *Paraxantharus*.

The male of the new species is currently placed in the genus *Xantharus*, however, as the new species shares diagnostic characters of both genera *Xantharus* and *Paraxantharus* it is uncertain whether its taxonomic position is final. The taxonomic status of the new species may require adjustment in future, when females of this species are found, as the reduction of antennule ancestral segments XXII and XXIII is much more pronounced in females.

The representatives of the genus *Xantharus* have been recorded at depths 220 to 235 m in North Atlantic (Andronov 1981), between 500 and 1535 m in the Antarctic waters (Schulz 1998, 2006), in hauls from depths up to 330 m from the west coast of Spitsbergen Island (Schulz and Kwasniewski 2004), and from depths of 306 m from the New Zealand waters (Bradford-Grieve 2005). Herein given record is the deepest species findings (970–994 m).

Xantharus sp.

(Fig. 8A–C)

Material. Two CV females, damaged; one partly dissected, body length 0.85 mm; Japan Sea, 44°56'N, 137°12'E, station A2–10, 13 August 2010, above the sea bed at depth of 455–550 m; other CV female, also damaged, partly dissected, not measured, Japan Sea, 42°26'N, 133°07'E, station C–1, 26 August 2010, above the sea bed at depth of 2670–2841 m.

Remarks. Two damaged juvenile females of *Xantharus* were sorted from two samples collected in the Japan Sea. Their antennules show typical for the genus *Xantharus* ancestral segments XXII and XXIII reduced in size compared with the segment XXI

(Fig. 8B). Rostrum typical of *Xantharus*, however, filaments broken (Fig. 8 A) and P5 is of similar for *Xantharus* female structure. *Xantharus* CV females were collected in the different samples at different depths (455–550 m and 2670–2871 m). It is uncertain whether they belong to the same species, and whether these CV female juveniles can be attributed to the new species described here from the adult male; thus no biological name is given for them.

***Bradyidius rakuma* (Zvereva, 1977)**

(Figs 12–15)

Aetideopsis rakuma Zvereva 1977: 6–8, fig. 1.

Bradyidius rakuma: Bradford and Jillet 1980: 19–20; Markhaseva 1996: 79, figs 57–58.

Material examined: 15 adult females, 1 adult male and 20 juveniles, Japan Sea, 44°56'N, 137°12'E, station A2–10, 14 August 2010, above the sea bed at depth of 455–456 m; 49 adult females and 25 adult males, Japan Sea, 44°50'N, 137°14'E, station A3–10, 14 August 2010, above the sea bed at depth of 1354–1356 m; 77 adult females, 5 males and 42 juveniles, Japan Sea, 43°10'N, 135°00'E, station B6–6, 25 August 2010, above the sea bed at depth of 970–994 m, and 10 adult females, 2 males and 8 juveniles Japan Sea, 43°13'N, 135°04'E, station B7–7, 25 August 2010, above the sea bed at depth of 470–528 m.

Description. Adult male, total length 2.15–2.35 mm, prosome 2.2–2.8 times as long as urosome. Rostrum (Fig. 12E) with two rami, divergent. Cephalosome (Fig. 12A–B) and pediger 1, and pedigers 4 and 5 fused; posterior corners prolonged into spines extending beyond posterior border of urosomite 1 (Fig. 12A, C–D). Caudal rami (Fig. 12C–D) with four terminal plus one ventral and lateral setae each.

Antennule (Fig. 13A–D) right reaching to one third to middle length of urosomite 2, of 23 free segments; armature as follows: I – 1s + 1ae, II–IV – 6s + 4ae, V – 2s + 2ae, VI – 2s + ?, VII to IX – 2s + 2ae each; X–XI – 4s + 4ae, XII – 1s + 1ae; XIII to XIV – 2s + 1ae each; XV – 1s + 1ae, XVI to XXI – 2s + 1ae each, XXII–XXIII – 2s +1ae, XXIV to XXV – 2s + 1ae each, XXVI – 2s, XXVII–XXVIII, 5s + 1a. Left antennule of 24 free segments; armature as follows: I – 1s + 1ae, II–IV – 6s + 4ae, V – 2s + 1ae, VI – 2s + 2ae, VII – 2s +1?; VIII to IX – 2s + 2ae each; X–XI – 4s + 4ae, XII – 1s + 1ae; XIII to XIV – 2s + 1ae each; XV – 1s + 1ae, XXVI to XIX – 2s + 1ae each, XX – 2s + 2ae; XXI – 2s + 1ae; XXII – 1s; XXIII – 1s +1ae, XXIV to XXV – 2s + 1ae each, XXVI – 2s, XXVII–XXVIII, 5s + 1a.

