

Tsuranarthrura shinsei, a New Genus and Species in Anarthruridae (Crustacea: Tanaidacea) from the Northwestern Pacific

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We establish the new anarthrurid genus *Tsuranarthrura* gen. nov. based on the new species *T. shinsei* sp. nov. collected from 1890 m depth off the eastern coast of Japan, northwestern Pacific Ocean. *Tsuranarthrura* gen. nov. is the third paratanaoid genus with members having a fused segment composed of pereonite 6 and the pleon, a character state previously restricted to the genera *Coalecerotanais* Larsen, 2003 (Family *incertae sedis*) and *Metagathotanaoides* Bird and Holdich, 1988 (Family Agathotanaoididae). Among anarthrurid genera, *Tsuranarthrura* gen. nov. is similar to *Anarthrura* Sars, 1882, *Anarthrurella* Bird, 2004, and *Crenicarpus* Drumm and Bird, 2016 in having the labrum not laterally compressed and the antenna with naked fourth and fifth articles from the distal end. However it differs from the latter three in having pereonite 6 fused with the pleon, the maxillipedal endite with a distal seta, the chelipedal merus with a ventral simple seta, and the merus naked on pereopods 2 and 3. We also present the nucleotide sequence for part of the cytochrome *c* oxidase subunit I (COI) gene in *T. shinsei* for future use in DNA barcoding or phylogeny.

Key Words: Malacostraca, Peracarida, Tanaidomorpha, Paratanaoidea, deep sea.

Introduction

We recently obtained specimens of an unusual paratanaoid tanaidacean from 1890 m depth in the northwestern Pacific off the eastern coast of Japan; this species has pereonite 6 fused with the pleon and lacks pereopod 6. These features are shared with *Coalecerotanais* Larsen, 2003 (Family *incertae sedis*), but the genus differs from our specimens in that the cheliped has the posterior free region and attaches to the cephalothorax via a sclerite (Larsen 2003b; Błażewicz-Paszkowycz *et al.* 2011). A fused segment comprising pereonite 6 and the pleon is also found in *Metagathotanaoides* Bird and Holdich, 1988 (Agathotanaoididae), but in *Metagathotanaoides*, this segment is laterally concave, the cephalothorax is longer than wide, the labrum is rounded, and pereopod 6 is present (Bird and Holdich 1988). Our specimens thus did not belong in *Coalecerotanais* or *Metagathotanaoides*. Although the fusion of pereonite 6 and the pleon, as far as is known, is restricted to these two genera, other features such as the relatively short, round cephalothorax, conical labrum, and cheliped attached ventromedially to the cephalothorax, indicated that our species belongs in the family Anarthruridae.

Bird (2004) reviewed the complex history of the taxonomy of Anarthruridae and established five new genera. Larsen (2013) removed the genus *Cristatotanaoides* Kudinova-Pas-

ternak, 1990 from the family, and four new genera were subsequently established (Bamber and Błażewicz-Paszkowycz 2013; Błażewicz-Paszkowycz *et al.* 2013; Drumm and Bird 2016; Józwiak *et al.* 2017). The family now contains 12 genera and 23 species (Anderson 2016; Józwiak *et al.* 2017). In having the labrum not laterally compressed and the antenna with naked fourth and fifth articles from the distal end, our species resembles species in three genera (*Anarthrura* Sars, 1882; *Anarthrurella* Bird, 2004; and *Crenicarpus* Drumm and Bird, 2016) but is distinguishable from them. Here we describe the species as new and establish a new genus for it. In addition, we present a partial sequence of the cytochrome *c* oxidase subunit I (COI) gene for future DNA barcoding or phylogenetic studies.

Materials and Methods

During the cruise KS 17-7 of the R/V *Shinsei-maru*, specimens of the new species were collected from 1890 m depth off the eastern coast of Japan with a box corer (Catalog No. 5153, Rigo, Japan). They were fixed and preserved in 99% ethanol. The methods used for dissection, preparation of slides, light microscopy, scanning electron microscopy (SEM), and drawing were as described by Kakui and Angspanich (2012).

Orientation and terminology here follow Larsen (2003a),

Table 1. Comparison of key characters among *Tsuranarthrura* gen. nov. and three similar genera. Based on data from Bird (2004); Drumm and Bird (2016); and this study.

