

A New Species of the Genus *Rhachotropis* (Crustacea: Amphipoda: Eusiridae) from Japan

MASAKUNI OKAZAKI  AND KO TOMIKAWA 

Graduate School of Humanities and Social Sciences, Hiroshima University, 1-1-1 Kagamiyama,
Higashihiroshima, Hiroshima 739-8524, Japan

ABSTRACT. A new eusirid amphipod, *Rhachotropis lowryi* sp. nov., is described from off Amamioshima Island, Japan, at 402 m depth. This new species differs from its congeners by the features of urosomite 1, pereopods 5–7 bases, uropod 3, and telson. A key to species of *Rhachotropis* from Japanese and adjacent waters is provided. Additionally, a nucleotide sequence of mitochondrial cytochrome *c* oxidase subunit I from the holotype of *R. lowryi* was determined for the future study.

Introduction

The genus *Rhachotropis* Smith, 1883 occurs in shallow to deep waters of the world's oceans (Barnard & Karaman, 1991; Lörz *et al.*, 2018a, b). This genus is composed of carnivorous amphipods that prey on zooplankton, such as copepods (Fanelli *et al.*, 2009; Lörz *et al.*, 2018b), and many species live as planktonic predators. To date, 64 species of *Rhachotropis* have been described (Lörz *et al.*, 2018a, b; Okazaki *et al.*, 2020). Nine species have been recorded from Japanese and adjacent waters: *R. aculeata* (Lepechin, 1780); *R. distincta* (Holmes, 1908); *R. inflata* (Sars, 1883); *R. macropus* Sars, 1893; *R. marinae* Lörz, Jażdżewska & Brandt, 2018; *R. natator* (Holmes, 1908); *R. oculata* (Hansen, 1887); *R. reiwa* Okazaki, Ohtsuka & Tomikawa, 2020; and *R. saskia* Lörz, Jażdżewska & Brandt, 2018 (Okazaki *et al.*, 2020).

Field surveys of the deep-sea amphipod fauna around Amamioshima Island, Amami Islands, Japan, have produced several previously undescribed species. One of these was described recently as *Rhachotropis reiwa* Okazaki, Ohtsuka & Tomikawa, 2020. In this study, we describe another new species of *Rhachotropis*.

Materials and methods

Collection. The present specimens were collected using a beam trawl (mouth opening 50 cm × 170 cm; mesh 15.5 mm) deployed from the TRV *Toyoshio-Maru* (Hiroshima University). The specimens were preserved in 99% ethanol on-board ship. For DNA extraction, muscle tissue was removed from the dorsal side of the pleon of the holotype.

Morphological examination. Appendages were dissected in 70% ethanol and mounted in gum-chloral medium on glass slides under a stereomicroscope (Olympus SZX7). The specimen was examined using a light microscope (Nikon Eclipse Ni) and illustrated with the aid of a camera lucida. Bodies were dehydrated through a graded ethanol series, and dried using hexamethyldisilazane (HMDS) (Nation, 1983). They were then sputter-coated with gold and observed using scanning electron microscopy (SEM, JSM-6510LV). The body length from the tip of the rostrum to the base of the telson was measured along the dorsal curvature to the nearest 0.1 mm. The specimens are deposited in the Tsukuba Collection Center of the National Museum of Nature and Science, Tokyo (NSMT).

Keywords: Amami Islands, Japan, Northwest Pacific Ocean, *Rhachotropis lowryi*, new species, taxonomy

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ORCID iD: Masakuni Okazaki <https://orcid.org/0009-0008-5350-8090>, Ko Tomikawa <https://orcid.org/0000-0003-1521-9016>

Corresponding author: Ko Tomikawa tomikawa@hiroshima-u.ac.jp

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DNA sequencing. The extraction of genomic DNA from pleon muscle followed Tomikawa *et al.* (2014). The cytochrome *c* oxidase subunit I (COI) gene [LCO1490 and HCO2198 (Folmer *et al.*, 1994)] primer set was used for PCR and cycle sequencing (CS) reactions. PCR reactions and DNA sequencing were performed following Tomikawa *et al.* (2016). DNA sequences have been deposited with the International Nucleotide Sequence Database Collaboration (INSDC) through the DNA Data Bank of Japan (DDBJ).

Taxonomy

Eusiridae Stebbing, 1888

Rhachotropis Smith, 1883

Type species. *Rhachotropis aculeata* (Lepechin, 1780).

Rhachotropis lowryi sp. nov.