Antenna (Fig. 13E), coxa with seta; basis with two setae; endopodal segment 1 without setae, endopodal segment 2 with 12 setae; exopod 7-segmented with 0, 0-1-1, 1, 1, 1, 1, 1 and 3 setae.

Mandible (Fig. 13F), gnathobase cutting edge with teeth reduced; exopod of five segments with 1, 1, 1, 1 and 2 setae; endopod segment 1 with two setae, endopod segment 2 with nine setae; basis with one seta, small.

Maxillule (Fig. 14A), praecoxal arthrite rudimentary, without setae; coxal endite absent, coxal epipodite with six setae; proximal basal endite with two setae, distal basal endite with three setae; endopod with 11 setae, exopod with 10 setae.

Maxilla (Fig. 13G), with setae poorly sclerotized at all endites and endopodite, their number as following: praecoxal endite bearing three setae, coxal with two setae; basal endites with two setae each; lobe of proximal endopodal segment with three setae. Endopod with four setae.

Maxilliped (Fig. 14B), syncoxa without setae; basis with one medial setae; endopod of six free segments with 2, 4, 4, 3, 3+1 and 4 setae.

P1 (Fig. 14C), basis with medial distal seta curved; endopod one-segmented with three medial and two terminal setae; lateral lobe well developed, details of Von Vaupel Klein's organ (Forshell and Ferrari 2014) were not considered in this study, rounded; exopod three-segmented, segment 1 with lateral spine small and thin, much smaller, then lateral spines of segment 2 and 3.

P2 to P4 as in female (Zvereva 1977).

P5 (Figs 12F, 14D–G) longer than urosome. Right leg coxa and basis shorter than in the left leg. Right leg exopod of two segments, segment 1 with tiny lateral spine, exopod segment 2 with 1 tiny lateral spine; endopod reaching beyond the middle length of exopod segment 1. Left leg exopod of three segments, segment 1 the longest; exopod segment 2 with semicircular attenuation covered by setules, segment 3 with sparse setules along medial edge.

Remarks. The male of *B. rakuma* is for the first time described. Until now the species *Bradyidius rakuma* was known after the female found in the single sample collected above the bottom at the depth 60 m in its type locality, the Sea of Okhotsk, Tobuti Bay, Aniva Gulf (Zvereva 1977; Markhaseva 1996). In the samples from the Japan Sea collected