Characters	<i>Tsuranarthrura</i>	<i>Anarthrura</i>	<i>Anarthrurella</i>	<i>Crenicarpus</i>
Pereonite 6	Fused to pleon	Distinct	Distinct	Distinct
Pleonites and pleotelson	Fused	Distinct or fused	Distinct	Distinct
# of setae on cheliped merus	1	1	1	≥5
# of setae on maxilliped endite	1	2	1	0
# of setae on merus of pereopods 2, 3	0	1	2	0

except that the term “plumose sensory seta(e)” (PSS; Bird 2011) is used instead of “broom seta(e)”. Body length (BL) was measured from the base of the antennules to the tip of the pleotelson, and body width at the widest portion of the cephalothorax (CW, cephalothorax width); BL was not measured in two specimens (NSMT-Cr 25817 and 25818) whose body was broken. Appendages were measured only in the holotype specimen. Measurements were made axially: dorsally on the body, antennules, antennae, and uropods; laterally on the pereopods and pleopods. Length and width in *Anarthrura simplex* Sars, 1882 were measured from the illustrations in Bird (2004).

Total DNA was extracted from the right cheliped (holotype) or the whole body except for the cephalothorax (paratype NSMT-Cr 25817) by using a NucleoSpin Tissue XS kit (TaKaRa Bio, Japan); after extraction, the exoskeleton of the latter (the former was lost during extraction) was recovered and mounted on a slide. Part of the COI gene was amplified by PCR with the primers LCO-1490 and HCO-2198 (Folmer *et al.* 1994). PCR amplification conditions with TaKaRa Ex Taq DNA polymerase (TaKaRa Bio) were 95°C for 1 min; 35 cycles of 95°C for 30 s, 50°C for 1 min, and 72°C for 1 min; and 72°C for 7 min. Methods for sequencing and sequence assembly were as described by Tomioka *et al.* (2016). Obtained sequences were deposited in the International Nucleotide Sequence Database (INSD) through the DNA Data Bank of Japan (DDBJ), under accession numbers LC326400 and LC326401. The type specimens were deposited in the crustacean collection of the National Museum of Nature and Science (NSMT), Tsukuba, Japan.

Family **Anarthruridae** Lang, 1971

Genus ***Tsuranarthrura*** gen. nov.

Type species. *Tsuranarthrura shinsei* sp. nov., by original designation.

Diagnosis. Body wall not heavily calcified. Pereonite 6 and pleon fused. Antenna with five articles; articles 1 and 2 naked. Labrum conical, not laterally compressed. Maxillipedal endite not tapering distally, with ventrosubdistal seta. Maxilliped-palp article 2 with three inner setae; article 3 with three long and one short inner setae. Chelipedal merus with ventral seta. Cheliped propodus with ventral seta but without outer crenulation, folds or ridges. Pereopods 2 and 3 merus naked. Pereopods 4 and 5 basis cylindrical (not swollen).

Etymology. The genus name (feminine) combines the Japanese word *tsuranaru* (‘continue without cutting’) with



Fig. 1. *Tsuranarthrura shinsei* gen. et sp. nov., holotype, sex indeterminate, fixed specimen. Right cheliped disjunct. Distal portion of left pereopod 5 lost during observation. Scale bar: 0.5 mm.

anarthrura (a genus name in the Anarthruridae), referring to the fused segment consisting of pereonite 6 and the pleon.

Remarks. In Anarthruridae, several authors have described antennal article 1 as being fused to the cephalothorax (*e.g.*, Błażewicz-Paszkowycz *et al.* 2013; Larsen 2013). In their species, the antenna seems to be five-articulate. This is also the case with our specimens: we observed only five antennal articles in individuals of *Tsuranarthrura* gen. nov., even by SEM. Although the most proximal article we observed seems to correspond to article 2 in other paratanaoids (*e.g.*, Larsen 2003a, fig. 2D as Tanaellidae; Bird 2011, fig. 18F as Paratanaidae; Bird 2012, fig. 4D as Heterotanaoididae; Kakui and Angsupanich 2012, fig. 5B as Nototanaoididae; Kakui and Shimada 2017, fig. 7E as Tanaopsidae), we designate it herein as ‘article 1’. This is because we followed Larsen’s (2003a) terminology and there is the possibility that the most proximal article could be equivalent to fused articles 1 and 2 in 6-articulate paratanaoids.

