

First Report of Teleotanaidae (Crustacea: Tanaidacea) from the Northwestern Pacific, with the Description of a New Species

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We describe *Teleotanais madara* sp. nov. from the surfaces of mangrove roots on mudflats at Iriomote Island, Ryukyu Islands, southwestern Japan. This is the first record of any teleotanaid species from the northwestern Pacific. *Teleotanais madara* resembles *T. gerlachi* and *T. gerlachi sensu* Sieg (1976), but differs in having a mid-inner simple seta on antennular article 2, two ventral setae on the basal article of the uropod, the chelipedal fixed finger with one or two ventral simple setae, ventrodistal simple setae on the pereopod-1 merus being half as long as the width of the merus, and the dactylus–unguis of pereopods 4–6 articulate. We also present the nucleotide sequence for part of the cytochrome *c* oxidase subunit I (COI) gene in *T. madara* for future use in DNA barcoding and phylogeny.

Key Words: Peracarida, Tanaidomorpha, Paratanaoidea, DNA barcode, Pacific Ocean, brackish, mangrove, mud.

Introduction

Teleotanais Lang, 1956 is the only genus in the family Teleotanaidae Bamber, 2008, which differs from other paratanaoids in having the following combination of characters: 1) a darkly pigmented body, 2) a pair of lateral circumplumose setae on pleonites 1–4, and 3) antennal article 3 as long as or longer than antennal article 4. This genus currently contains three nominal species: *T. gerlachi* Lang, 1956 from Brazil (southwestern Atlantic Ocean), type species for the genus; *T. indiaensis* Larsen and Sahoo in Larsen *et al.* (2013) from India (Indian Ocean); and *T. warragamba* Bamber, 2008 from Australia (southwestern Pacific Ocean) (Lang 1956; Bamber 2008; Larsen *et al.* 2013). Sieg's (1976) redescription of nominal *T. gerlachi* from El Salvador (eastern equatorial Pacific Ocean) differed in several ways from Lang's (1956) description (*e.g.*, the number of the ventral simple setae on the fixed finger), and Bamber (2008: p. 179) stated that Sieg's "material from Pacific El Salvador attributed to *T. gerlachei* [*sic*; = *T. gerlachi*] needs critical re-examination"; we thus refer herein to specimens from El Salvador as *T. gerlachi sensu* Sieg (1976).

During sampling on mudflats around Iriomote Island, Ryukyu Islands, southwestern Japan, in 2017, the first author collected tanaidaceans that proved to be an undescribed species in *Teleotanais*, the first record for the family Teleotanaidae from the Northwestern Pacific. Here we describe the species as new and present a sequence for part of the mitochondrial COI (cytochrome *c* oxidase subunit I) gene for future DNA barcoding and phylogenetic studies.

Materials and Methods

Studied individuals were collected from mud covering the surfaces of mangrove roots on mudflats around the Shira River on Iriomote Island on 23 February 2017. The sediment was sieved through a 0.5 mm-mesh net and tanaidaceans were picked from the debris with forceps, and fixed and preserved in 99% ethanol. The methods used for dissection, preparation of slides, light microscopy, and drawing were as described by Kakui and Angsupanich (2012). The type specimens were deposited in the Invertebrate Collection of the Hokkaido University Museum (ICHUM), Sapporo, Japan. In the new Japanese names presented, the suffixes *-ka* and *-zoku* are the taxonomic ranks family and genus, respectively, in Japanese.

Orientation and terminology here follow Larsen (2003), except that the term "plumose sensory seta" (PSS; Bird 2011) was used instead of "broom seta", and the term "step-tipped plumose seta" (Kakui *et al.* 2010) was used. We proposed two new terms, "serrate-tipped curved-spiniform seta(e)" and "serrate-tipped spiniform seta(e)" for the setae found in the inner dorsodistal/dorsosubdistal regions of the maxillipedal endite. 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). Appendages were measured in one specimen. Measurements were made axially on digital images by using ImageJ (Rasband 2019): dorsally on the body, antennules, antennae, and uropods; laterally on the chelipeds, pereopods, and pleopods. The length and width of



Fig. 1. *Teleotanis madara* sp. nov., holotype female (ICHUM-5844), ethanol fixed specimen, dorsal (A) and left (B) views. Scale: 1 mm.

congeners were measured from original illustrations if these measurements were not provided in descriptions.

Total DNA was extracted from a cheliped of the holotype specimen by using a NucleoSpin Tissue XS kit (TaKaRa Bio, Japan); after extraction, the exoskeleton 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 90 s; 35 cycles of 95°C for 30 s, 50°C for 30 s, 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). The sequence obtained was submitted to the International Nucleotide Sequence Database (INSD) through the DNA Data Bank of Japan (DDBJ).

