Integrative taxonomy of *Janirella* (Isopoda: Asellota: Janirellidae), with descriptions of two new species from the Japan Trench and an amended classification of the genus

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Abstract

We describe two new *Janirella* species, *Janirella scutum* sp. n. and *Janirella spinoscutum* sp. n., collected at depths of 2893–3176 m on the landward slope of the Japan Trench, northwestern Pacific. These species differ from congeners in having a fusiform body with dorsal spines on each pereonite; and the pleotelson with two pairs of short and one pair of long lateral projections; rostrum as long as cephalothorax, tip concave, with two distal spines. They differ from one another in the number and size of dorsal spines on the pereonites. We determined partial sequences for the cytochrome *c* oxidase subunit I (COI) gene for the two new species and seven other *Janirella* species and constructed a COI-based maximum-likelihood tree of *Janirella*. In the tree, the subgenus *Parjanirella* was monophyletic but embedded within a paraphyletic group of species in the subgenus *Janirella*. Based on this result, we propose the elimination of subgenus ranks in *Janirella*.

Keywords Biodiversity · Deep sea · Phylogeny · Subgenus

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Introduction

Janirella Bonnier, 1896, one of three genera in the family Janirellidae Menzies, 1956, differs from the other genera in having a fusiform body and the cephalothorax with a true rostrum (Just 2009). *Janirella* currently contains 37 species and two subspecies that inhabit the sea floor at depths of 875 to 9043 m in the Pacific and Atlantic oceans, nearly half (17) of these species were reported from the northwestern Pacific (Just 2009; Ohta et al. 2020).

Birstein (1971) subdivided *Janirella* into two subgenera, *Janirella* Bonnier, 1896 and *Parjanirella* Birstein, 1971. The former contains 33 species and shows a wide distribution spanning both oceans, whereas all five species in the latter have been reported only from the Japan Trench and the Kuril–Kamchatka Trench in the northwestern Pacific (Just 2009; Ohta et al. 2020). Gamô (1983) amended the subgeneric diagnoses, with the two subgenera currently distinguished by the number of the pairs of lateral projections on the pleotelson (three to five pairs in *Janirella*; one pair in *Parjanirella*), and the presence/absence of a spine or seta on the apex of lateral projections on pereonites (present in *Janirella*; absent in *Parjanirella*). The latter diagnostic character has, however, not been consistently adopted. For example, an apical spine or seta is lacking in *J.* (*J.*) *lobata* Richardson, 1908; *J.* (*J.*) *magnifrons* Menzies, 1962; and *J.* (*J.*) *fusiformis* Birstein, 1963. For practical purpose, the state of the first diagnostic character alone has been used to distinguish the two subgenera.

In a recent deep-sea faunal survey, we collected several *Janirella* species, two of which occurred at depths of around 3000 m on the western slope of the Japan Trench and appeared to be undescribed species. Here we describe these two species, present DNA sequences for the cytochrome *c* oxidase subunit I (COI) gene from eight *Janirella* species and present a COI-based phylogenetic tree for *Janirella* species to test the currently accepted classification of *Janirella*.

Materials and methods

Sampling and morphological observation

Our *Janirella* individuals were collected from 10 stations at depths of 2886–6211 m in the Japan Trench and adjust landward slope from 2016 to 2023 (Table 1), aboard the research vessels (R/V) *Shinsei-maru* (Japan Agency for Marine-earth Science and Technology, JAMSTEC) and R/V *Hakuho-maru* (JAMSTEC), using the 3 m and 4 m beam trawls with inner nets (φ 330–500 µm; see Akiyama et al. 2008) and an Agassiz-type trawl. In addition, two outgroup specimens were also collected from adjust landward slope of the Japan Trench (Table 1). Specimens were kept cool throughout the sorting process and fixed on board with boiling water and 99.5% ethanol. The habitus of specimens in ethanol was observed under an SZM720T stereomicroscope (AS ONE, Japan). Dissections were carried out with needles under an SZX9 stereomicroscope (OLYMPUS, Japan). Appendages were mounted on glass slides in glycerin and observed with a BX53 light microscope (OLYMPUS, Japan); after observation, remaining body and appendages were stored in 99.5% ethanol.

The terminology for setae and spines follows Riehl and Brandt (2010); we abbreviated “broom and pedestal pappose seta” as “BP seta” and “sensory seta” as “SS” in this study. Body length (BL) was measured from the base of the antennula to the base of the uropod, excluding the posterior projection on the pleotelson; body width (BW) was measured at the widest part of the pereon, excluding the lateral projections. Body-segment width was measured at the widest point of each segment, excluding the lateral projections. Cephalothorax length was measured from the base of the antennula to the posterior margin of the cephalothorax. Pleotelson length was measured from the anterior margin of the pleotelson to the base of the uropod. The length of posterior projection on the pleotelson was measured from the base of uropod to the tip of the pleotelson. Pencil drawings were done by hand with the aid of a drawing tube and inked by using Clip Studio Paint EX (CELSYS, Japan). Identification to species of specimens included in the molecular analysis (except for the two species described here) followed Birstein (1963, 1971), Gamô (1983), and Kussakin (1988). All *Janirella* specimens studied were deposited in the Invertebrate Collection of the Hokkaido University Museum (ICHUM), Sapporo, under catalogue numbers ICHUM8836–ICHUM8843.

DNA extraction, PCR amplification, and Sanger sequencing

Total DNA was extracted from one to three pereopods from each of 18 isopods by using a DNeasy Blood and Tissue Kit (QIAGEN, Germany). Part of the COI gene was amplified by PCR with the primer pair LCO1490 and HCO2198 (Folmer et al. 1994). PCR amplifications were performed with TaKaRa Ex Premier DNA polymerase (TaKaRa Bio, Japan); amplification conditions were 94 ºC for 60 s followed by 35 cycles of 98 ºC for 10 s, 42 ºC for 15 s, and 68 ºC for 30 s.

Amplification products were purified by using ExoSAP-express (Thermo Fisher Scientific, USA). Sequencing reactions were conducted with a BigDye Terminator Cycle Sequence Kit v3.1 [Applied Biosystems (ABI), USA]; after purification with a BigDye XTerminator Purification Kit (ABI), nucleotide sequences were determined on an ABI 3130xl automated DNA sequencer.

Phylogenetic analysis

A COI dataset comprising 18 *Janirella* sequences and two outgroup specimens from our study, and two sequences of *J. longicauda* (determined by authors of this manuscript and submitted directly to GenBank in 2020) (Table 1) was aligned by using ClustalW (Higgins et al. 1994) implemented in MEGA X software (Kumar et al. 2018); the aligned dataset was 652 bp long. The optimal substitution model, determined with the Akaike information criterion (AIC) in the ModelFinder (Kalyaanamoorthy et al. 2017) program packaged in IQ-TREE 1.6.12 (Nguyen et al. 2015), for each (first, second, third) codon were TPM2+F+G4, SYM+I, and TPM3+F+I, respectively. A maximum likelihood (ML) analysis was conducted in IQ-TREE 1.6.12, with nodal-support values obtained from approximate Bayesian computation (Anisimova et al. 2011) and an ultrafast bootstrap analysis for 1000 pseudoreplicates. Sequence divergences were calculated using the Kimura 2-parameter (K2P) distances model within each species with MEGA X. Tree was visualized by using iTOL (Letunic and Bork 2021; https://itol.embl.de/) and prepared for publication with Adobe Illustrator (Adobe, USA).

Results

Taxonomy

Family Janirellidae Menzies, 1956

[Japanese name: Kazari-mizumushi-ka]

Genus *Janirella* Bonnier, 1896

[New Japanese name: Kazari-mizumushi-zoku]

***Janirella scutum* sp. n.**

[New Japanese name: Tate-kazari-mizumushi]

https://zoobank.org/NomenclaturalActs/1CC15A80-1C18-4D72-B833-3E98C5B63735

(Figs. 1–4)

Diagnosis. Pereonites 2 and 3 each with four dorsal spines. Pleotelson with two anterior pairs of short and one pair of long lateral projections. Rostrum as long as cephalothorax, tip concave, with two distal and two or three short lateral spines.

Description of holotype male. Body (Fig. 1a, b) fusiform, BL = 4.4 mm, body depth about 0.3 times BW, BW 0.48 times BL; cephalothorax to pereonite III increasing in width; pereonite III (widest body segment) 1.1 times as wide as pereonite IV; pereonites IV to VII decreasing in width; pereonite VII slightly wider than pleotelson; fine setae sparsely distributed on body segments. Granules (some with seta) present on dorsal surface of cephalothorax and pereonites, dense laterally and sparse dorsally on pereonites; granules (some with seta) covering dorsal surface of pleotelson. Coxa slightly visible dorsally on pereonite V.

Cephalothorax with pair of tapering lateral projections and pair of small dorsal spines. Rostrum as long as cephalothorax, tip concave, with two distal and two or three short lateral spines. Pereonites all subequal in length, with transverse groove dorsally. Pereonite I with pair of anterior dorsolateral spines bearing apical spine-like seta, pair of tapering lateral projections, two small dorsal and two dorsolateral spines. Pereonites II–IV each with pair of anterolateral projections, each bearing apical spine-like seta, pair of tapering posterolateral projections length 4.5, 5.0, 0.3 times anterolateral projections respectively, two dorsal and two dorsolateral spines. Pereonites V–VII each with pair of tapering anterolateral projections, two small dorsal and two dorsolateral spines. Sternite horn on ventral side of pereonite VII, length 0.4 times body depth at pereonite VII (Fig. 1d).

Pleotelson (Fig. 1a–d) length about 0.8 times as maximum pleotelson width; lateral margin with two pairs of short lateral projections anteriorly and one posterior pair of long projections posteriorly, each with apical spine-like seta; posterior projection length about 0.9 times pleotelson length. Dorsal surface with pair of longitudinal grooves, two dorsal spines.