Our specimens of *Tsuranarthrura* gen. nov. lack the pereopod 6. This is similar to the condition in *Coalecerotanais*, the sole paratanaoid genus having a fused segment composed of the pereonite 6 and the pleon, and lacking the pereopod 6. The early manca stage in tanaidaceans generally lacks the pereopod 6 (*cf.* Larsen 2003a), and Larsen (2003b) and Błażewicz-Paszkowycz *et al.* (2011) proposed that *Coalecerotanais* adults may lack this pereopod through neoteny. As we could not judge whether our specimens were in the manca or postmanca stage, we did not include this character state in the diagnosis of *Tsuranarthrura* gen. nov.

The confamilial genera *Tsuranarthrura* gen. nov., *Anarthrura*, *Anarthrurella*, and *Crenicarpus* all have the labrum not compressed laterally, and the fifth and fourth anten-

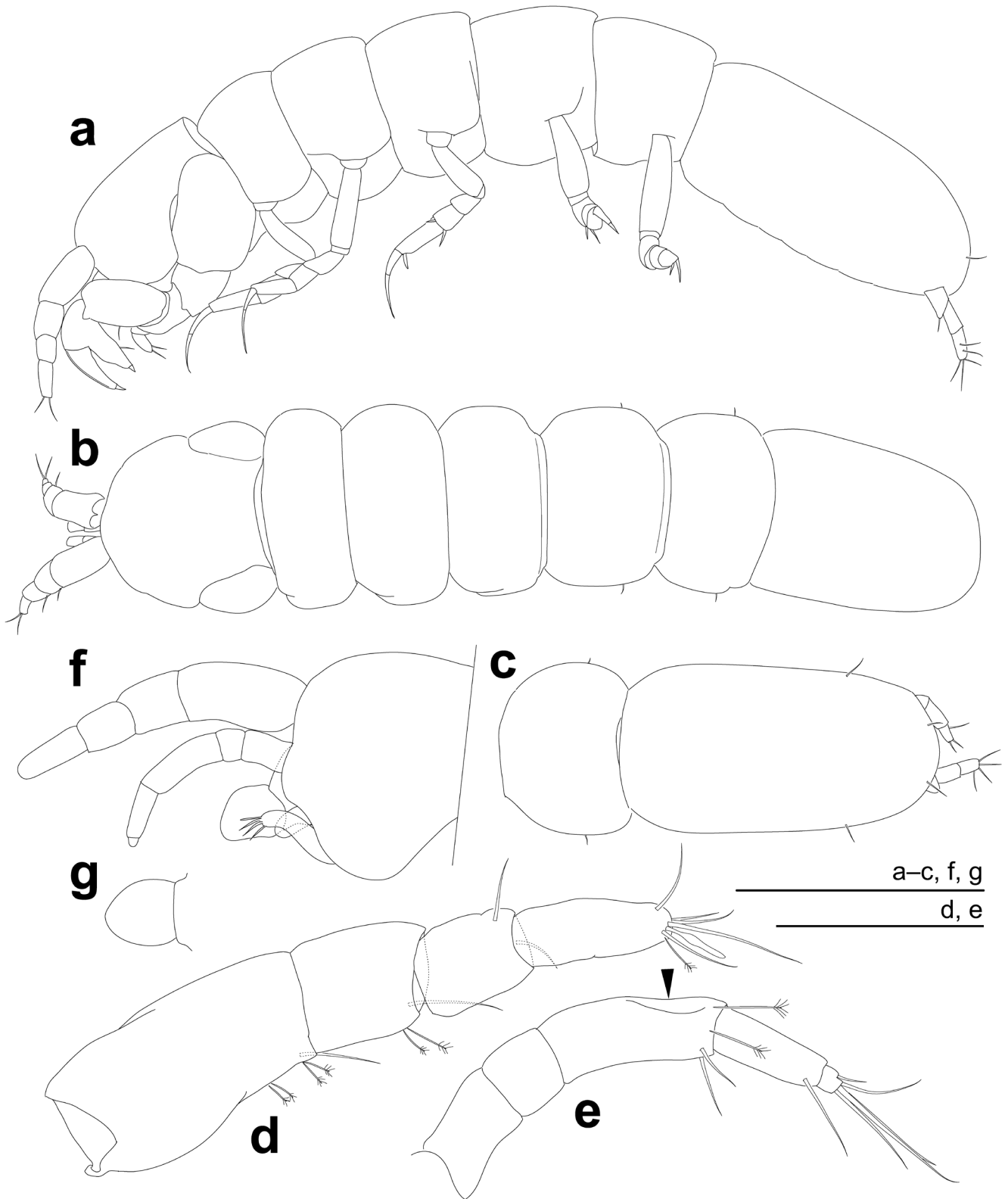


Fig. 2. *Tsuranarthrura shinsei* gen. et sp. nov., holotype, sex indeterminate. a, body, left view; b, body, dorsal view at the front of carapace; c, pereonite 5 and fused segment consisting of pereonite 6 and pleon, dorsal view at the front of fused segment; d, left antennule; e, left antenna with artifactual depression (arrowhead); f, anterior region of cephalothorax, left view, most setal ornamentation and mouthparts omitted; g, labrum, dorsal view. Scale bars: 0.5 mm (a–c), 0.1 mm (d, e), 0.25 mm (f, g).

nal articles from distal end naked (Bird 2004; Drumm and Bird 2016). *Tsuranarthrura* gen. nov. differs from the other three in having pereonite 6 fused with the pleon, the cheli-

pedal merus with a ventral seta, the maxillipedal endite with a ventrosubdistal seta, and the merus of pereopods 2 and 3 without setae (Table 1).