Family **Teleotanidae** Bamber, 2008
 [New Japanese name: *Madara-tanaisu-ka*]
 Genus **Teleotanis** Lang, 1956
 [New Japanese name: *Madara-tanaisu-zoku*]
Teleotanis madara sp. nov.
 [New Japanese name: *Madara-tanaisu*]
 (Figs 1–3)

Diagnosis. Antennule darkly pigmented; article 2 with mid-inner simple seta. Antennal article 3 with single simple seta in distal region. Maxilliped with endite bearing distal serrate-tipped curved-spiniform seta and subdistal serrate-tipped spiniform seta in inner dorsal region; palp article

4 with mid-outer simple seta. Cheliped with fixed finger bearing one or two ventral simple setae; dactylus with two subproximal simple setae on cutting surface. Pereopod-1 merus with two ventrodistal simple setae being half as long as width of merus. Dactylus–unguis of pereopods 4–6 not fused. Uropod with basal article bearing two ventral simple setae; endopod biarticulate.

Etymology. This species-group name is derived from the Japanese noun *madara* (mottled), referring to the mottling on the body.

Material Examined. Holotype: ovigerous female, ICHUM-5844, BL 2.58 mm, CW 0.35 mm, dissected, eight slides and one vial; INSD accession number LC472886; mouth of Shiira River (24°19'25.1"N 123°54'38.3"E), Iriomote Island, Ryukyu Islands, southwestern Japan, mud on mangrove roots, 23.ii.2017, collected by Y. Tanabe. Paratypes: three preparatory females (ICHUM-5845, BL 1.66 mm, CW 0.25 mm, dissected, six slides and one vial; ICHUM-5846, BL 2.50 mm, CW 0.29 mm, dissected, nine slides and one vial; ICHUM-5847, BL 2.55 mm, CW 0.30 mm, dissected, six slides and one vial); same collection data as for holotype.

Description of female. Based primarily on ICHUM-5844, with some observations from ICHUM-5845–5847.

Body (Figs 1, 2A, B) dorsoventrally flattened, seven times as long as CW, pigmented red-brown (Fig. 1; pigmentation retained in ethanol). Cephalothorax length 0.16 times as long as BL, length 1.23 times width, with pair of simple setae posterior to