Antennula (Fig. 1e) with nine articles: article 1 rectangular, length 1.6 times width, covered with scales, distally with two BP setae, and some simple setae; article 2 length 0.7 times as article 1 length, distal part with two BP setae and some simple setae; article 3 as long as article 2, with three simple setae ventrodistally; article 4 length 0.2 times article 3, with BP seta distally; article 5 length 1.9 times article 4 and equal to article 6; articles 6–9 decreasing in length, each with aesthetasc. Antenna (Fig. 1f, g, g1, g2, g3) long, length 1.65 times BL, peduncle articles 3 and 4 covered with scales. Peduncle article 1 trapezoidal; article 2 trapezoidal, slightly longer than article 1, with two short distal setae; article 3 trapezoidal, with one robust and some simple setae dorsodistally and two long simple setae ventrodistally; squama length 0.4 times article 3 length, with two robust setae and simple seta distally; article 4 triangular, with some dorsal and three long ventral simple setae distally; article 5 entirely covered with short simple setae; article 6 length 1.5 times article 5 length, entirely covered with short simple setae. Flagellum length 0.9 times peduncle, with 41 articles; article 1 long, about five times as long as article 2, articles 2–41 equal in length, each article with 1–4 distal simple setae.

Clypeus and labrum (Fig. 2a) smooth. Left mandible (Fig. 2c) with lacinia mobilis 2 half as wide as incisor, with three teeth and two simple setae distally. Incisor with five teeth. Setal row with nine serrate setae. Molar process about twice as long as incisor, with five teeth and row of simple setae distomedially. Palp articles 1 and 2 subequal in length; article 1 with four long simple setae distally; article 2 with three short serrate setae distolaterally; article 3 length 0.5 times article 2, with dense rows of stiff and serrate setae on concave and distal margins. Right mandible (Fig. 2d) with incisor bearing five teeth. Setal row with 11 serrate setae. Molar process about twice as long as incisor, with three large and some small teeth and row of some simple setae distolaterally. Palp articles 1 and 2 subequal in length; article 1 with four long simple setae distally; article 2 with three short serrate setae distolaterally; article 3 length 0.6 times article 2, with dense row of stiff setae and serrate setae on concave margin. Lower lip (Fig. 2e) with large, ovoid outer lobe bearing dense row of fine setae medially; inner lobe small, rounded. Maxilla I (Fig. 2f) outer plate with 10 serrate distal setae and distomedial simple setae; inner plate with four long distal simple setae and surrounding short setae. Maxilla II (Fig. 2g) with outer and middle lobes subequal in length; inner lobe broader, shorter, rounded distally, with three distal and one distomedial serrate setae, with surrounding simple setae in distal and medial regions; outer lobe flat distally, with three long serrate setae distally, medial row of simple setae, and simple fine setae on lateral margin; middle lobe flat distally, with three long serrate setae distally, two medial rows of simple setae. Maxilliped (Fig. 2b) with coxa naked. Epipod length 1.1 times endite basis, tapering distally, covered with circular scales, without setae. Endite (Fig. 2b1) length 2.3 times width, distally concave, with row of four broad, fan-shaped serrate setae surrounded simple fine setae; dorsal medial region with numerous fine setae; lateral margins with fine setae; midline margins with three (left) or four (right) coupling hooks. Palp with five articles; article 1 with one lateral and one medial setae; article 2 rectangular, as wide and about three times as long as article 1, with fine lateral setae, five long medial, and several short distal setae; article 3 rectangular, length about 0.7 times article 2 length, with eight distomedial setae and some lateral setae; article 4 slightly shorter and narrower than article 3, with five distomedial, one or two distal, one lateral, and one distolateral simple setae; article 5 narrowest, length about 0.8 times article 4 length, with approximately ten simple setae distally.

Pereopod I (Fig. 3a) shorter and more robust than following pereopods, relative lengths (basis : ischium : merus : carpus : propodus : dactylus) 1 : 0.6 : 0.3 : 0.9 : 0.5 : 0.3. Basis length 2.5 times width; basis covered dorsally with tubercles and entirely with fine setae. Ischium as long as wide, covered entirely with fine setae. Merus triangular, length 0.6 times width, with two dorsodistal, one ventrodistal, and one mid-ventral SS, and ventral fine setae. Carpus length 2.4 times width; dorsal region with fine setae; ventral region with five simple setae anteriorly, eight SS and five simple setae marginally, and SS posterodistally. Propodus 2.8 times as long as wide, with several simple setae dorsally, three simple setae dorsodistally, and five SS and several simple setae ventrally. Dactylus three times as long as wide, with one dorsodistal and three ventral fine setae, and ventrodistal simple seta; main claw length 0.7 times dactylus length.

Pereopods II–VII (Figs. 3b–f, 4a, b) similar but variable in number of setae on carpus and propodus. Pereopod II (Fig. 3b) relative lengths (basis to dactylus) 1 : 0.6 : 0.3 : 0.8 : 0.7 : 0.4. Basis 3.3 times as long as wide, covered with tubercles dorsally, with dorsoproximal BP seta and dorsolateral SS; entirely covered with fine setae. Ischium 2.8 times as long as wide, entirely covered with fine setae. Merus trapezoidal, 1.3 times as long as wide, with two dorsodistal SS, and one dorsodistal and several ventral fine setae. Carpus 3.8 times as long as wide; dorsal region with fine setae; ventral region with six SS and two simple setae anteriorly, two SS marginally, and eight sensory and three simple setae posteriorly. Propodus 5.3 times as long as wide, with posterior distal subtriangular lobe; dorsal region with several simple setae; ventral region with four simple setae anteriorly, six SS marginally, and four simple setae posteriorly; ventrodistal corner with SS and several simple setae. Dactylus four times as long as wide, with one dorsodistal and three ventral fine setae and ventrodistal simple seta; main claw half as long as dactylus. Number and condition of ventral setae on carpus and propodus of pereopods III–VII summarized in Table 2.

Pleopod I (Fig. 4c) length 3.0 times width, with slight dorsolateral projection bearing some scales. Inner lobe distally pointed, overlapping outer lobe at base, with approximately 15 simple setae laterally; outer lobe fringed with fine setae. Pleopod II (Fig. 4d) protopod triangular, length 3.5 times width, acutely pointed; stylet length equal to protopod length; exopod inserted on 0.3 of protopod length from distal margin, hook robust, 1.6 times width of proximal part of exopod. Pleopod III (Fig. 4f) endopod trapezoidal, length 2.0 times width, with five long distal plumose setae; exopod triangular, length 0.8 times endopod length, 3.5 times width, acutely pointed; lateral and partly medial margins covered with dense fine setae, with relatively long simple seta apically. Pleopod IV (Fig. 4g) endopod broadly triangular, length 1.8 times width, pointed apically; exopod rhomboidal, length 0.9 times endopod length, 2.9 times width, with pointed apex bearing long plumose seta. Pleopod V (Fig. 4h) ovoid, length equally to pereopod IV endopod, 1.6 times width, thickened laterally.

Uropod (Fig. 1h) protopod with three simple distal setae, broken; ramus length 4.0 times width and 0.8 times protopod length, with three simple setae distomedially and broom seta apically.

Description of paratype female. Body fusiform, BL = 5.4 mm, body depth about 0.2 times BW, BW 0.52

times BL, proportionally slightly wider than holotype male, widest at pereonite 3, with numerous granules and spines dorsally, as in male. Cephalothorax, rostrum, pereonites, and pereopods as in male.

Operculum (Fig. 4e) subtriangular, length 1.4 times width, apex slightly pointed and distal margin with some fine setae; ventrodistal area with some short setae.

Type material. Holotype: male (ICHUM-8836), BL 4.4 mm, western Japan Trench, Station EC4, off Erimo Cape, Hokkaido, Japan, (41º20.79’N, 144º56.46’E to 41º20.52’N, 144º57.30’E), 3,143–3,176 m depth, 3-m beam trawl, 19 August 2020, R/V *Shinsei-maru*. Paratype: 1 female (ICHUM-8837), BL 5.4 mm, same collection data as for the holotype.

Specimens for DNA sequencing. Holotype male (ICHUM-8836) and paratype female (ICHUM-8837); one male (ICHUM-8838) and one female (ICHUM-8839), same collection data as for the holotype.

Etymology. The specific name is a singular noun in the nominative case, derived from the Latin *scutum* (shield), referring to the convex, shield-like, fusiform body shape.

Distribution. This species collected from only type localities.

***Janirella spinoscutum* sp. n.**

[New Japanese name: Toge-tate-kazari-mizumushi]

https://zoobank.org/NomenclaturalActs/3A6FFF7B-E636-4B23-AE6A-2C0A9CBDB8FB

(Figs. 5–8)

Diagnosis. Pereonites II and III each with eight dorsal spines. Pleotelson with two pairs of short anterolateral projections and one pair of longer mid-lateral projections. Rostrum as long as cephalothorax, tip concave, with two distal spines.

Description of males, based primarily on holotype. Body (Fig. 5a, b) fusiform, BL = 6.5 mm, body depth about 0.2 times BW, BW 0.48 times BL; cephalothorax to pereonite III increasing in width; pereonite III (widest body segment) 1.1 times as wide as pereonite IV; pereonite IV to pleotelson decreasing in width. Coxae slightly visible dorsally on pereonites II–VII.

Cephalothorax with pair of tapering lateral projections and pair of robust dorsal spines; rostrum as long as cephalothorax, tip concave, with two distal spines, short dorsal spines, and several dorsal fine setae. Pereonites all subequal in length. Pereonite I with pair of tapering lateral projections and six dorsal/dorsolateral spines. Pereonites II and III each with pair of anterolateral projections, pair of tapering posterolateral projections length equally to and 3.5 times anterolateral projections, six dorsal and two dorsolateral spines. Pereonite IV with pair of anterolateral projections, pair of tapering posterolateral projections length 2.5 times anterolateral projections, four dorsal and two dorsolateral spines. Pereonites V and VI each with pair of tapering anterolateral projections and four dorsal and two dorsolateral spines. Pereonite VII with pair of tapering lateral projections (left one broken in holotype) and four dorsal spines. Sternite horn on ventral side of pereonite VII, length 0.2 times body depth at pereonite VII (Fig. 5d).