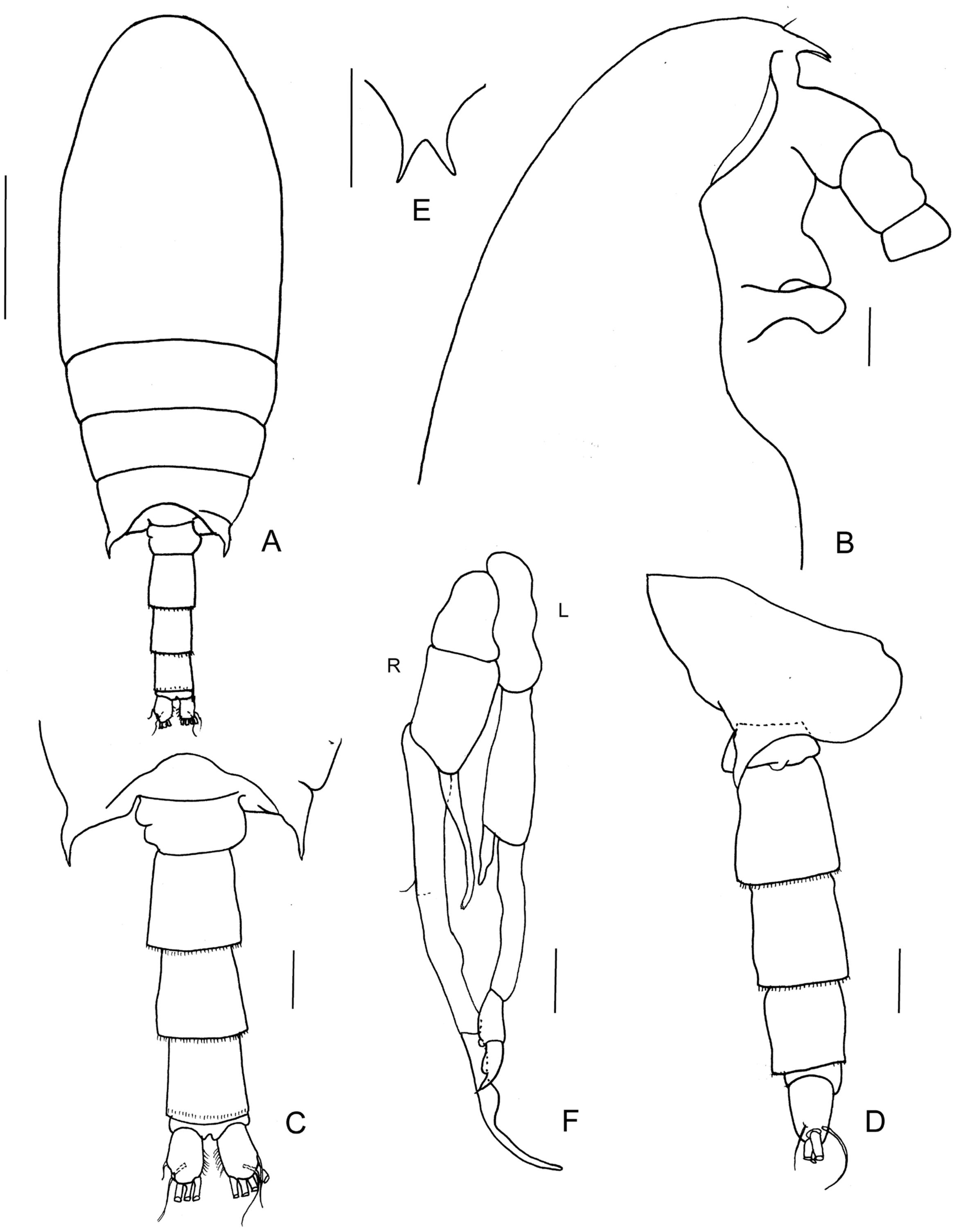

Fig. 12. *Bradyidius rakuma* (Zvereva, 1977), male; A – habitus, dorsal; B – cephalosome, anterior, lateral; C – posterior prosome and urosome, dorsal; D – posterior prosome and urosome, lateral; E – rostrum; F – P5. Scale bars: A, 0.5 mm, B–F, 0.1 mm. R, right; L, left.