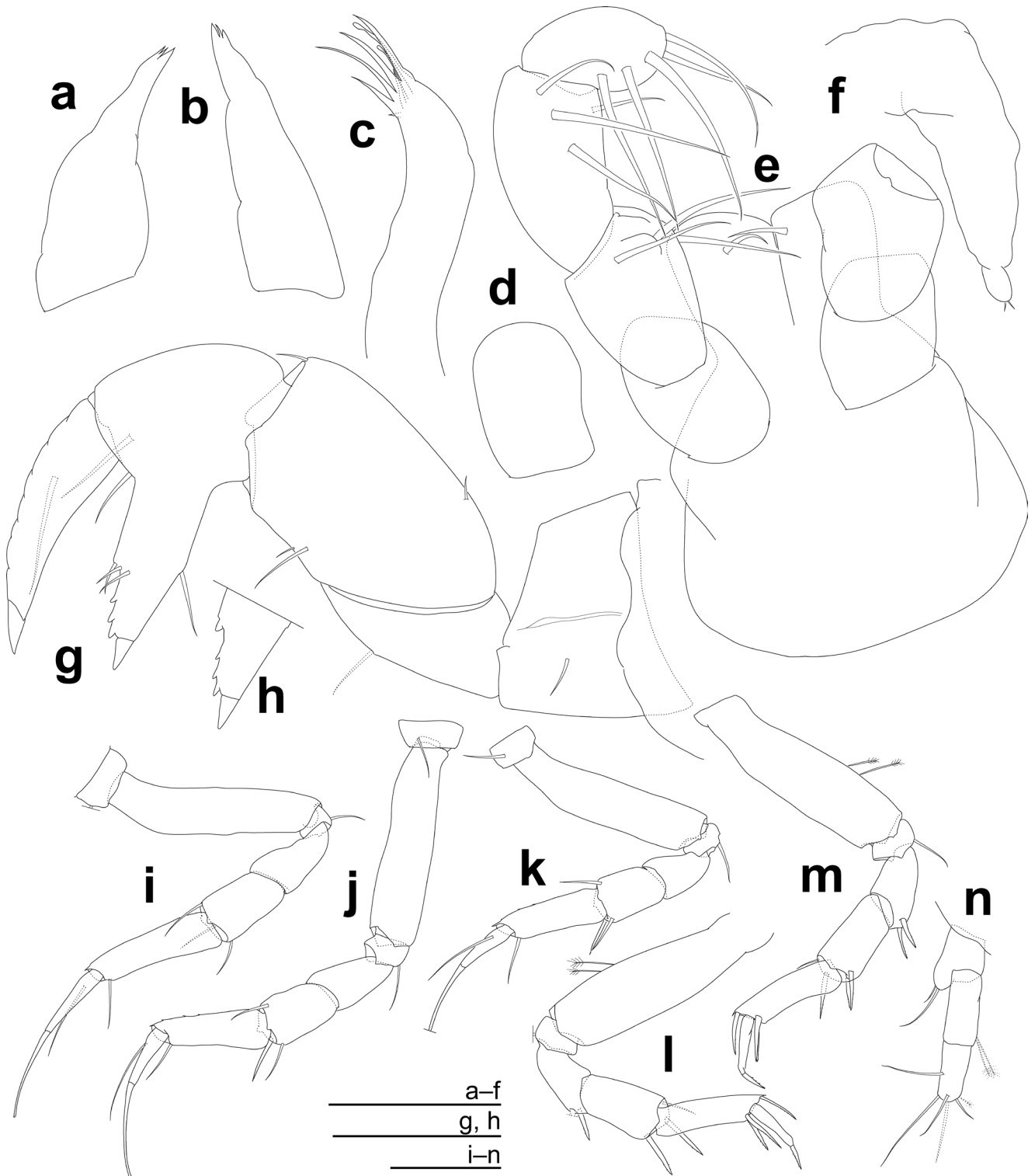


Fig. 3. *Tsuranarthrura shinsei* gen. et sp. nov., holotype, sex indeterminate. a, left mandible; b, right mandible; c, maxillule; d, maxilla; e, maxillipeds, left palp partly omitted; f, epignath; g, left cheliped, basis with artifactual crack on outer surface; h, left chelipedal fixed finger, setae omitted; i-l, left pereopods 1-4; m, right pereopod 5; n, left uropod. Scale bars: 0.025 mm (a, b), 0.05 mm (c-f), 0.1 mm (g-n).

Tsuranarthrura shinsei sp. nov.
(Figs 1-5)

Diagnosis. Same as for the genus.

Etymology. The specific name (a noun in apposition) is derived from R/V *Shinsei-maru*, the vessel from which the

type specimens were collected.

Material examined. Holotype. Sex indeterminate, NSMT-Cr 25816 (BL 1.99 mm, CW 0.38 mm), dissected, six slides and one vial; INSD accession number LC326400; R/V *Shinsei-maru*, Off Miyagi, Japan, Northwestern Pacific Ocean (38°44.29'N, 143°10.06'E), 1890 m depth, box corer,