Pleotelson (Fig. 5a–e) length about 0.8 times longer than maximum pleotelson width; lateral margin with two pairs of short lateral projections anteriorly and one posterior pair of long projections posteriorly, each with apical spine-like seta; posterior projection length about 0.8 times pleotelson length; Dorsal surface with sparsely distributed granules (some with seta), pair of longitudinal grooves, four dorsal and four dorsolateral spines.

Antennula (Fig. 5f) with 12 articles. Article 1 rectangular, length 1.9 times width, with BP seta and some simple setae distally; article 2 half as long as article 1, distally with four BP setae and some simple setae; article 3 length 2.0 times article 2; article 4 length 0.1 times article 3; article 5 length 2.8 times article 4 and equal to article 6; articles 6–12 decreasing in length, each with aesthetasc; articles 6, 8, and 12 with one, one, and three simple setae, respectively. Antenna (Fig. 5g–i) long, length 1.55 times BL, peduncle covered with scales. Peduncle article 1 triangular; article 2 trapezoidal, slightly longer than article 1, with some short lateral setae; article 3 trapezoidal, with some simple and some robust setae dorsodistally and some simple setae ventrodistally; squama length 0.4 times article 3 length, with distal fine seta; article 4 trapezoidal, with some short ventrodistal simple setae; article 5 entirely covered with short simple setae; article 6 length 1.3 times article 5 length, entirely covered with short simple setae. Flagellum length 0.6 times peduncle, with 50 articles, each article with 1–4 distal simple setae.

Clypeus and labrum (from paratype ICHUM-8841; Fig. 6a) smooth. Left mandible (Fig. 6c, c1,c2) with lacinia mobilis length 0.3 times incisor, with five teeth and two simple setae distally. Incisor with six teeth; setal row with approximately 15 serrate setae. Molar process about twice as long as incisor, with row of some simple setae distomedially. Palp articles 1 and 2 subequal in length; article 1 with four long simple setae distally; article 2 with three serrate and one pectinate setae; article 3 length 0.7 times article 2, with dense row of stiff setae and serrate setae on concave and distal margins. Right mandible (from paratype ICHUM-8841; Fig. 6d) with incisor bearing four teeth. Setal row with approximately 12 serrate and two simple setae. Molar process about twice as long incisor, with some small teeth. Palp articles 1 and 2 subequal in length; article 1 with five long simple setae distally; article 2 with two short serrate setae distolaterally; article 3 with dense row of stiff setae and serrate setae on concave and distal margins. Lower lip (Fig. 6e) with large, rounded outer lobe having dense row of fine setae medially, inner lobe small, rounded, with short setal row distomedially. Maxilla I (Fig. 6f) outer plate with 11 serrate distal setae, some distomedial simple setae, and dense fine setal row on part of lateral region; inner plate with four long distal simple setae and surrounding short setae. Maxilla II (Fig. 6g) with outer and middle lobes subequal in length, inner lobe broader, shorter; outer lobe rounded distally, setae lost during dissection; middle lobe rounded distally, distal and mediolateral margins with row of simple setae; inner lobe rounded distally, with four distal and one distomedial serrate setae and surrounding simple setae on distal and medial margins. Maxillipedal (Fig. 6b) coxa naked. Epipod tapering distally, length 1.2 times endite basis, covered with circular scales, with medial dense fine setae. Endite basis length 2.1 times width, distally concave, with row of three broad fan-shaped serrate setae surrounded simple fine setae; dorsomedial region with numerous fine setae; medial margin with three coupling hooks. Palp with five articles; article 1 without setae; article 2 rectangular, about three times as long as article 1, as wide as article 1, with some fine lateral setae, and eight medial long and several distal setae; article 3 trapezoidal, length about 0.7 times article 2 length, with eight distomedial setae and some lateral setae; article 4 slightly shorter and narrower than article 3, with two distomedial and one distolateral simple setae; article 5 narrowest, length about 0.7 times article 4 length, with four simple setae distally.

Pereopod I (Fig. 7a) shorter and more robust than following pereopods, relative lengths ratios (basis to dactylus) about 1 : 0.4 : 0.2 : 0.8 : 0.4 : 0.2. Basis 3.2 times as long as wide, ventrally with some fine setae and dorsoproximal BP seta, covered dorsally with tubercles. Ischium 1.6 times as long as wide, covered entirely with fine setae. Merus triangular, length 0.7 times width, with two dorsodistal, two ventrodistal, and one ventral SS and ventral fine setae. Carpus 2.4 times as long as wide; dorsal and dorsodistal regions with fine setae; ventral region with approximately 10 simple setae anteriorly, seven SS and some simple setae marginally, and SS posterodistally. Propodus twice as long as wide, with some simple setae dorsally, three simple setae dorsodistally, and five SS ventrally. Dactylus three times as long as wide, with two dorsodistal and two ventral fine setae; main claw length 0.7 times dactylus length.

Pereopods II–VII (Figs. 7b–e, 8a, b) similar but variable in number of setae on carpus and propodus. Pereopod II (Fig. 7b) relative article lengths (basis to dactylus) 1 : 0.7 : 0.3 : 0.7 : 0.7 : 0.3. Basis 3.5 times as long as wide, covered with tubercles dorsally, two robust (unclear whether sensory) setae dorsolaterally, and fine setae over the entirety. Ischium 2.8 times as long as wide, with some fine setae over the entirety. Merus trapezoidal, 1.4 times as long as wide, with two dorsodistal SS, and several ventrodistal and several lateral fine setae. Carpus 3.7 times as long as wide; dorsal region with fine setae; ventral region with 10 SS and three simple setae anteriorly, 11 SS marginally, SS and three simple setae posteriorly. Propodus 7.5 times as long as wide, with posterior distal subtriangular lobe; dorsal region with simple setae; ventral region with seven simple setae anteriorly and eight SS posteriorly; ventrodistal corner with one SS. Dactylus four times as long as wide, with three dorsodistal fine setae, ventrodistal simple seta, and three ventrolateral fine setae; main claw length 0.3 times dactylus length. Number and condition of ventral setae on carpus and propodus of pereopods III–VII summarized in Table 2.

Pleopod I (Fig. 8c) 3.1 times width, with slight dorsolateral projection having some scales. Inner lobe pointed, overlapping outer lobe at base, with approximately 12 lateral simple setae; outer lobe fringed with fine setae. Pleopod II (Fig. 8d, e) protopod triangular, length 3.3 times width, acutely pointed; stylet (Fig. 8e) length 0.8 times protopod length; exopod inserted on 0.3 of protopod length from distal margin, hook narrow, 0.5 times width of proximal part of exopod. Pleopod III (Fig. 8f) endopod trapezoidal, 1.9 times width, with three long distal plumose setae, medial margin partly covered with dense fine setae; exopod with length 0.8 times endopod length and 3.4 times width, acutely pointed, lateral and part of medial margin covered with dense fine setae, with long simple seta apically. Pleopod IV (Fig. 8g) endopod broadly oval, tip broken; exopod trapezoidal, length 2.5 times width, pointed apex with long plumose seta, lateral margin covered with dense fine setae. Pleopod V (Fig. 8h) oval, length 1.6 times width, thickened laterally.

Uropod (Fig. 5j) protopod with some simple distal setae; ramus length 0.8 times protopod length, with one lateral and one apical simple seta.

Description of paratype female. Body fusiform, BL = 5.6 mm, body depth about 0.2 times BW, BW 0.56 times BL, proportionally slightly wider than holotype male; widest at pereonite 3, dorsal spines relatively large, similar in size to those in male but slightly smaller to male. Cephalothorax, rostrum, all pereonites, and pereopods similar to those in male.

Operculum (Fig. 5k) subtriangular, length 1.4 times as long as width, apex slightly pointed, and ventrodistal area with some fine setae.

Type material. Holotype: male (ICHUM-8840), BL 6.5 mm, western Japan Trench, Station K5, off Onagawa, Miyagi, Honshu Island, Japan (38º28.98'N, 143º28.24'E to 38º27.51'N, 143º28.74'E), 2893–2886 m depth, 3-m beam trawl, 12 November 2016, R/V *Shinsei-maru*. Paratypes: one male (ICHUM-8841), BL 6.5 mm, western Japan Trench, Station K7, off Otsuchi, Iwate, Honshu Island, Japan (39º20.00'N, 143º33.20'E to 39º21.21'N, 143º33.33'E), 2928–3024 m depth, 3-m beam trawl, 13 November 2016, R/V *Shinsei-maru*; one female (ICHUM-8842), BL 5.6 mm, same collection data as for paratype male.

Specimens for DNA sequencing. Holotype male (ICHUM-8840), paratype male (ICHUM-8841), and paratype female (ICHUM-8842); one female (ICHUM-8843), same collection data as for paratypes.

Etymology. The specific name *spinoscutum* is a compound noun in the nominative case, derived from the Latin *spina* (spine) and *scutum* (shield), meaning spiny shield.

Distribution. This species collected from only type localities.

Phylogeny and genetic distance

We obtained novel partial nucleotide sequences for the COI gene (652 bp) from 20 individuals representing eight *Janirella* species and two munnopsid species for outgroups (DDBJ/EMBL/GenBank accession numbers LC816599–LC816616, LC833825, LC833826; Table 1). The maximum K2P distance within taxa was 2.0% in *J.* (*Parjanirella*) *sedecimtuberculata*. Our phylogenetic tree (Fig. 9) shows a fully supported *J.* (*Parjanirella*) clade (approximate Bayesian value [BP] = 1.000; ultrafast bootstrap value [BS] = 100%) embedded within a paraphyletic *Janirella* (*Janirella*) group. The *Janirella* (*Parjanirella*) clade is the sister group to *J.* (*J.*) *spinosa* + *J.* (*J.*) *polychaeta*, with high nodal support (BP/BS = 1.000/95%). *J.* (*J.*) *fusiformis*, *J.* (*J.*) *longicauda*, and *J.* (*J.*) *tuberculata* clade were moderately supported (BP/BS = 1.000/95%), but no strong support was found among other species. Species of *J.* (*Janirella*) did not form an exclusive clade, i.e., *J.* (*Janirella*) was not monophyletic in our tree.