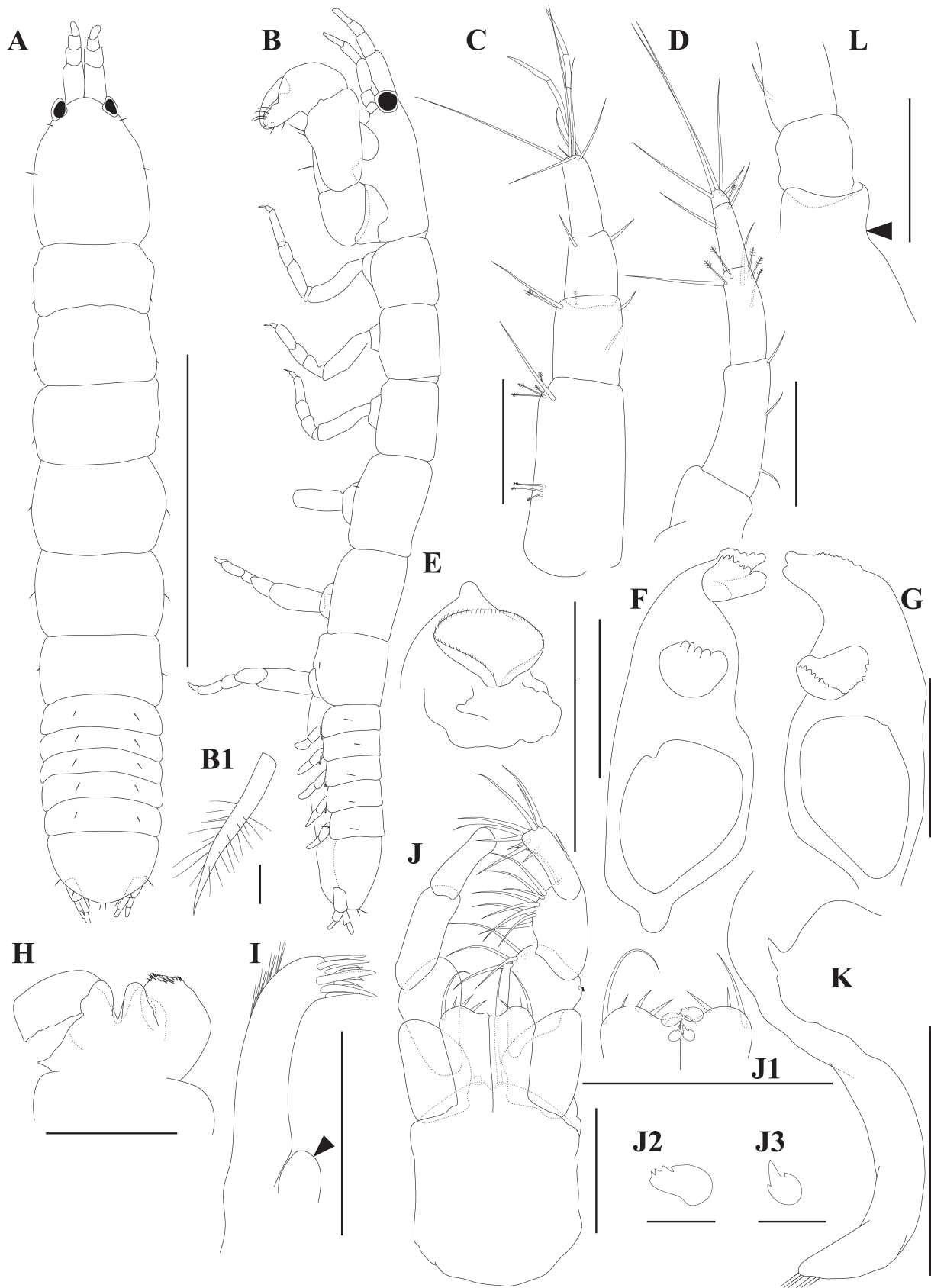


Fig. 2. *Teleotanais madara* sp. nov., female. A–J, J1–3, holotype (ICHUM-5844); K, paratype (ICHUM-5846); L, paratype (ICHUM-5847). A, body, dorsal view; B, body, lateral view; B1, mid-lateral circumplumose seta on pleonite; C, left antennule, dorsal view; D, left antenna, outer view; E, labrum; F, G, left and right mandibles, respectively; H, labium; I, maxillule and maxilla (arrowhead); J, maxillipeds, dorsal view (setae omitted from left palp and inner dorsal region of endite); J1, distal portion of maxillipedal endite, dorsal view; J2, serrate-tipped curved-spiniform seta; J3, serrate-tipped spiniform seta; K, epignath; L, proximal portion of right antenna, outer view (arrowhead, article 1 fused to cephalothorax). Scales: A, B, 1 mm; B1, J2, J3, 0.01 mm, others, 0.1 mm.