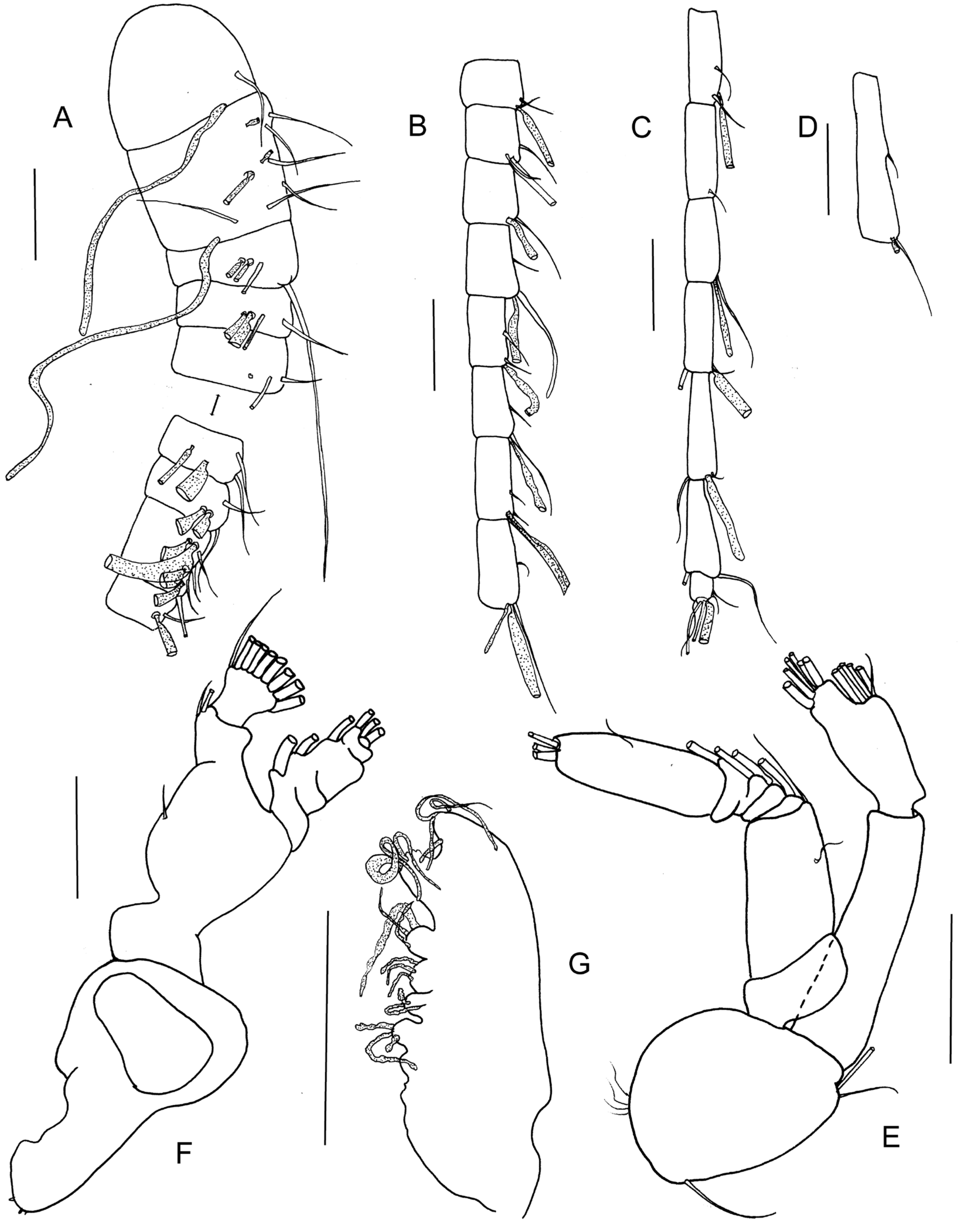

Fig. 13. *Bradyidius rakuma* (Zvereva, 1977), male; A – left antennule, ancestral segments I–XII; B – left antennule, ancestral segments XIII–XX; C – left antennule, ancestral segments XXI–XXVIII; D – right antennule, fused ancestral segments XXII–XXIII; E – antenna; F – mandible; G – maxilla. Scale bars: 0.1 mm.