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[New Japanese name: Amami-ryūgū-yokoebi]

Figs 1–5

Holotype: NSMT-Cr 30790, ovigerous female (6.4 mm, G1746), off Amamioshima Island, Kagoshima, Japan, 27.9675°N, 129.4005°E, 402 m depth, coll. K. Tomikawa, 26 May 2008. **Paratypes:** NSMT-Cr 30791, female (5.6 mm); NSMT-Cr 30792 female (5.5 mm); NSMT-Cr 30793, female (4.8 mm); NSMT-Cr 30794, 2 females (4.6 mm, 5.9 mm); data as for holotype.

Diagnosis. Head with developed rostrum; eyes large. Pereonites 1–7 dorsally smooth, weakly rugose. Pleonites 1–3 each with middorsal and dorsolateral teeth, those of pleonite 3 minute. Epimeral plate 3 with strongly serrate posterior margin. Pereopods 5–7 with posteriorly produced basis. Telson cleft for 44%.

Description of holotype. Head (Fig. 1A, C, D) dorsally smooth; rostrum longer than half of head, pointed; eyes large, ovate; lateral cephalic lobe weakly produced, anterodistal corner squarish; antennal sinus absent. Pereonites 1–7 (Fig. 1A) dorsally smooth, weakly rugose. Pleonites 1–3 (Fig. 1A, B, E) each with middorsal and dorsolateral teeth, those of pleonite 3 minute. Epimeral plates 1–3 (Figs 1B, 2A–C) with posterodistal corner rounded, posterior margin of epimeral plate 3 strongly serrate. Dorsal margin of urosomites smooth (Fig. 1A, E).

Antenna 1 (Fig. 2D) with peduncular articles 1–3 1.0:0.7:0.2 in length ratio; peduncular article 1 with long setae on posterior margin; peduncular article 2 with calceoli (Fig. 1F) on anterior margin; primary flagellum with 9 articles, bearing calceoli; accessory flagellum not seen. Antenna 2 (Fig. 2E): peduncular articles 4 with calceoli on anterior margin, posterior margin with long setae; peduncular article 5 slightly shorter than article 4, with calceoli on anterior margin, posterior margin with a few short setae; flagellum 12-articulate with calceoli.

Upper lip (Fig. 2F) with ventral margin weakly convex, with setae. Mandible (Fig. 2G, H) incisor with distal tooth, left lacinia mobilis (Fig. 2G) wide, 6-dentate, right (Fig. 2H) narrow with minute teeth; accessory setal row with

blade setae, molar process weakly triturative, edges lined with short blades; palp 3-articulate, length ratio of articles 1–3 1.0:2.3:2.3, article 1 with minute setae, article 2 with 15 setae, anterior margin of article 3 lined with setae. Lower lip (Fig. 2I) with broad outer lobes, setulose; inner lobes distinct, fused medially. Maxilla 1 (Fig. 2J) with narrow inner plate, bearing 2 plumose setae apically; outer plate subrectangular with 9 serrate robust setae; palp 2-articulate, article 1 subrectangular with 2 setae; article 2 with 7 apical and 2 inner marginal robust setae, and subapical slender setae. Maxilla 2 (Fig. 2K) with broad inner plate; outer plate slightly longer than inner plate, bearing long setae on apical margin. Maxilliped (Fig. 2M) with ovate inner plate, short, not reaching half-length of palp article 1; outer plate exceeding distal part of palp article 1, medial margin almost straight, lined with setae; palp 4-articulate.

Gnathopod 1 (Fig. 3A), coxa strongly produced anteriorly, with short setae; basis weakly curved, anterior and posterior margins with short setae, anterodistal corner with long setae; carpus lobate posteriorly with setae; propodus oval, width 0.5 times length, anterior submargin with short setae, palmar margin convex, setose; dactylus long, slender, reaching end of palm. Gnathopod 2 (Fig. 3B), coxa subrectangular, bearing short setae; basis curved, anterior and posterior margins with short setae, anterodistal and posterodistal corners with long setae; carpus lobate posteriorly with setae; propodus oval, width 0.5 times length, anterior margin without setae, palmar margin convex, setose; dactylus long, slender, reaching end of palm.

Pereopod 3 (Fig. 3C), coxa subrectangular; basis long, straight, anterior and posterior margins with short setae and a few long setae; length ratio of merus, carpus, propodus, and dactylus 1.0:1.6:1.7:1.3; dactylus slender, slightly curved, with short setae. Pereopod 4 (Fig. 3D), coxa with shallow posterior concavity; posterior margins of basis with long setae; merus and carpus with long setae on posterior margins; length ratio of merus, carpus, propodus, and dactylus 1.0:1.5:1.4:1.4. Pereopod 5 (Fig. 3E), coxa bilobate, anterior and posterior lobes equal in size; basis produced posteriorly; anterior margin of merus with long setae; length ratio of merus, carpus, propodus, and dactylus 1.0:1.0:1.9:1.0. Pereopod 6 (Fig. 4A) with coxa bilobate, posterior lobe larger than anterior one; basis strongly expanded posteriorly, posterodistal margin with long setae; anterior margin of merus with long setae; length ratio of merus, carpus, and propodus and dactylus 1.0:1.0:1.9:0.9. Pereopod 7 (Fig. 4B), coxa rounded; basis broad, strongly expanded posteriorly with short setae.