Discussion

Janirella scutum sp. n. and *J. spinoscutum* sp. n. are closely similar, sharing the following morphological characters: dorsal spines present on each pereonite, the pleotelson with two pairs of short anterolateral and one pair of long lateral projections, and the posterior projection on the pleotelson shorter than pleotelson length. This combination of characters distinguishes these two species from the other congeners.

Janirella scutum sp. n. and *J. spinoscutum* sp. n. differ in the number of dorsal/dorsolateral spines on pereonites 2 and 3 (four in *J. scutum* sp. n., eight in *J. spinoscutum* sp. n.), the size of dorsal spines on segments, especially on the pleotelson (larger in *J. spinoscutum* sp. n.), and the number and condition of setae on the pereopodal carpus and propodus (*J. spinoscutum* sp. n. has more UB setae than *J. scutum* sp. n.). Conspicuous dorsal spines on the pereonites have also been reported in 10 species of the genus: *J. nanseni* Bonnier, 1896; *J. lobata* Richardson, 1908; *J. spongicola* Hansen, 1916; *J. carribica* Menzies; 1962; *J. diplospinosa* Birstein, 1971; *J. hexaspinosa* Birstein, 1971; *J. priseri* Chardy, 1972; and *J. laubieri* Chardy, 1974; *J. aculeata* Gamô, 1983; and *J. sydneyae* George, 2004. These species differ from *J. scutum* sp. n. and *J. spinoscutum* sp. n. in having the lateral projections on the pleotelson subequal in length or having only one pair of lateral projections. Similar to the two new species, *J. longicauda* Ohta, Kojima, & Shimomura, 2020 has two pairs of short anterior and one pair of long posterior lateral projections on the pleotelson, but it differs from the two new species in following features: lacking dorsal spines on the pereonites; having longer posterior projection of pleotelson; having longer stylet on the pleopod II.

In our COI-based tree, a fully supported *J.* (*Parjanirella*) clade was embedded within a paraphyletic group containing *J.* (*Janirella*) sequences, including those from the two new species. Since the two subgenera do not form reciprocally monophyletic groups, there is no justification (on phylogenetic grounds, at least) for retaining *Parjanirella* as a subgenus. Having one pair of lateral projections on the pleotelson does constitute a synapomorphy for the *J. sedecimtuberculata* + *J. verrucosa* clade and distinguishes that clade from other *Janirella* clades in which species have three or more projections. We cannot rule out the possibility that phylogenetic trees based on other gene markers would support the two-subgenera classification, but based on our tree, we propose elimination of the subgenus *Parjanirella*, thus combining all specific names directly under the genus name *Janirella*.

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Declarations

Conflict of interest The authors declare that they have no conflicts of interest.

Ethical approval The authors followed all applicable international, national, and/or institutional guidelines for animal testing, animal care, and use of animals.

Sampling and field studies All necessary permits for sampling and observational field studies have been obtained by the authors from the competent authorities and are mentioned in Acknowledgements, if applicable.

Data availability The manuscript includes all information such as museum depositories and deposition numbers for specimens and sequences.

Author contributions MO conceived the research, acquired funding, made morphological observations, conducted the molecular lab work and analyses, and wrote a first draft of the manuscript. SK supervised the research and designed research cruises KS-20-18, KH-22-8, and KH-23-5. KK helped with the structure of the manuscript and provided advice on morphological observations. MO, KK, and SK participated in sampling expeditions. MS provided several specimens. KK, SK, and MS reviewed and commented on the draft manuscript.

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Figure captions

Fig. 1 *Janirella scutum* sp. n., holotype male, ICHUM-8836. **a** Body, dorsal view, most appendages omitted; **b** body, lateral view, most appendages omitted; **c** pleotelson, ventral view; **d** pleotelson, lateroventral view; **e** right antennula dorsal view; **f** left antenna, peduncle articles 1–4, dorsal view; **g–g3** left antenna, dorsal (**g**) and ventral (**g1**) views, enlarged views of proximal part of flagellum (**g2**) and distal tip (**g3**); **h** uropod, the protopod broken.

Fig. 2 *Janirella scutum* sp. n., holotype male, ICHUM-8836. **a** Anterior part of body, ventral view; **b, b1** maxillipeds, dorsal view; **b1** enlarged distal margin of left maxillipedal endite; **c** left mandible, dorsal view; **d** right mandible, dorsal view; **e** lower lip; **f l**eft maxilla I, ventral view; **g** left maxilla II, ventral view

Fig. 3 *Janirella scutum* sp. n., holotype male, ICHUM-8836. **a** Left pereopod I, posterior view; **b** left pereopod II, anterior view; **c** right pereopod III, anterior view; **d** left pereopod IV (basis to carpus), anterior view; **e** right pereopod IV, carpus to main claw, posterior view; **f** right pereopod V, anterior view

Fig. 4 *Janirella scutum* sp. n. **a**–**d**, **f**–**h** Holotype male, ICHUM-8836; **e** paratype female, ICHUM-8837. **a** Right pereopod VI, anterior view; **b** right pereopod VII, anterior view; **c** pleopod I, dorsal view, setae on left lobe omitted; **d** right pleopod II, dorsal view; **e** pleopod II, operculum, ventral view; **f** left pleopod III, dorsal view; **g** left pleopod IV, dorsal view; **h** left pleopod V, ventral view

Fig. 5 *Janirella spinoscutum* sp. n. **a**–**c**, **f**–**j** Holotype male, ICHUM-8840; **d** paratype male, ICHUM-8841; **e**, **k** paratype female, ICHUM-8842. **a** Body, dorsal view, most appendages omitted; **b** body, lateral view, most appendages omitted; **c** pleotelson, ventral view; **d** pleotelson, lateroventral view; **e** pleotelson, ventral view; **f r**ight antennula, ventral view; **g** left antenna peduncle articles 1–4, dorsal view; **h** left antenna peduncle articles 1–4, ventral view; **i** right antenna, ventral view; **j** uropod

Fig. 6 *Janirella spinoscutum* sp. n. **a**, **e** Paratype male, ICHUM-8841; **b**–**g** holotype male, ICHUM-8840. **a** Anterior part of body, ventral view; **b, b1** right maxilliped, dorsal view, enlarged distal margin of endite (**b1**); **c**, **c1**, **c2** left mandible lacking distal tip, dorsal view (**c**), broken incisor and lacinia mobilis, ventral view (**c1**), mandibular palp (**c2**); **d**, **d1** right mandible, ventral view (**d**), enlarged mandibular palp article 3 (**d1**); **e** half of lower lip; **f** left maxilla I, ventral view; **g** left maxilla II, ventral view

Fig. 7 *Janirella spinoscutum* sp. n., holotype male, ICHUM-8840. **a** Left pereopod I, anterior view; **b** left pereopod II, anterior view; **c** right pereopod III, anterior view; **d** right pereopod IV, anterior view; **e** right pereopod V, anterior view

Fig. 8 *Janirella spinoscutum* sp. n., holotype male, ICHUM-8840. **a** Right pereopod VI, anterior view; **b** right pereopod VII, anterior view; **c** pleopod I, dorsal view; **d** right pleopod II, dorsal view, stylet lost; **e** stylet of left pleopod II; **f** right pleopod III, ventral view; **g** right pleopod IV, ventral view; **h** right pleopod V, ventral view

Fig. 9 Maximum likelihood phylogenetic tree based on mitochondrial COI gene sequences (652 bp) from nine species in *Janirella*, with two species in family Munnopsidae as outgroup taxa. Arabic numbers near nodes indicate bootstrap values for approximate Bayesian posterior probabilities (left) and ultrafast bootstrap analyses. Asterisks indicate maximum values (*, 1.000 for Bayesian posterior probabilities; **, 100 for ultra-rapid bootstraps). The scale at the top left indicates branch length in substitutions per site.

Table 1. Specimens used in phylogenetic tree with sampling station data. Newly acquired accession numbers are shown in bold.

Species	GenBank accession NO.	Site	Cruise NO.	Coordinates trawl start-end, lat./long.	depth [m]	Gear	Sex	Specimen voucher
J. scutum **sp. n.**	**LC816609**	EC4	KS-20-18	41.29°N 144.13°E–41.26°N 144.13°E	3,143–3,176	3m BT	Male	ICHUM-8836 (Holotype)
J. scutum **sp. n**	**LC816610**	EC4	KS-20-18	41.29°N 144.13°E–41.26°N 144.13°E	3,143–3,176	3m BT	Male	ICHUM-8838
J. scutum **sp. n.**	**LC816615**	EC4	KS-20-18	41.29°N 144.13°E–41.26°N 144.13°E	3,143–3,176	3m BT	Female	ICHUM-8837 (Paratype)
J. scutum **sp. n.**	**LC816616**	EC4	KS-20-18	41.29°N 144.13°E–41.26°N 144.13°E	3,143–3,176	3m BT	Female	ICHUM-8839
J. spinoscutum **sp. n.**	**LC816603**	K7	KS-16-18	39.33°N 143.55°E–39.35°N 143.56°E	2,928–3,024	3m BT	Female	ICHUM-8842 (Paratype)
J. spinoscutum **sp. n.**	**LC816606**	K5	KS-16-18	38.48°N 143.47°E–38.46°N 143.48°E	2,893–2,886	3m BT	Male	ICHUM-8840 (Holotype)
J. spinoscutum **sp. n.**	**LC816604**	K7	KS-16-18	39.33°N 143.55°E–39.35°N 143.56°E	2,928–3,024	3m BT	Female	ICHUM-8843
J. spinoscutum **sp. n.**	**LC816605**	K7	KS-16-18	39.33°N 143.55°E–39.35°N 143.56°E	2,928–3,024	3m BT	Male	ICHUM-8841 (Paratype)
J. longicauda	LC535322	KANO6	KS-17-6	39.42°N 143.75°E–39.43°N 143.70°E	3,547–3,370	3m BT	Male	NSMT-Cr 27494
J. longicauda	LC535323	KANO6	KS-17-6	39.42°N 143.75°E–39.43°N 143.70°E	3,547–3,370	3m BT	Male	NSMT-Cr 27492
J. polychaeta	**LC816607**	KANO6	KS-17-6	39.42°N 143.75°E–39.43°N 143.70°E	3,547–3,370	3m BT	Female	
J. polychaeta	**LC816608**	KANO6	KS-17-6	39.42°N 143.75°E–39.43°N 143.70°E	3,547–3,370	3m BT	Female	
J. fusiformis	**LC816599**	A3	KH-22-8	41.35°N 144.94°E–41.34°N 144.96°E	6,116–6,131	4m BT	Male	
J. fusiformis	**LC816602**	A3	KH-22-8	41.35°N 144.94°E–41.34°N 144.96°E	6,116–6,131	4m BT	Male	
J. spinosa	**LC816600**	D3	KH-22-8	40.84°N 144.35°E–40.83°N 144.36°E	6,169–6,211	Agassiz T	Female	
J. tuberculata	**LC816601**	A3	KH-22-8	41.35°N 144.94°E–41.34°N 144.96°E	6,116–6,131	4m BT	Female	
J. tuberculata	**LC816611**	F5	KH-23-5	39.54°N 143.86°E–39.53°N 143.85ºE	4,556–4,565	4m BT	Male	
*J. sedecimtuberculata**	**LC816612**	A8	KH-23-5	41.12°N 145.59°E–41.12°N 145.61ºE	6,124–6,113	4m BT	Female	
*J. sedecimtuberculata**	**LC816614**	F7b	KH-23-5	39.67°N 144.08°E–39.68°N 144.07°E	5,314–5,313	Agassiz T	Male	
*J. verrucosa**	**LC816613**	F14	KH-23-5	39.47°N 144.82°E–39.46°N 144.81°E	5,795–5,798	4m BT	–**	