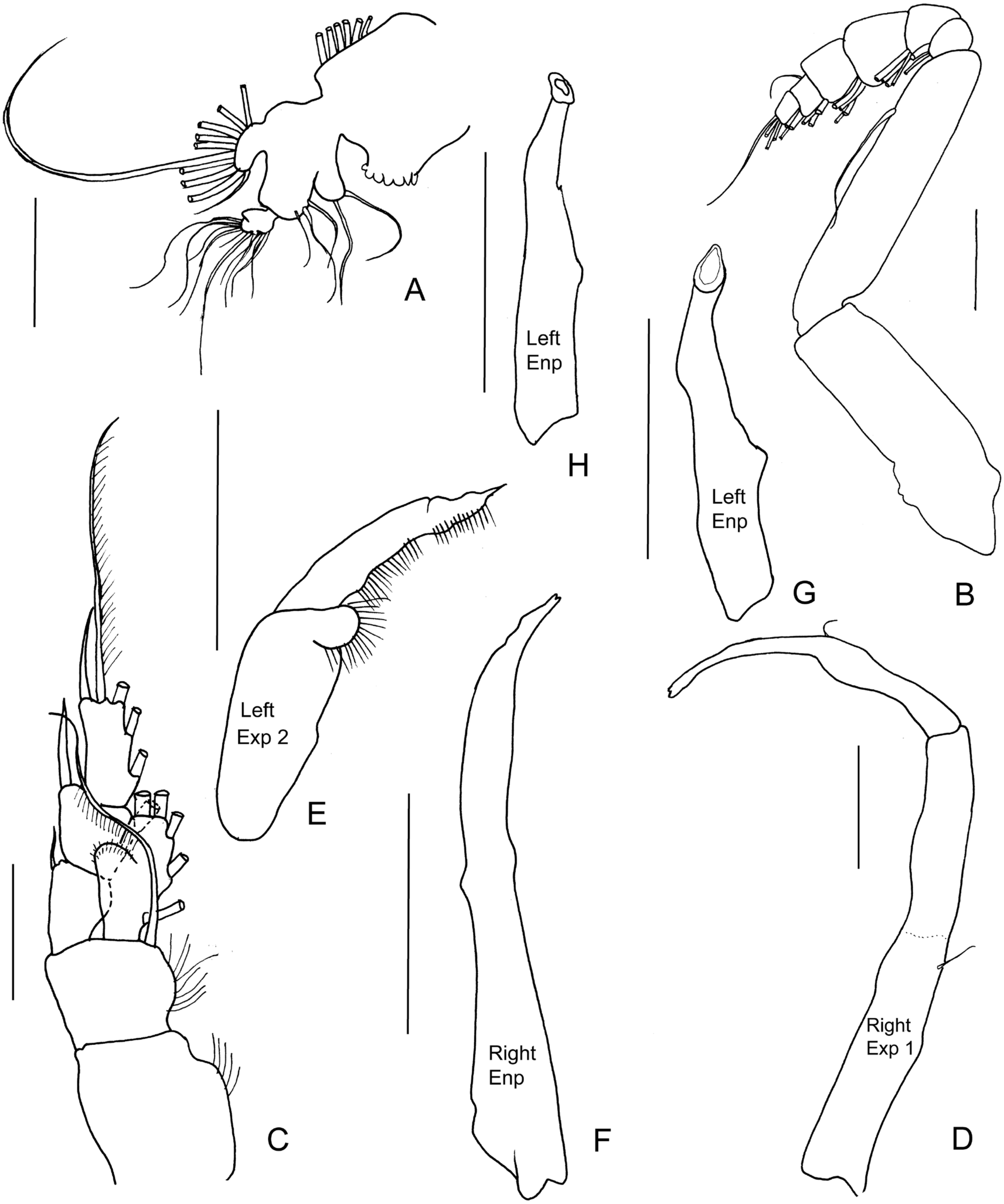

Fig. 14. *Bradyidius rakuma* (Zvereva, 1977), male; A – maxillule; B – maxilliped; C – P1; D – P5, right exopod segments 1 and 2; E – P5, left exopod segments 2 and 3; F – P5, right endopod; G–H – left endopod, different specimens. Scale bars: 0.1 mm. R, right; L, left.