Coxal gills (Figs 3C–E, 4A) large, broad, present on gnathopod 2 to pereopod 7.

Pleopods 1–3 (Fig. 4C–E), peduncle broad, inner distal corner with paired retinacula (Fig. 4F).

Uropod 1 (Fig. 5A) peduncle long, length 3.8 times width, with robust setae on medial and lateral margins; inner ramus 1.1 times length peduncle, with 3 robust setae on medial margin; outer ramus 0.9 times length of inner ramus, lateral margin with 5 robust setae. Uropod 2 (Fig. 5B), peduncle length 2.5 times width, with robust setae on medial and lateral distal corners; inner ramus 1.9 times length of peduncle, with 7 and 3 robust setae on medial and lateral margins, respectively; outer ramus 0.8 times length of inner ramus, with 7 robust setae on lateral margin. Uropod 3 (Fig. 5C), peduncle short, length 1.6 times width, with

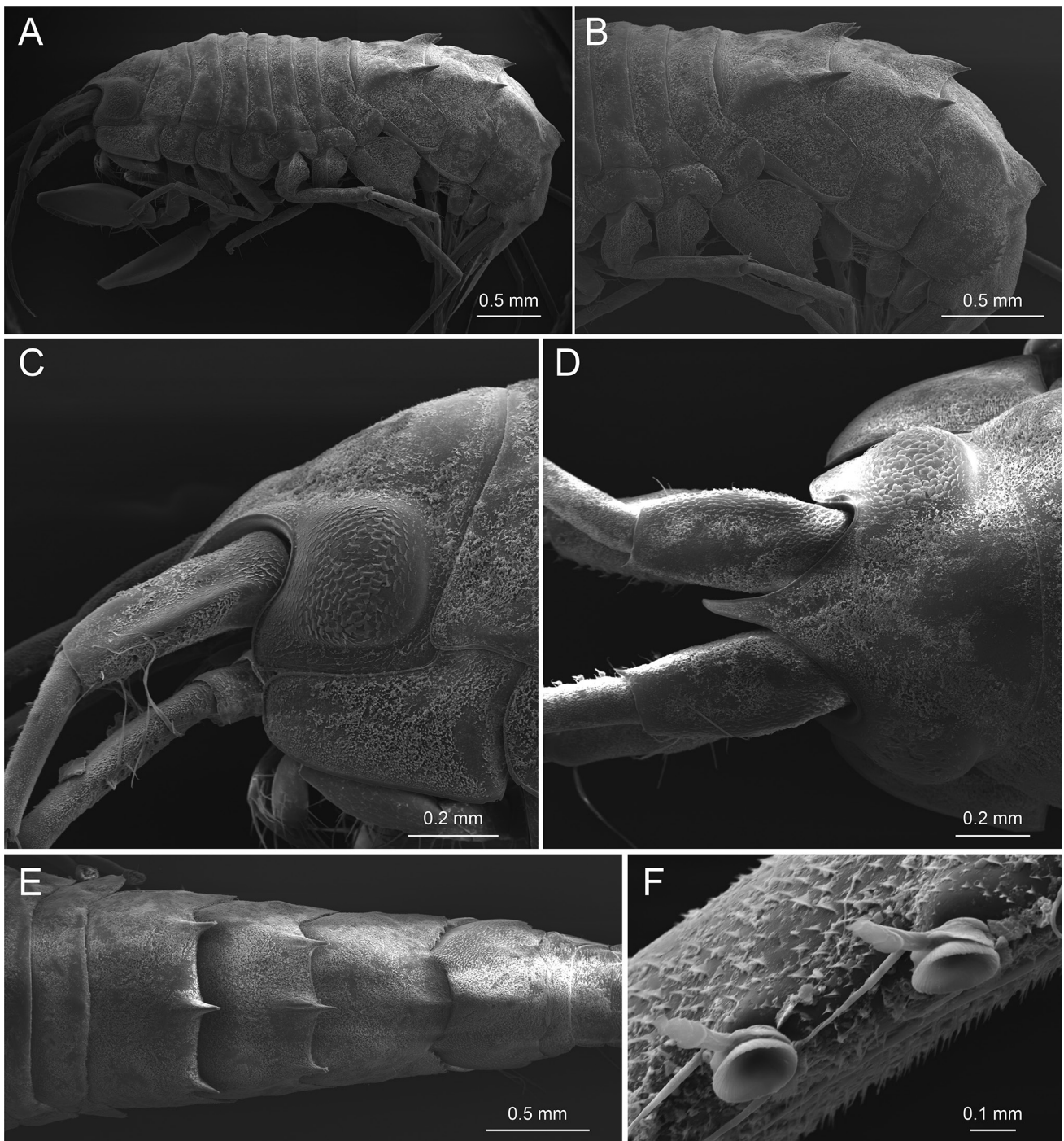


Figure 1. SEM photographs of *Rhachotropis lowryi* sp. nov.: (A–C, F) paratype female, 5.6 mm, NSMT-Cr 30791; (D, E) paratype female, 4.8 mm, NSMT-Cr 30793. (A) habitus, lateral view; (B) posterior part of body, lateral view; (C) head, lateral view; (D) head, dorsal view; (E) posterior part of body, dorsal view; (F) calceoli on antenna 1.

slender setae on medial margin; inner ramus, length 2.4 times peduncle, medial and lateral margins with 4 and 2 robust setae, respectively; outer ramus almost as long as inner ramus, lateral margin with 5 robust setae. Telson (Fig. 5D) length 1.9 times width, cleft for 44%, with lateral plumose setae on basal part.

11 eggs.

Nucleotide sequence. One 658 bp COI sequence of holotype was determined (GenBank accession number LC727553). Among available data in the INSDC database, the sequence of *R. lowryi* sp. nov. and that of *R. reiwa* Okazaki, Ohtsuka

& Tomikawa, 2020 have the highest similarity (23.8% uncorrected *p*-distance).

Distribution. Known only from the type locality.

Etymology. Named after Dr James K. Lowry.

Remarks. *Rhachotropis lowryi* sp. nov. differs from its congeners by the combination of the following features: 1) urosomite 1 without dorsal process; 2) pereopod 5 basis with produced posterior margin; 3) uropod 3 with peduncle shorter than 0.5 times the outer ramus; 4) uropod 3 with inner and outer rami of the same length; and 5) telson cleft