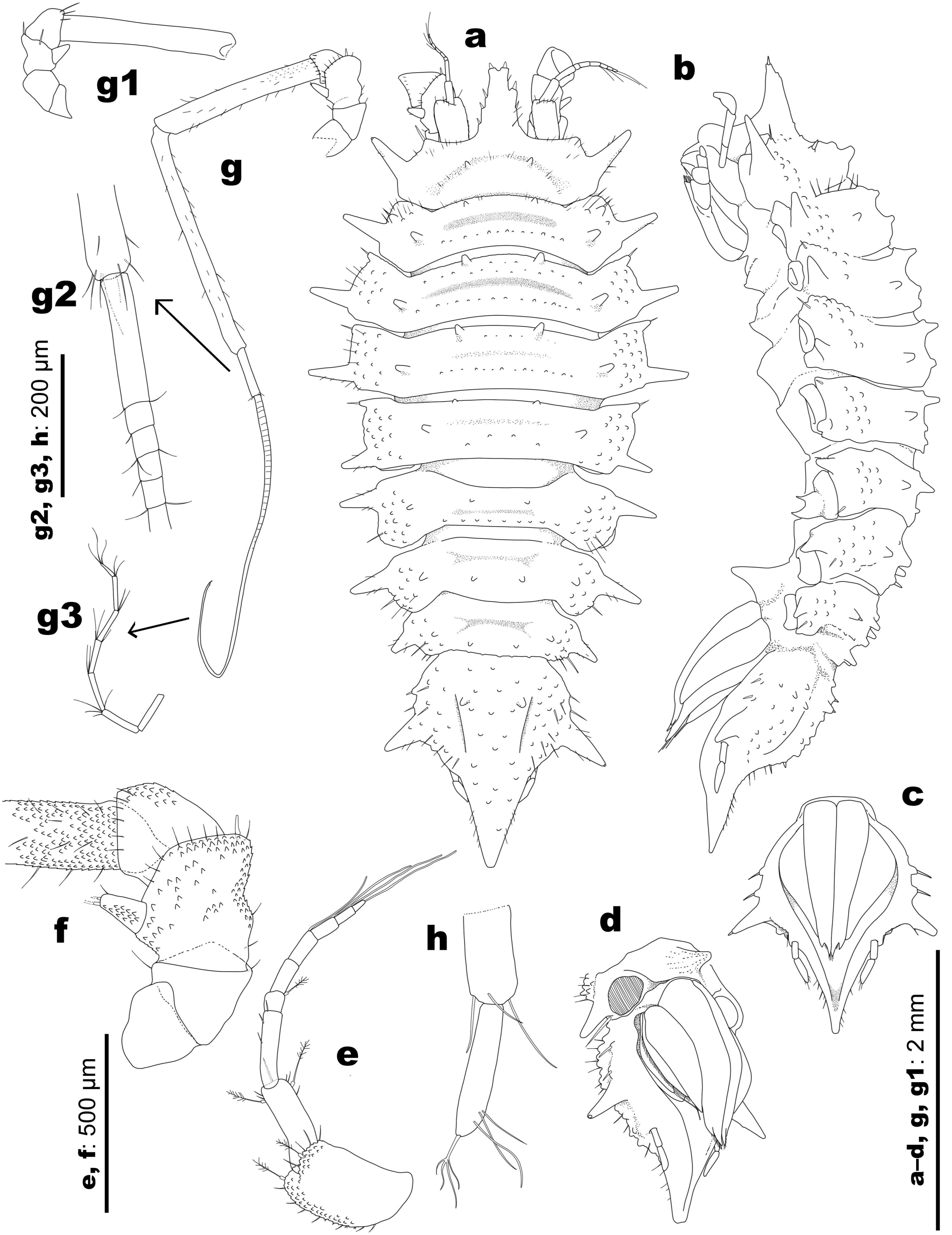
Ilyarachna kussakini	**LC833825**	K5	KS-16-18	38.48°N 143.47°E–38.46°N 143.48°E	2,893–2,886	3m BT	Female
Munnopsurus sp.	**LC833826**	Bent1-3	KS-18-2	39.34°N 142.27°E–39.34°N 142.27°E	577–563	3m BT	Female

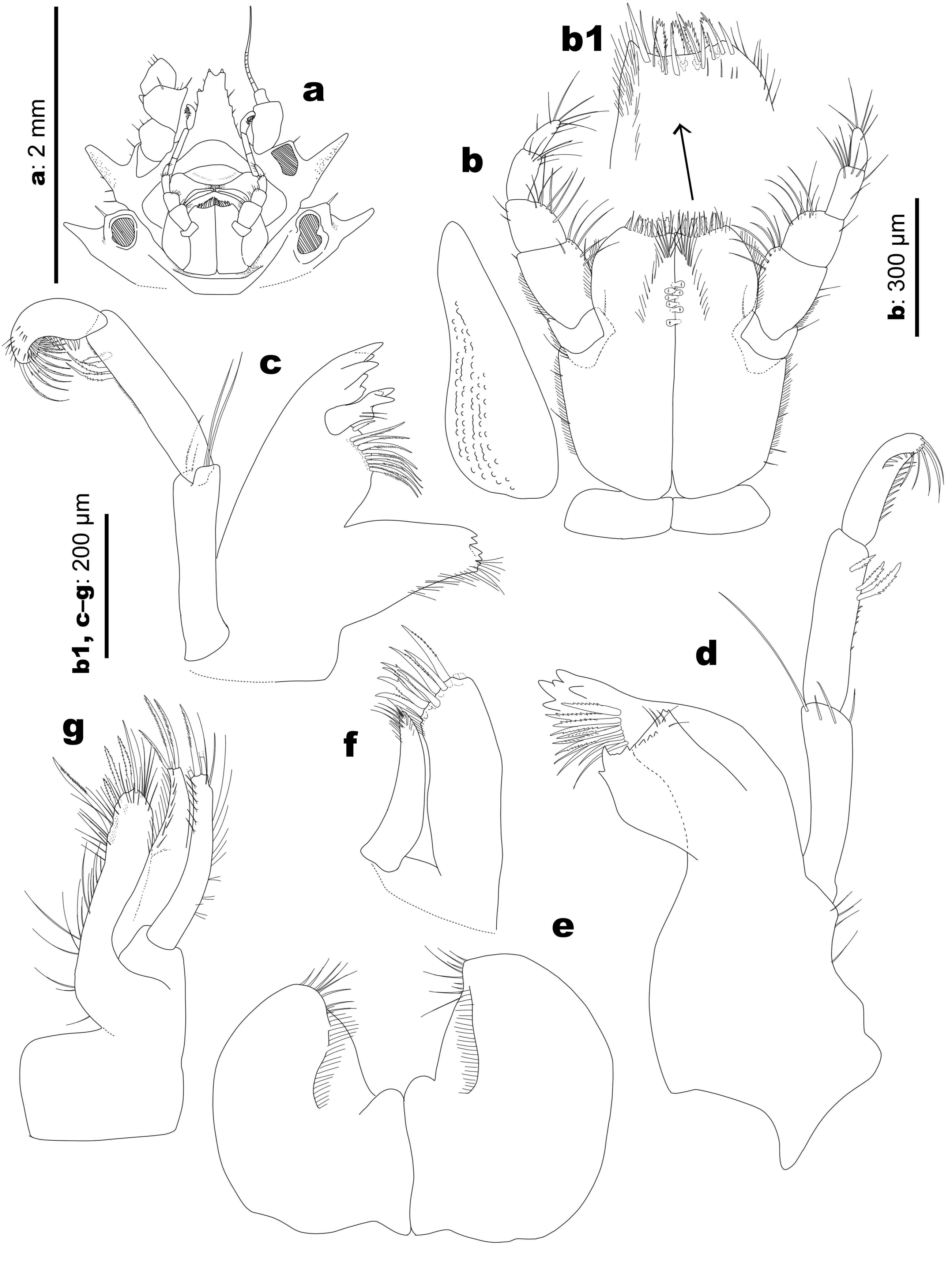
*members of subgenus *Parjanirella*.