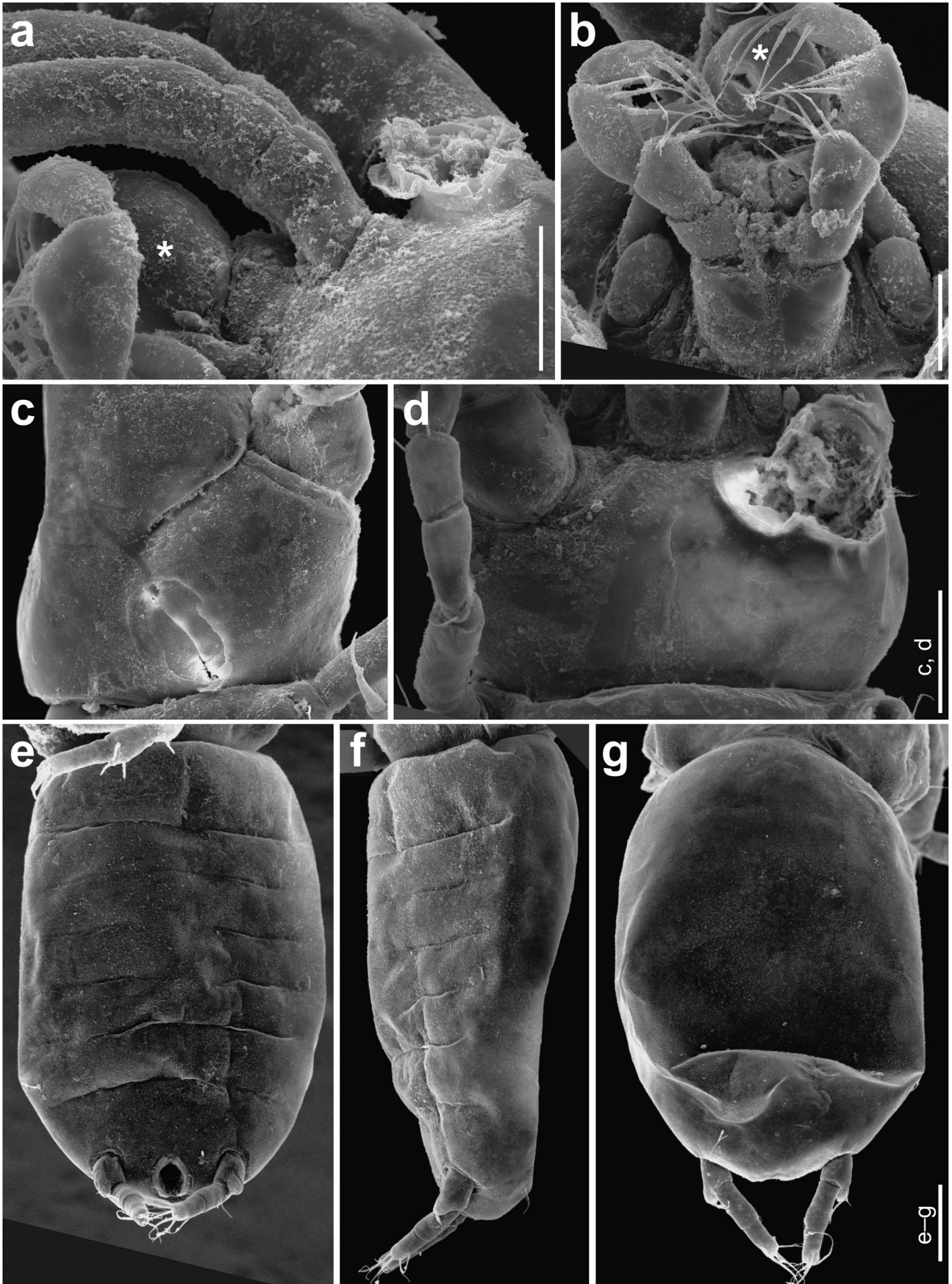


Fig. 4. *Tsuranarthrura shinsei* gen. et sp. nov., paratype NSMT-Cr 25818, sex indeterminate, SEM images. a, b, anterior portion of cephalothorax, left (a) and ventral (b) views, left antennule detached; c, d, posterior portion of cephalothorax, right (c) and ventral (d) views, dorsal surface of carapace and border between carapace and pseudocoxa artifactually depressed, left cheliped detached; e–g, fused pereonite 6 and pleon, ventral (e), left (f), and dorsal (g) views, dorsal surface artifactually depressed. *, labrum. Scale bars: 0.05 mm (a, b), 0.1 mm (c–g).