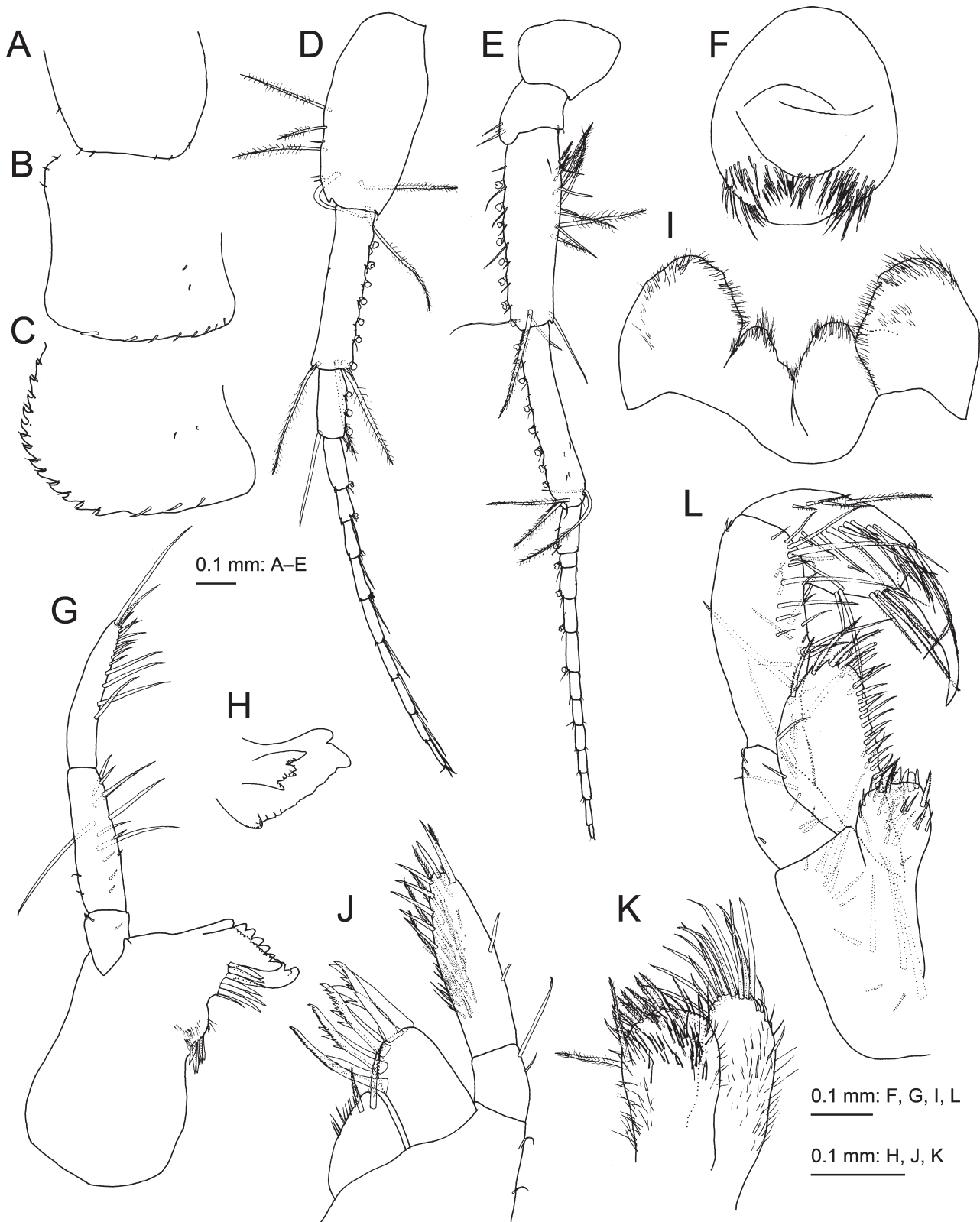


Figure 2. *Rhachotropis lowryi* sp. nov., holotype female, 6.4 mm, NSMT-Cr 30790: (A–C) epimeral plates 1–3, lateral view; (D) antenna 1, medial view; (E) antenna 2, medial view; (F) upper lip, anterior view; (G) left mandible, medial view; (H) incisor and lacinia mobilis of right mandible, medial view; (I) lower lip, anterior view; (J) maxilla 1, anterior view; (K) maxilla 2, anterior view; (L) maxilliped, anterior view.

for 44% of its length. The new species is similar to *R. reiwa* Okazaki, Ohtsuka & Tomikawa, 2020, described from off Amamioshima Island, in having pereopods 5 and 6 with a posteriorly produced basis and relatively deeply incised

telson (more than 38% of telson length). However, *R. lowryi* sp. nov. is distinguished from *R. reiwa* by the following features (features of *R. reiwa* in parentheses): (1) pereonite 7 dorsally smooth (bearing middorsal tooth); (2) epimeral plate