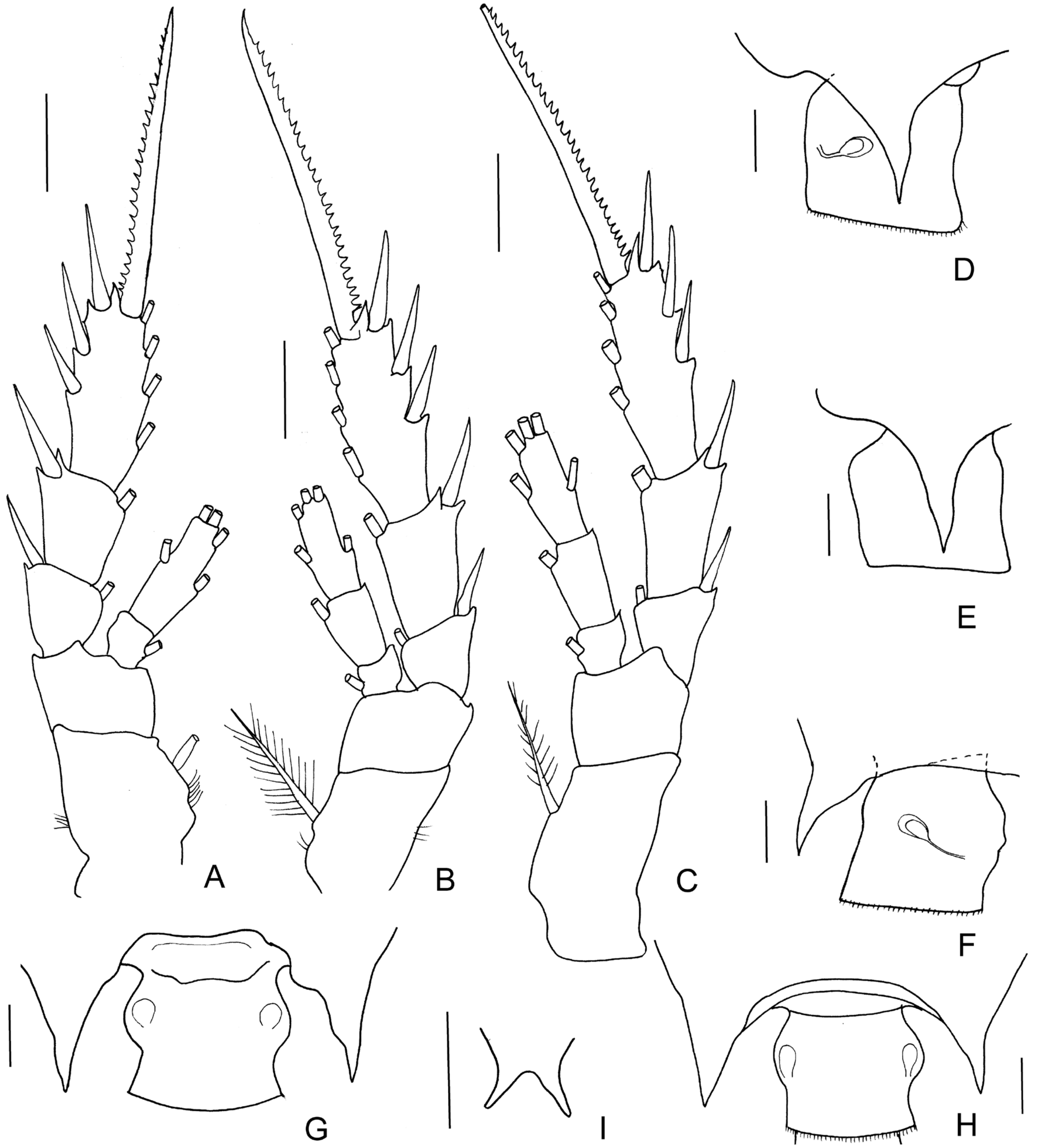

Fig. 15. *Bradyidius rakuma* (Zvereva, 1977), male, A – P2; B – P3; C – P4; female, D–F – prosome posterior corners and genital double somite, lateral view, different specimens; G–H – prosome posterior corners and genital double somite, dorsal view; I – rostrum. Scale bars: 0.1 mm.

by SoJaBio expedition in the depths range from 455 to 1356 m the species was quite numerous and represented by males and females, the later show a bit variative length of pediger 5 spine-like posterior corners (Fig. 15 D–H) and total length 2.85–3.05 mm.

RESULTS

The samples containing specimens of the Japan Sea calanoid deep-water demersal fauna have been obtained during the near-bottom sampling in the Japan Sea in frames of SoJaBio expedition in 2010. Of total 14 samples collected during SoJaBio above the sea bed, only five contained benthopelagic calanoid representatives, these are: *P. japonica* sp. nov., *X. dubius* sp. nov., *Xantharus* sp. and *B. rakuma*. All these taxa belong to the evolutionary young calanoid superfamily Clausocalanoidea. Benthopelagic calanoid fauna in the geographically close waters of Japan (e.g., Amami Oshima, Zamami Islands and Nansei Islands) and Korea (Yogji Island) shows higher diversity and includes more clausocalanoidean taxa and also representatives of the other calanoid, superfamilies, e.g., Arietelloidea and Pseudocyclopoidea (Ohtsuka and Boxshall 2004; Ohtsuka at al. 2003, 2005; Soh et al. 2013; Komeda et al. 2021). It is not clear whether the absence of the individuals from the other calanoid superfamilies can be considered a typical feature of the Japan Sea calanoid demersal fauna, or this is explained by poor materials available for the study. The collection studied and presented herein can be considered the first step contribution to the Japan Sea near-bottom calanoid fauna knowledge.

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