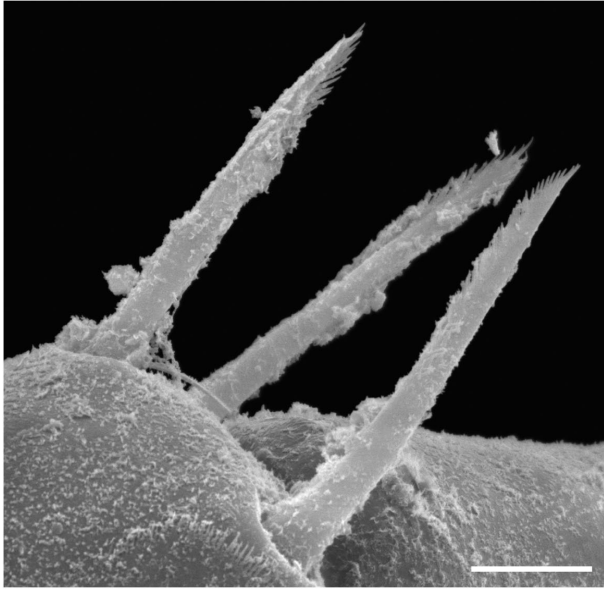


Fig. 5. *Tsuranarthrura shinsei* gen. et sp. nov., paratype NSMT-Cr 25818, sex indeterminate, SEM image. Serrate spiniform setae on right pereopod-4 carpus. Scale bar: 0.01 mm.

mud bottom, 11.viii.2017. Paratypes: one sex indeterminate, NSMT-Cr 25817 (CW 0.36 mm), dissected, three slides; INSD accession number LC326401; one sex indeterminate, NSMT-Cr 25818 (CW 0.38 mm), dissected, one slide and two SEM stubs. Paratypes with same collection data as for holotype.