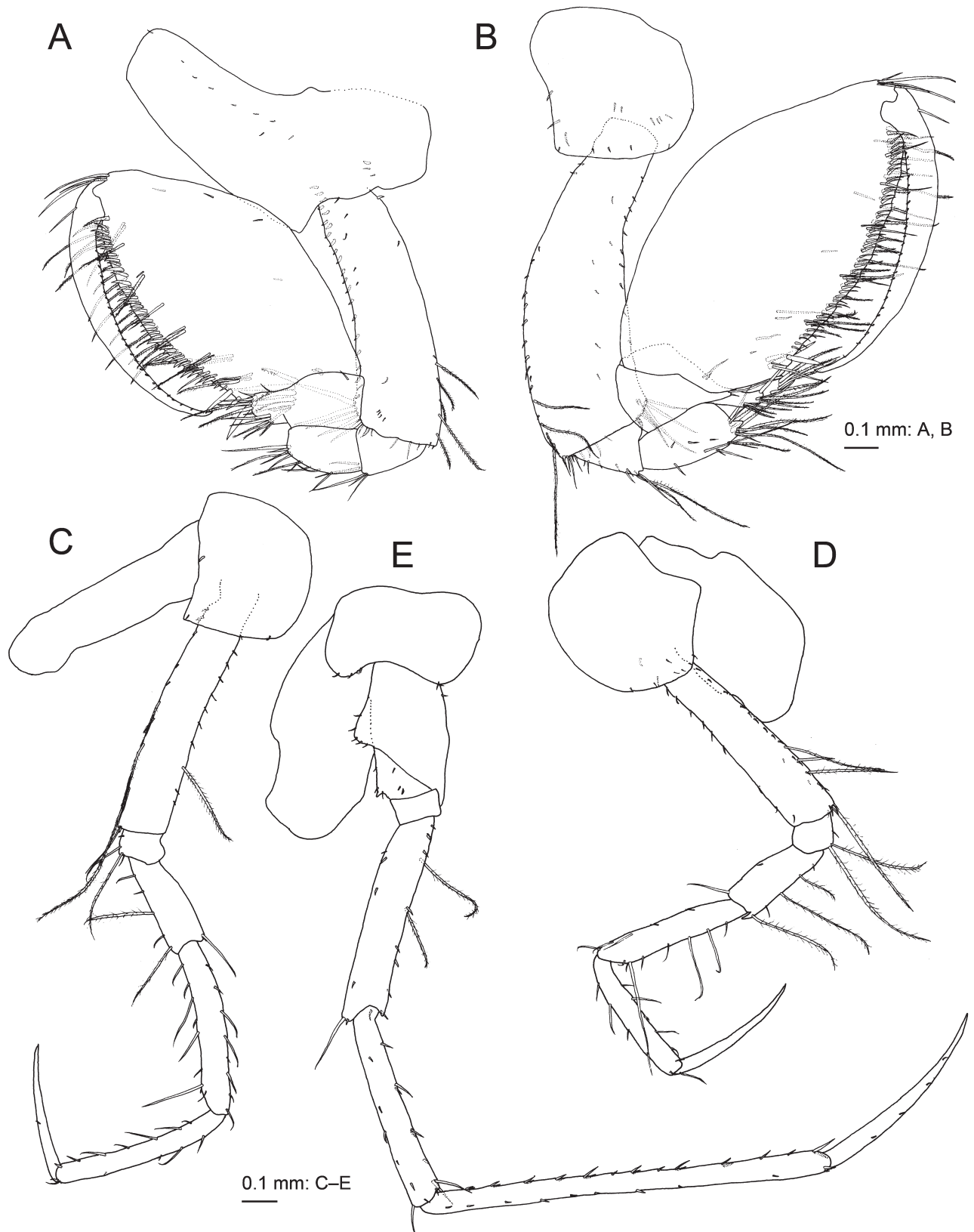


Figure 3. *Rhachotropis lowryi* sp. nov., holotype female, 6.4 mm, NSMT-Cr 30790: (A) gnathopod 1, lateral view; (B) gnathopod 2, lateral view; (C–E) pereopods 3–5, lateral view.

3 with strongly serrate posterior margin (weakly serrate); (3) pereopod 7 with basis strongly produced posteriorly (rounded but not produced); and (4) uropod 3 with inner and outer ramus of the same length (outer ramus slightly

shorter than inner). Although this new species and *R. reiwa* occur in the same geographic area, the two species are highly differentiated genetically (23.8% uncorrected *p*-distance), indicating that they are clearly distinct species. *Rhachotropis*