** sex cannot be identified because of lacking pleotelson bearing pleopods.

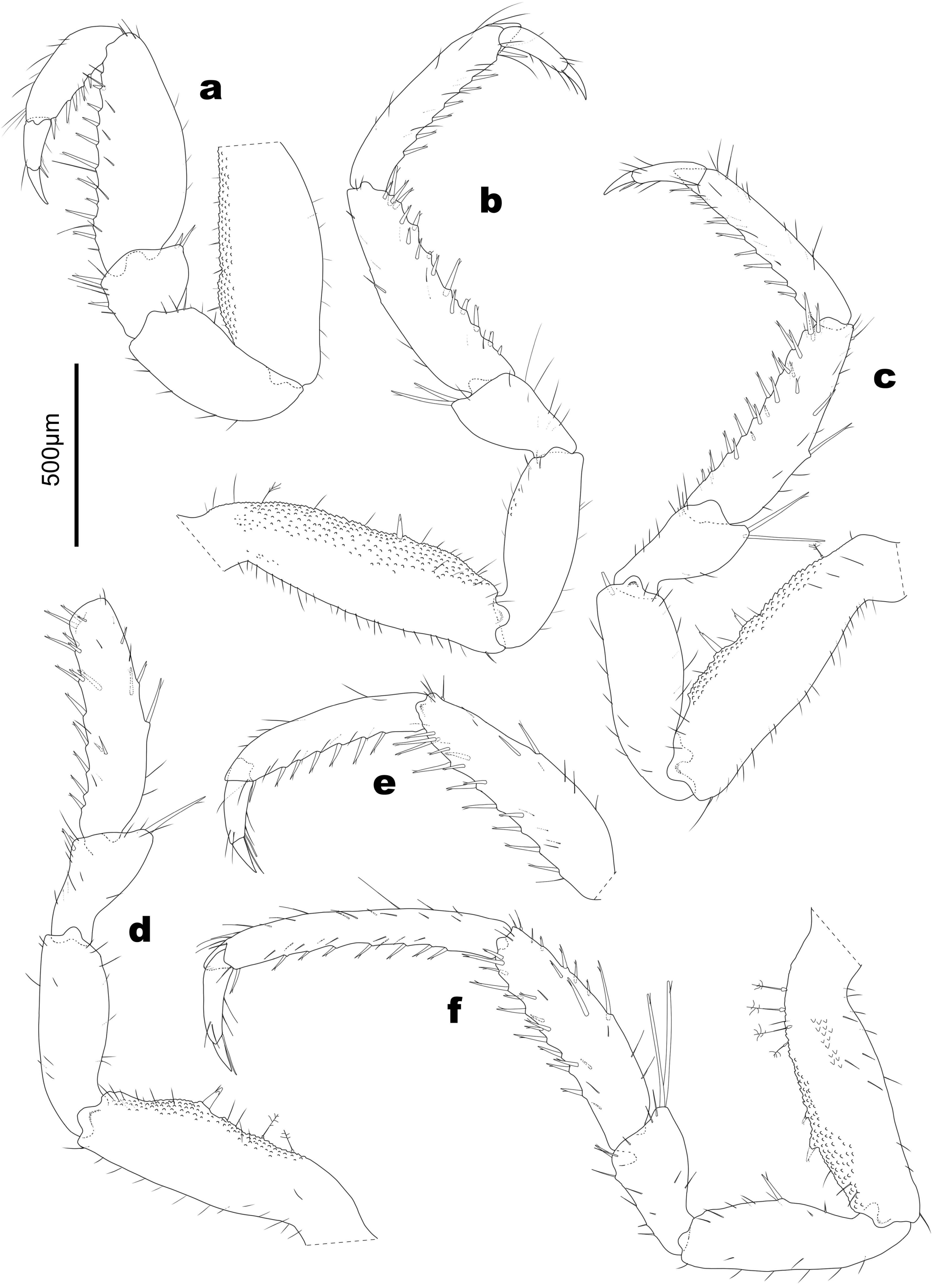
Table 2. Number and condition of ventral setae on the carpus and propodus of pereopods 3–7 for the holotypes of *J. scutum* **sp. nov.** and *J. spinoscutum* **sp. nov.** P3–7, pereopods 3–7.

		Carpus			Propodus		
		Anterior	Marginal	Posterior	Anterior	Marginal	Posterior
J. scutum **sp. n.**	P3	8 UB	8 UB	1 UB and 5 fine	6 fine	8 UB	3 fine
	P4	6 UB and 1 fine	6 UB and 1 fine	2 UB and 5 fine	6 fine	7 UB	3 fine
	P5	5 UB and 2 fine	7 UB	4 UB and 1 fine	6 fine	8 UB	4 fine
	P6	3 UB and 3 fine	10 UB and 1 fine	3 UB and 3 fine	4 fine	8 UB	1 UB and 3 fine
	P7	3 UB and 1 fine	9 UB	3 UB	3 fine	8 UB	2 UB and 2 fine
J. spinoscutum **sp. n.**	P3	6 UB and 6 fine	10 UB	1 UB and 1 fine	10 fine	15 UB and 2 fine	10 fine
	P4	3 UB and 3 fine	12 UB	2 UB and 5 fine	8 fine	17 UB	-
	P5	5 UB and 5 fine	14 UB	1 UB and 2 fine	9 fine	12 UB	1 fine
	P6	4 UB and 5 fine	14 UB	1 UB and 3 fine	6 fine	12 UB	1 fine
	P7	4 UB and 4 fine	12 UB	2 UB and 4 fine	1 UB and 6 fine	13 UB	-