Other material. One sex indeterminate, NSMT-Cr 25819 (BL 1.79 mm, CW 0.37 mm), one vial, with same collection data as for holotype.

Description. Based on holotype; sex indeterminate.

Body (Figs 1, 2a–c, 4) slightly dorsoventrally flattened, 5.24 times as long as CW, BL 1.99 mm; body wall not heavily calcified. Cephalothorax 0.16 times as long as BL, 0.86 times as long as wide, naked; anterior edge rounded in dorsal view; eye lobe absent. Pereonites 1–5 with length ratio of 1.00:1.23:1.37:1.51:1.52; all wider than long; pereonites 1–3 naked; pereonites 4 and 5 with lateral simple seta. Pereonite 6 and pleon fused (Fig. 2c), 0.32 times as long as BL, 1.91 times as long as wide, with one lateral and one distal pairs of simple setae; lateral margins almost parallel; posterior edge round in dorsal view; vestigial articulations between segments evident on ventral surface (Fig. 4e–g).

Antennule (Fig. 2d) 0.96 times as long as cephalothorax; articles 1–4 with length ratio of 1.00:0.43:0.37:0.60. Article 1 with distal simple seta and several PSS. Article 2 with distal simple seta and two PSS. Article 3 with two distal simple setae. Article 4 with five simple setae, PSS, and aesthetasc in distal region. Antenna (Figs 2e, 4a) with five articles, 0.72 times as long as antennule; articles 1–5 with length ratio of 1.00:0.67:1.63:1.20:0.20. Articles 1 and 2 naked. Article 3 with two distal simple setae and two PSS (arrowhead, Fig. 2e: artifactual depression). Article 4 with distal simple seta. Article 5 with one subdistal and four distal simple setae.

Labrum (Figs 2f, g, 4a, b) conical, not depressed later-

ally, naked. Mandibles (Fig. 3a, b) without molar process and *lacinia mobilis*; incisor narrow and distally multifurcate. Labium not observed. Maxillule (Fig. 3c) with endite bearing eight distal spines; palp not observed. Maxilla (Figs 3d, 4b) rectangular, naked. Maxilliped (Figs 3e, 4b) with naked basis; endite slightly widening distally, with ventrosubdistal simple seta. Palp with article 1 naked; article 2 with three inner simple setae; article 3 with three long and one short inner simple setae; article 4 with five simple setae. Epignath (Fig. 3f) falciform, with minute distal setae.

Cheliped (Figs 3g, h, 4c, d) attached ventromedially to cephalothorax. Basis shorter than wide, with outer simple seta. Merus with ventral simple seta. Carpus 1.67 times as long as wide, with one dorsal, one dorsodistal, and two ventral simple setae. Chela slightly longer than carpus. Propodal palm with one inner and one outer simple setae at insertion of dactylus. Fixed finger slightly longer than palm, with simple seta on ventral margin, three mid-dorsal simple setae and four dorsal processes (Fig. 3h) on cutting surface, and triangular claw. Dactylus-unguis slightly longer than fixed finger, with inner simple seta and row of dorsal ridges. Unguis triangular.