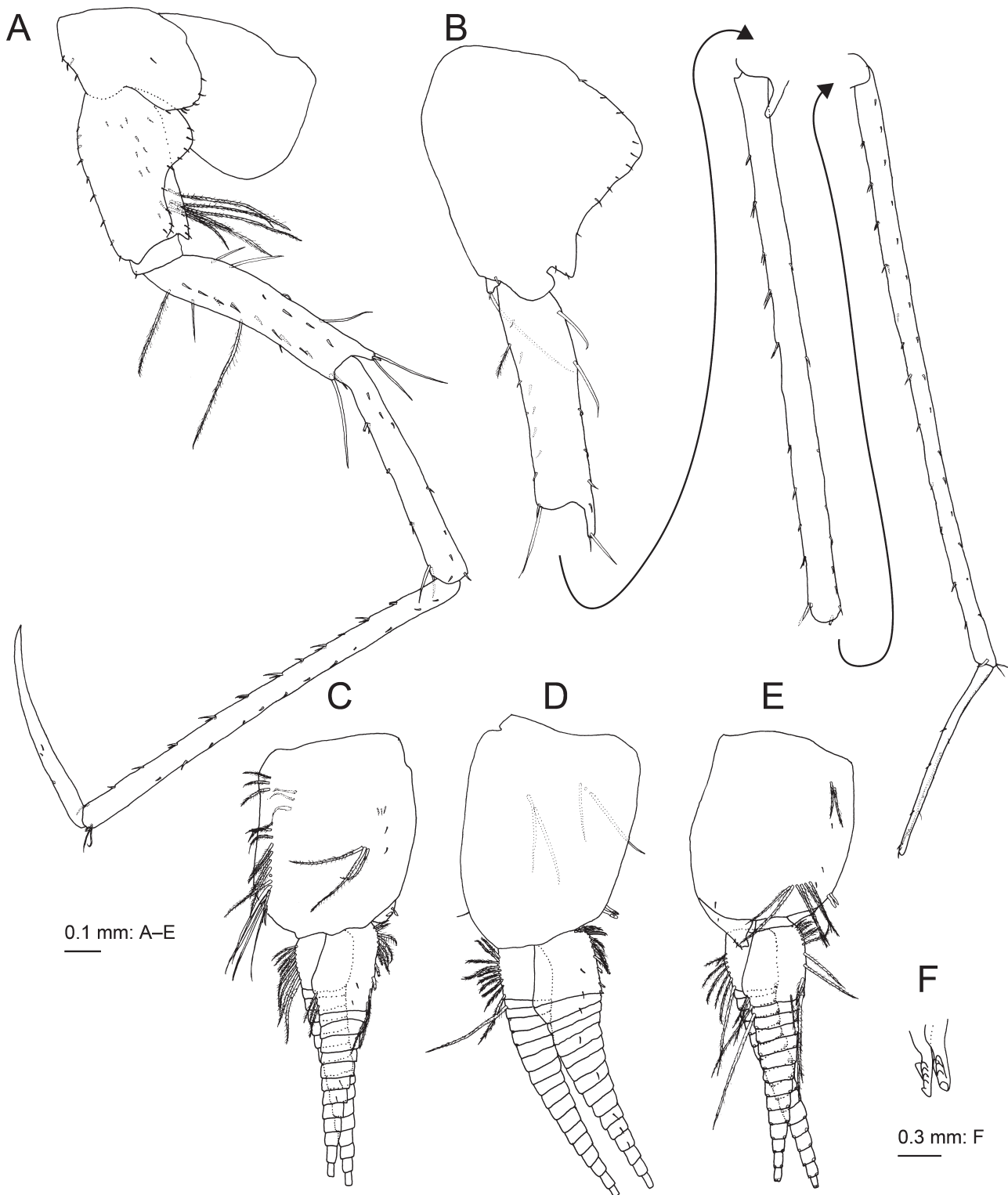


Figure 4. *Rhachotropis lowryi* sp. nov., holotype female, 6.4 mm, NSMT-Cr 30790: (A) pereopod 6, lateral view; (B) pereopod 7 (coxa broken), lateral view; (C–E) pleopods 1–3, posterior views; (F) retinacula of pleopod 2, posterior view.

lowryi sp. nov. shares the features of a prominent posterior margin of the