a
b
c
d
e
f
g
g1
g2
g3
h
g2, g3, h: 200 µm
e, f: 500 µm
a–d, g, g1: 2 mm



a: 2 mm
a
b1
b
b: 300 µm
c
b1, c–g: 200 µm
d
g
f
e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b
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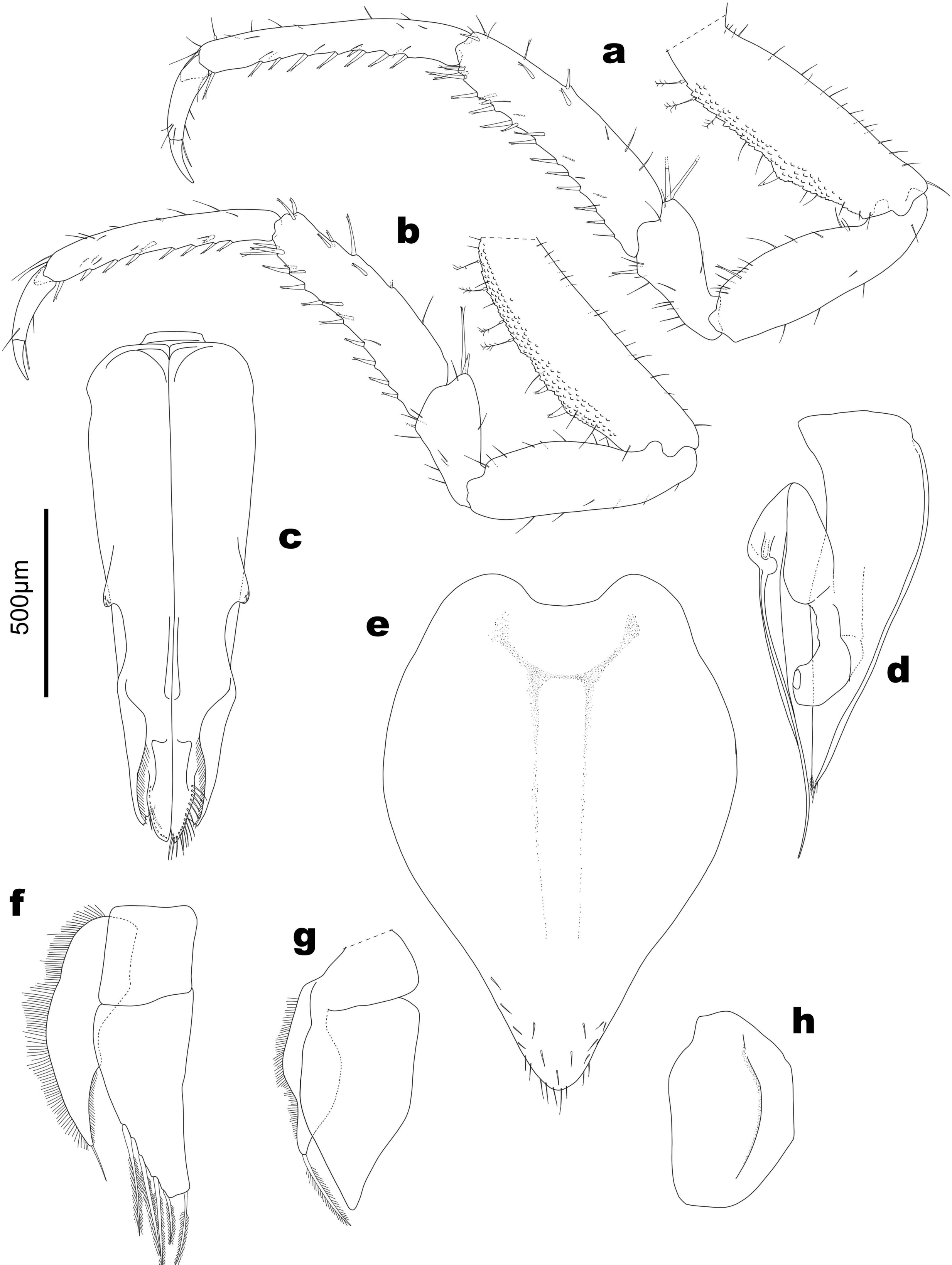
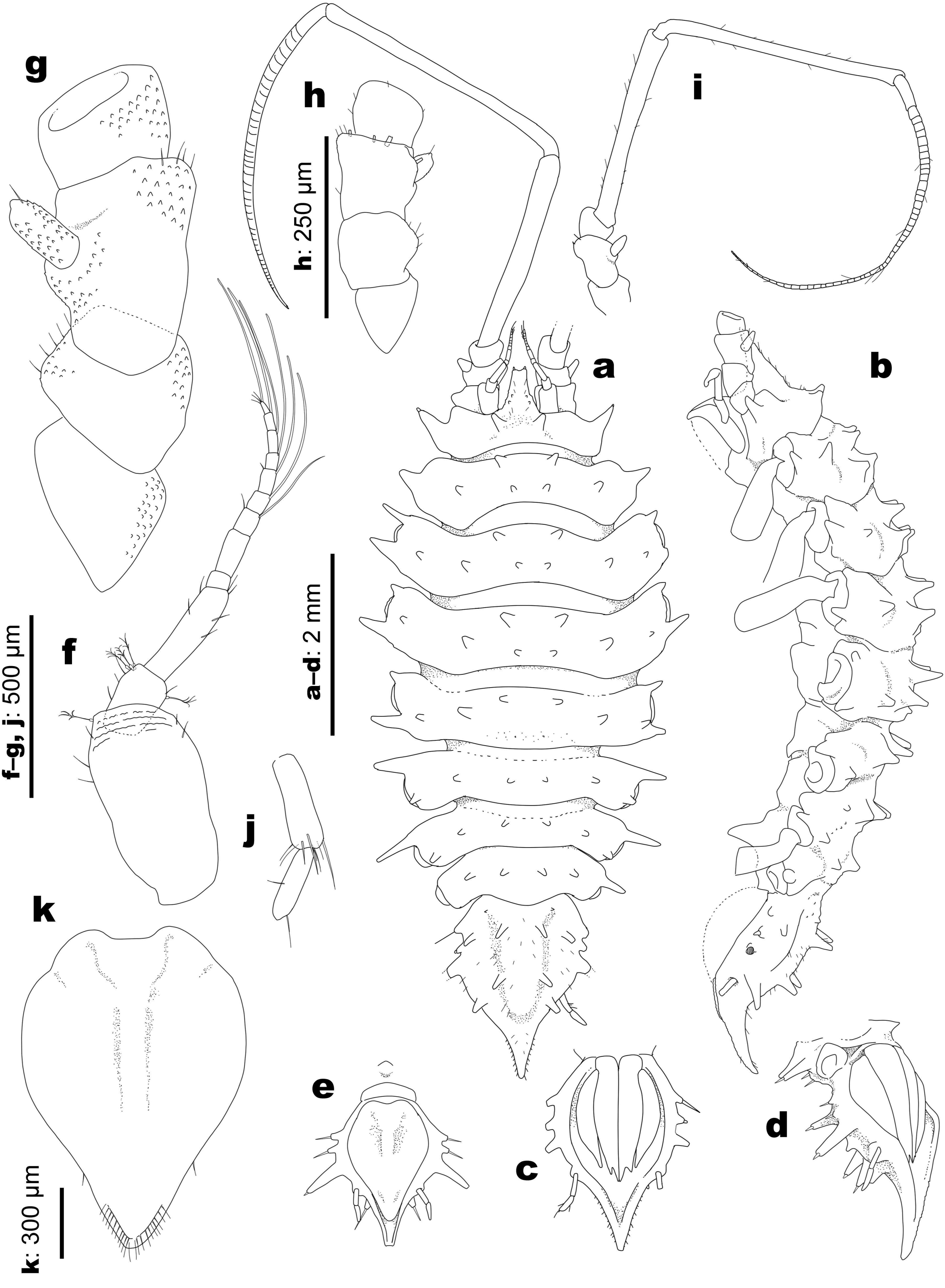
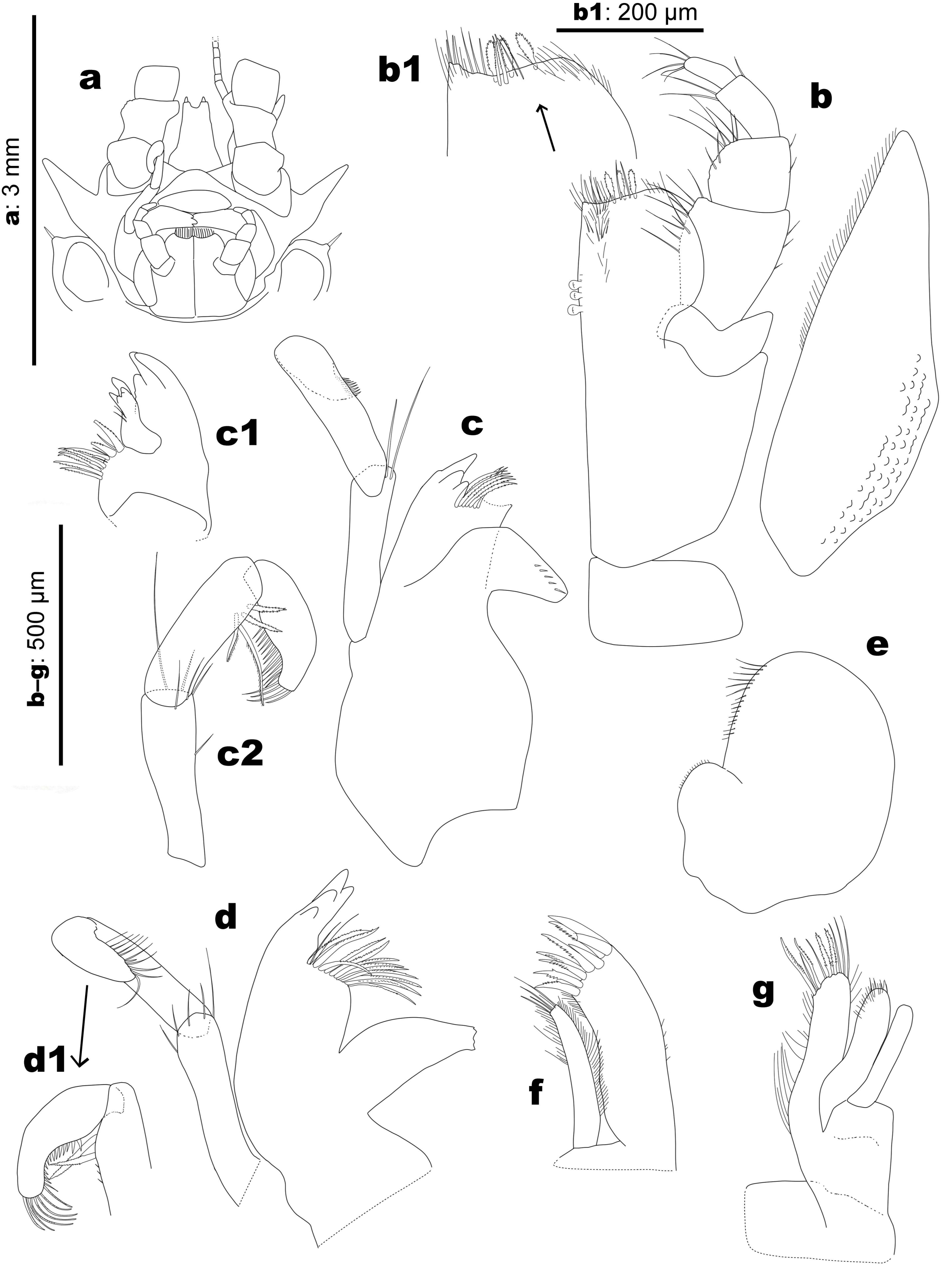
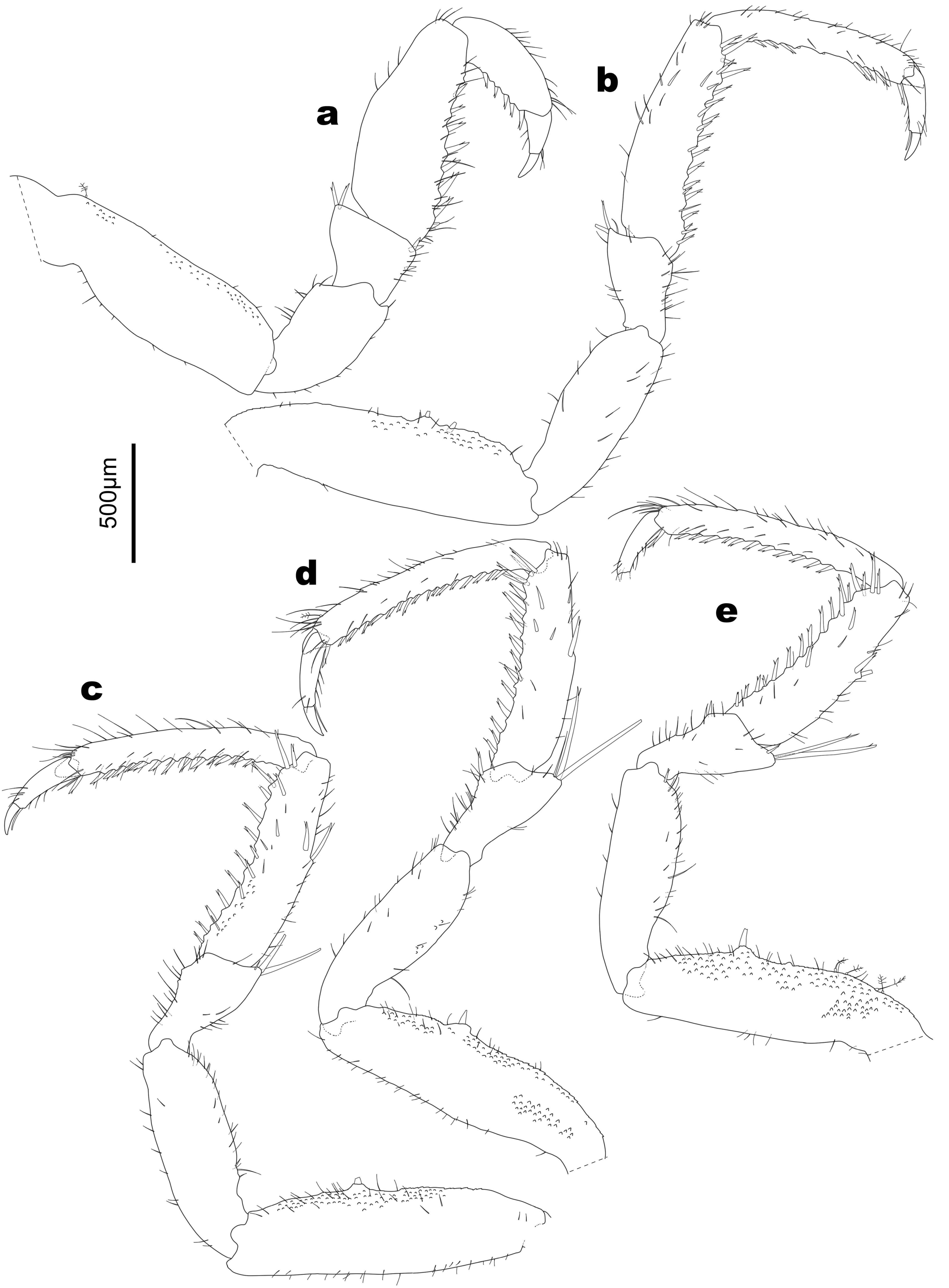
500µm
d
e
f