Pereopods 1–5 cylindrical, with length ratio of 1.00:0.94:0.85:0.84:0.86 (distal portion of pereopod-3 unguis broken). Pereopod 1 (Fig. 3i) 0.19 times as long as BL, with length ratio of basis, ischium, merus, carpus, propodus, and dactylus-unguis 1.00:0.07:0.34:0.36:0.61:0.83. Coxa with simple seta. Basis cylindrical, narrow, 4.36 times as long as wide, naked. Ischium with ventral simple seta. Merus naked. Carpus with one dorsal, one inner, and one ventral simple setae in distal region. Propodus with ventrodistal simple seta and dorsodistal microtrichia. Dactylus with proximal seta. Unguis 1.22 times as long as dactylus, naked. Pereopod 2 (Fig. 3j) with length ratio of articles from basis to dactylus-unguis 1.00:0.10:0.29:0.37:0.52:0.76. Coxa, basis, ischium, merus, and dactylus-unguis similar to those of pereopod 1. Carpus with one dorsodistal and one ventrodistal simple setae and ventrodistal spiniform seta. Propodus with ventrodistal simple seta and dorsal serration on edge in distal half. Pereopod 3 (Fig. 3k) with length ratio of articles from basis to dactylus-unguis 1.00:0.08:0.25:0.33:0.48:0.69; similar to pereopod 2. Pereopod 4 (Figs 3l, 5) without coxa. Length ratio of articles from basis to dactylus-unguis 1.00:0.08:0.25:0.39:0.44:0.38. Basis cylindrical, 3.38 times as long as wide, with two ventral PSS. Ischium with ventral simple seta. Merus with two ventrodistal serrate spiniform setae. Carpus with dorsodistal simple seta and two distal serrate spiniform setae (*cf.* Fig. 5). Propodus with one dorsal and two ventral serrate spiniform setae and dorsal microtrichia in distal region. Dactylus naked. Unguis 0.48 times as long as dactylus, with ventral setation. Pereopod 5 (Fig. 3m) with length ratio of articles from basis to dactylus-unguis 1.00:0.09:0.27:0.35:0.43:0.38; similar to pereopod 4, except carpus with three distal serrate spiniform setae.

Pleopods absent.

Uropod (Fig. 3n) with exopod fused to basal article bearing two simple setae. Endopod biarticulate; article 1 with two distal PSS; article 2 0.78 times as long as article 1, with

one middle and four distal simple setae and PSS.

Variation. In addition to the holotype (NSMT-Cr 25816), two paratype specimens (NSMT-Cr 25817, 25818) were observed. All specimens had a fused segment consisting of pereonite 6 and the pleon. The numbers of simple setae, spiniform setae, serrate spiniform setae and aesthetascs on appendages, and of processes on the chelipedal fixed finger, were identical among the three specimens, with the following exceptions. 1) There were five (NSMT-Cr 25817, 25818) or four (NSMT-Cr 25816) distal simple setae on antennular article 4. 2) There were two (left in holotype; Fig. 3l), three (right in holotype, left in NSMT-Cr 25817, and right in NSMT-Cr 25818; Fig. 5), or four (right in NSMT-Cr 25817) distal serrate spiniform setae on the pereopod-4 carpus.

Genetic information. Partial COI sequences (651 bp, encoding 216 amino acids) were determined from the holotype specimen NSMT-Cr 25816 and the paratype specimen NSMT-Cr 25817; INSD accession numbers LC326400 and LC326401; the two sequences were identical. The sequence in the INSD most similar to our COI sequence, as determined by BLAST searches (Altschul *et al.* 1990), was from the tanaidacean *Typhlotanais variabilis* Hansen, 1913 (Typhlotanaidae) (identity score 74%, query cover 70%, Błażewicz-Paszkowycz *et al.* 2014). To date, no other anarthrurid nucleotide sequences have been deposited in public databases (DDBJ 2017).

Distribution. So far known only from the type locality.

Remarks. Although *Anarthrura simplex* does not have pereonite 6 fused to the pleon, this is the only confamilial species having a fused segment (consisting of the pleonites and pleon). Here we present additional differences between *T. shinsei* sp. nov. and *A. simplex* not mentioned in the Remarks section for *Tsuranarthrura* gen. nov. 1) All pereonites are wider than long in *T. shinsei* sp. nov., whereas pereonites 2–5 are longer than wide in *A. simplex*. 2) The mandibular incisor is narrow and multifurcate in *T. shinsei* sp. nov. but subrectangular in *A. simplex*. 3) The number of spines on the maxillular endite is eight in *T. shinsei* sp. nov., but four in *A. simplex*. 4) The length of dactylus-unguis is about four-fifths that of the propodus in pereopods 4 and 5 in *T. shinsei* sp. nov., but about two-thirds in *A. simplex*.

So far four anarthrurid species were reported from around Japan: *Anarthruopsis langi* Kudinova-Pasternak, 1976, *Anarthruopsis longa* Kudinova-Pasternak, 1984, *Siphonolabrum tenebrosus* Bird, 2007, and *Keska sei* Błażewicz-Paszkowycz *et al.* 2013 (Bird 2007; Błażewicz-Paszkowycz *et al.* 2013). *Tsuranarthrura shinsei* sp. nov. is the fifth anarthrurid species around Japan.

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