basis of pereopod 5 with the following five species: *R. aculeata* (Lepechin, 1780), *R. gubilata* J. L. Barnard, 1964, *R. oweni* Lörz, 2015, *R. palporum* Stebbing, 1908, and *R. reiwa*. A comparison of features with these five species is shown in Table 1.

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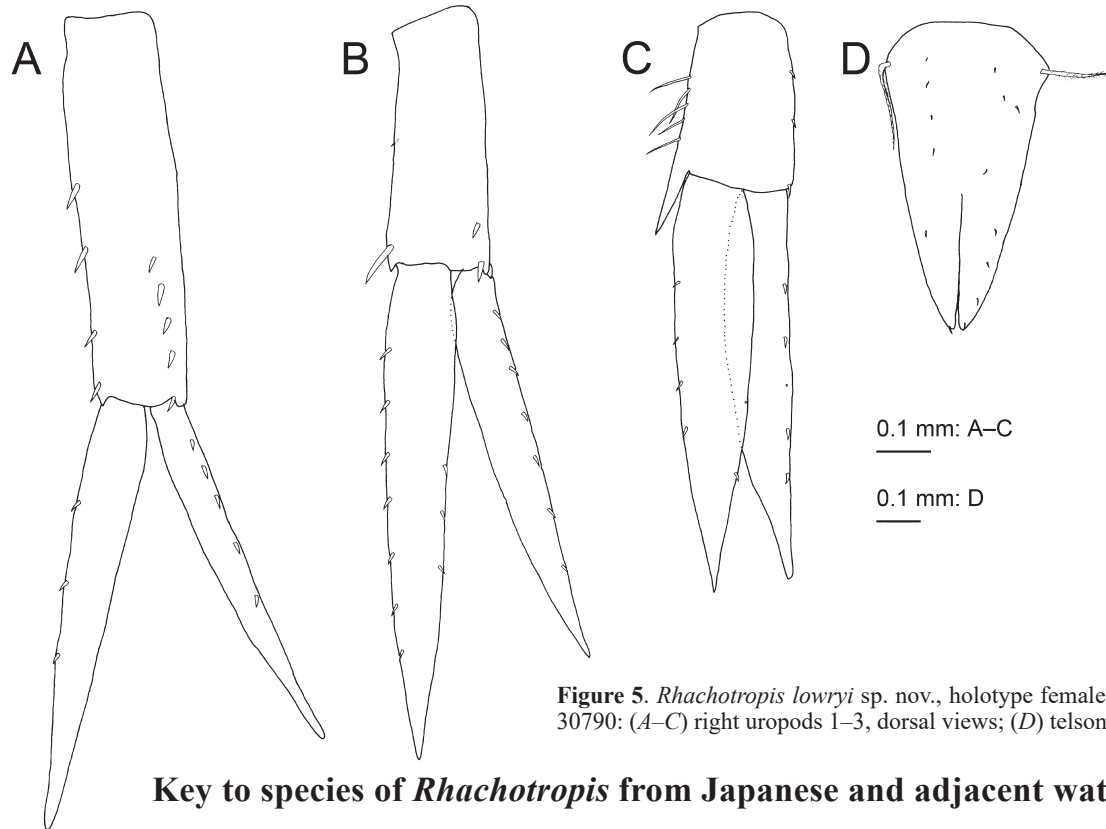