a
b
c
d
e
f
g
h
500µm



g
h
i
h: 250 µm
a
b
f–g, j: 500 µm
f
a–d: 2 mm
j
k
e
c
d
k: 300 µm


a: 3 mm
b1: 200 μm
b–g: 500 μm
a
b1
b
c1
c
c2
d
d1
e
f
g


a
b
c
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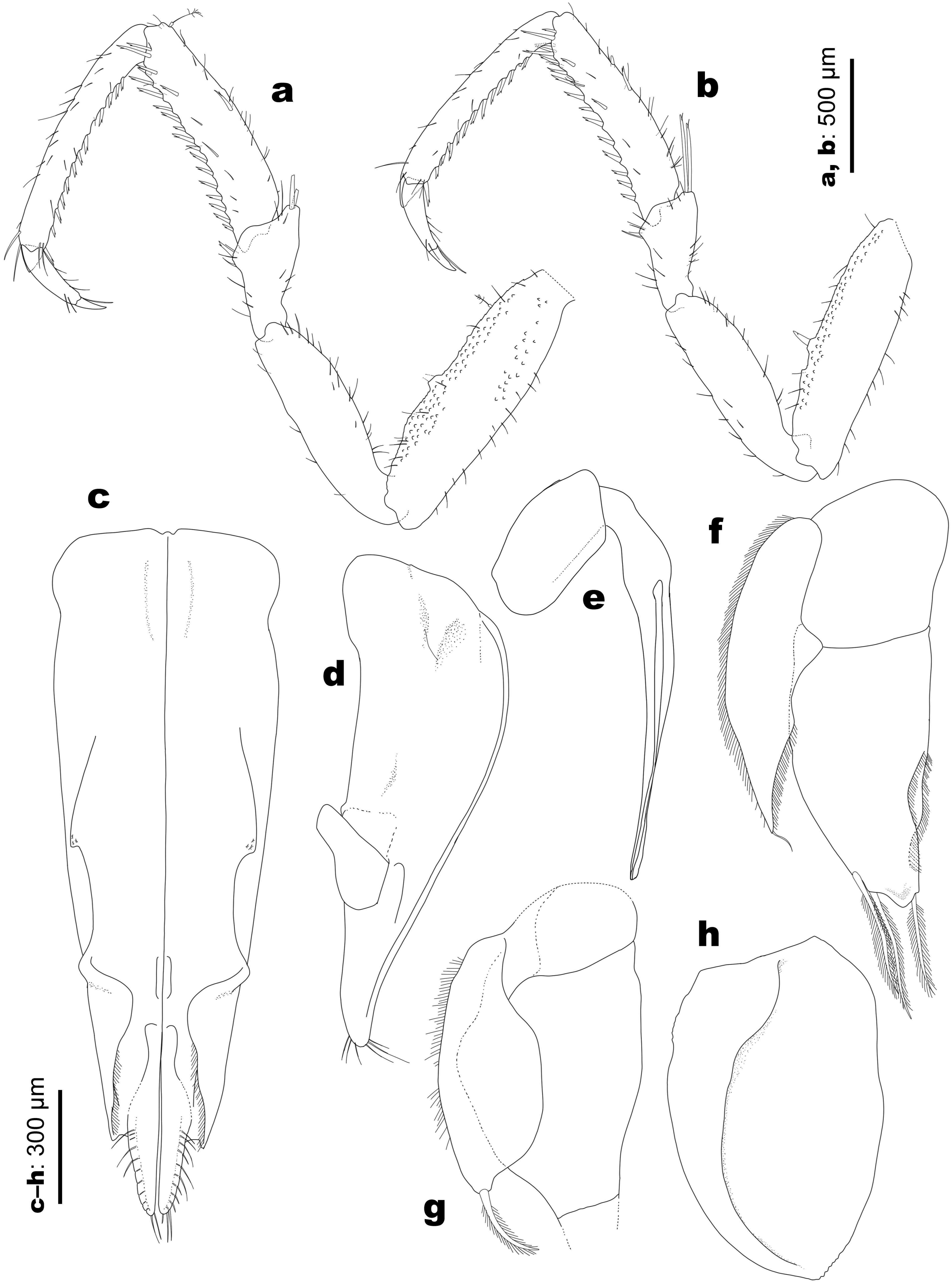
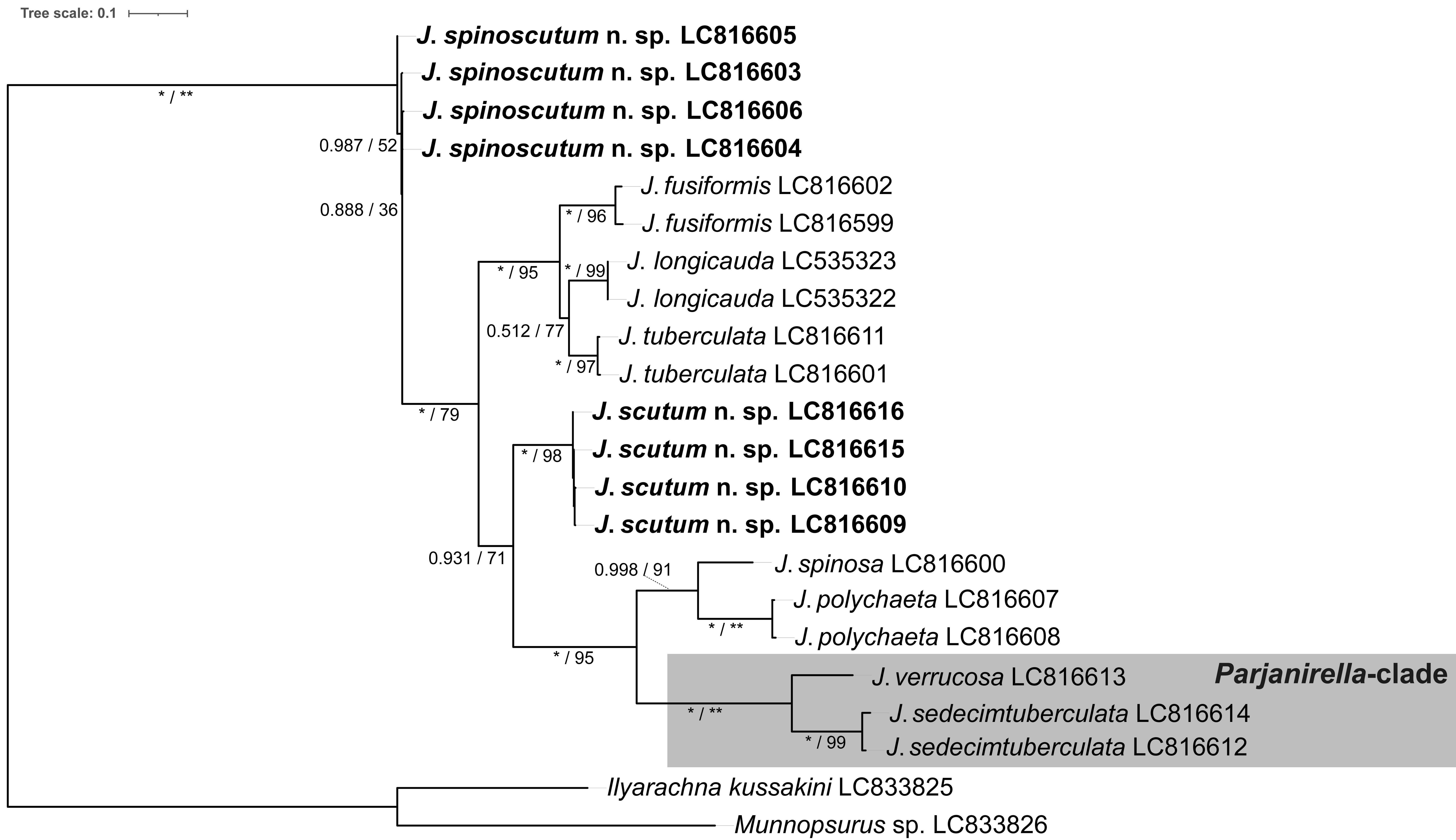
e
500µm



a
b
a, b: 500 µm
c
d
e
f
g
h
c–h: 300 µm



Tree scale: 0.1
J. spinoscutum n. sp. LC816605
J. spinoscutum n. sp. LC816603
J. spinoscutum n. sp. LC816606
J. spinoscutum n. sp. LC816604
* / **
0.987 / 52
0.888 / 36
J. fusiformis LC816602
J. fusiformis LC816599
* / 96
J. longicauda LC535323
J. longicauda LC535322
* / 99
* / 95
J. tuberculata LC816611
J. tuberculata LC816601
0.512 / 77
* / 97
* / 79
J. scutum n. sp. LC816616
J. scutum n. sp. LC816615
J. scutum n. sp. LC816610
J. scutum n. sp. LC816609
* / 98
0.931 / 71
J. spinosa LC816600
0.998 / 91
J. polychaeta LC816607
J. polychaeta LC816608
* / **
* / 95
Parjanirella-clade
J. verrucosa LC816613
J. sedecimtuberculata LC816614
J. sedecimtuberculata LC816612
* / **
* / 99
Ilyarachna kussakini LC833825
Munnopsurus sp. LC833826