Figure 5. *Rhachotropis lowryi* sp. nov., holotype female, 6.4 mm, NSMT-Cr 30790: (A–C) right uropods 1–3, dorsal views; (D) telson, dorsal view.

Key to species of *Rhachotropis* from Japanese and adjacent waters

- | | | |
|---|---|---------------------------|
| 1 | Head with dorsal protrusion | 2 |
| — | Head dorsally smooth | 3 |
| 2 | Pereopods 5 and 6 basis produced posteriorly | <i>R. aculeata</i> |
| — | Pereopods 5 and 6 basis not produced posteriorly | <i>R. marinae</i> |
| 3 | Pereonite 7 with middorsal tooth | 4 |
| — | Pereonite 7 dorsally smooth | 6 |
| 4 | Pleonite 3 and urosomite 1 with middorsal tooth | <i>R. macropus</i> |
| — | Pleonite 3 and urosomite 1 without middorsal tooth | 5 |
| 5 | Pereopod 5 basis not produced posteriorly. Pereopod 6 basis oval | <i>R. oculata</i> |
| — | Pereopod 5 basis strongly produced posteriorly. Pereopod 6 basis triangular | <i>R. reiwa</i> |
| 6 | Urosomite 1 with dorsal tooth | 7 |
| — | Urosomite 1 dorsally smooth | 8 |
| 7 | Pereonites dorsally smooth. Telson cleft for 5% of its length | <i>R. distincta</i> |
| — | Pereonites with dorsal protrusion. Telson cleft for 10% of its length | <i>R. saskia</i> |
| 8 | Eyes small, not pigmented. Telson elongate, length 3.8 times width | <i>R. natator</i> |
| — | Eyes large, pigmented. Telson not elongate, length shorter than 2 times width | 9 |
| 9 | Pereopods 5–7 basis produced posteriorly | <i>R. lowryi</i> sp. nov. |
| — | Pereopods 5–7 basis not produced posteriorly | <i>R. inflata</i> |

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Table 1. Morphological comparison among species of *Rhachotropis* [*R. aculeata* (Lepechin, 1780); *R. gubilata* J. L. Barnard, 1964; *R. oweni* Lörz, 2015; *R. palporum* Stebbing, 1908; and *R. reiwa* Okazaki, Ohtsuka & Tomikawa, 2020] with pereopod 5 basis produced posteriorly. Note that pereopod 5 has not been described in some species.

	eyes	pereonite 7 dorsal and dorsolateral processes	pereonite 7 lateral process	epimeral plate 3 posterior margin	urosomite 1 dorsal process	coxa 1	pereopod 7 basis posterior margin	uropod 3 rami	telson
<i>R. lowryi</i> sp. nov.	large	absent	absent	strongly serrate	absent	produced anteriorly with rounded tip	produced with rounded margin	same length	cleft for 44%
<i>R. aculeata</i>	large	present	present	serrate	present	produced anteriorly with acute tip	produced with rounded margin	outer ramus shorter than inner	cleft for 30%
<i>R. gubilata</i>	small	absent	present	?	absent	produced anteriorly with acute tip	produced with acute tip	outer ramus slightly shorter than inner	slightly cleft
<i>R. oweni</i>	small	absent	absent	not serrate	absent	not produced anteriorly	extremely produced with rounded tip	outer ramus slightly shorter than inner	cleft for 10%
<i>R. palporum</i>	absent	absent	present	not serrate	present	produced anteriorly with acute tip	extremely produced with acute tip	same length	cleft for 14%
<i>R. reiwa</i>	large	present	absent	weakly serrate	absent	produced anteriorly with rounded tip	not produced	outer ramus slightly shorter than inner	cleft for 38%

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