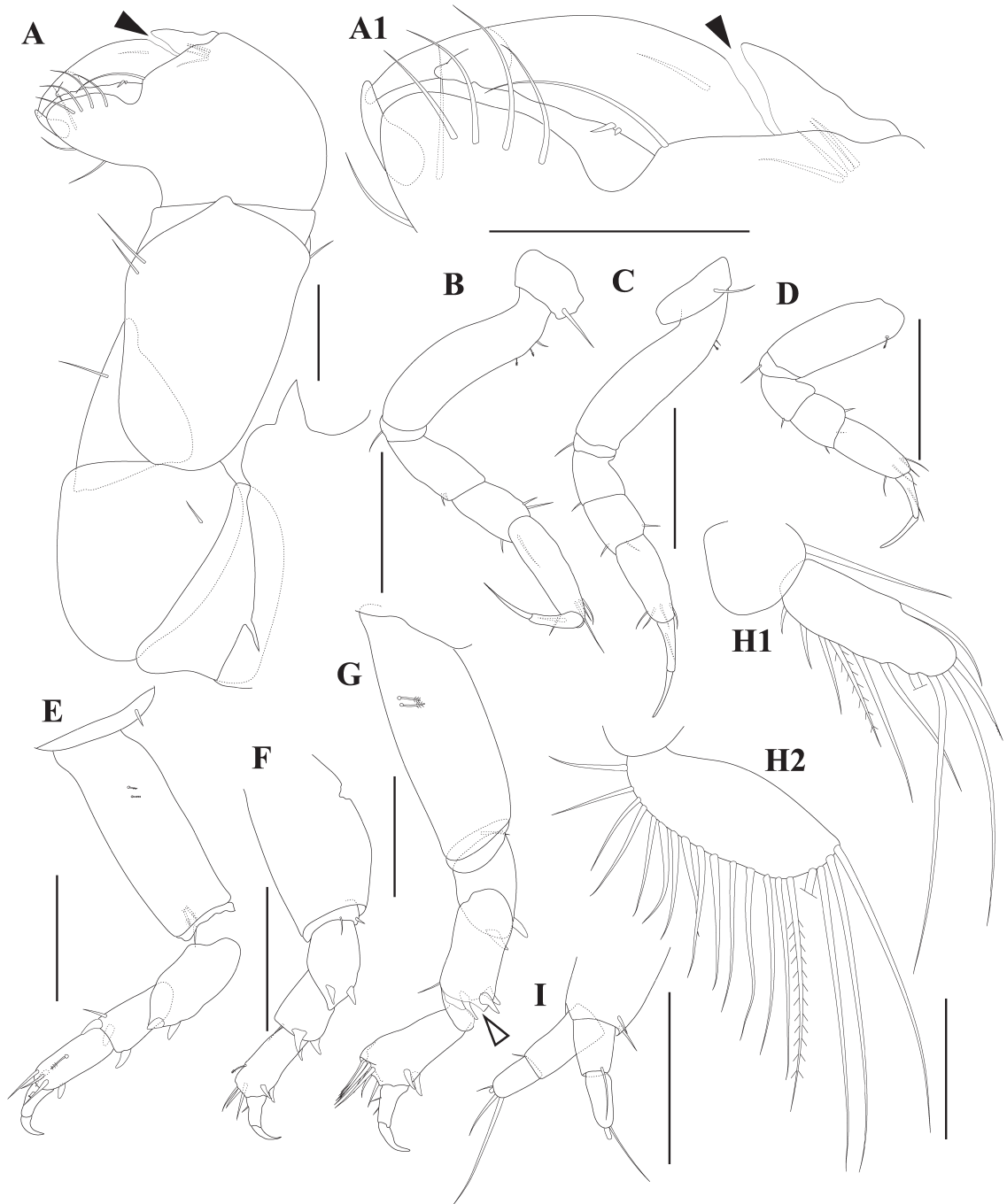


Fig. 3. *Teleotanaïs madara* sp. nov., female. A, A1, E, G, H1, H2, I, holotype (ICHUM-5844); B-D, F, paratype (ICHUM-5845). A, left cheliped (proximal portion of dactylus partly broken), outer view; A1, same, fixed finger and dactylus; B-G, right pereopods 1-6; H1, basal article and endopod of right pleopod 1, most setal ornamentation omitted; H2, distal portion of basal article and exopod of right pleopod 1, most setal ornamentation omitted; I, right uropod, outer view. Black arrowheads, broken portion on dactylus; white arrowhead, broken portion on carpus. Scales: 0.1 mm.

eyes and pair of mid-lateral simple setae. Pereonites 1-6 with length ratio 1.00:1.10:1.18:1.33:1.23:1.04; pereonites with pair of lateral simple setae. Pleon length 0.16 times BL. Pleonites all wider than long, with pair of dorsal simple setae; pleonites 1-4 with pair of mid-lateral circumplumose setae (Fig. 2B1); pleonite 5 with two pairs of simple mid-lateral setae. Pleotelson length 0.72 times width, as wide as pleonites, with three pairs of lateral simple setae and pair of posterior simple setae.

Antennule (Fig. 2C) 0.80 times as long as cephalothorax; articles 1-4 with length ratio 1.00:0.38:0.31:0.43. Article 1 with outer distal simple seta and several outer subproximal and outer distal PSS. Article 2 with one mid-inner, one outer distal, and one inner distal simple setae and several distal PSS. Article 3 with one outer distal and one inner distal simple setae. Article 4 with several simple setae and two aesthetascs in distal region. Antenna (Fig. 2D, L) with six articles (article 1 fused to cephalothorax; Fig. 2L, arrowhead),

0.95 times as long as antennule; articles 2–6 with length ratio 1.00:2.60:2.03:1.39:0.33. Articles 1 and 2 naked. Article 3 with one dorsosubproximal, one mid-dorsal, and one dorsodistal simple setae. Article 4 with one dorsodistal and one ventrodistal simple setae and several PSS. Article 5 with one mid-ventral and one dorsodistal simple setae and distal PSS. Article 6 with five distal simple setae.

Labrum (Fig. 2E) not projected anteriorly, setulate distally. Mandibles (Fig. 2F, G) with well-developed conical molar process, denticulate in masticatory region. Left mandible (Fig. 2F) with denticulate incisor and denticulate lacinia mobilis. Right mandible (Fig. 2G) with bifurcate incisor, subdistal anterior margin crenulate. Labium (Fig. 2H) with inner and outer lobes setulate on distal margin; outer lobe much larger, without labial process. Maxillular (Fig. 2I) endite with eleven spiniform setae, and outer subdistal setation; palp broken. Maxilla (Fig. 2I, arrowhead) naked. Maxilliped (Fig. 2J, J1–3) with medially fused basis bearing ventral simple seta at insertion of palp (seta reaching beyond distal margin of endite). Endite (Fig. 2J1) with outer distal simple seta, and three (left) or two (right) distal spiniform setae; inner dorsal region with distal serrate-tipped curved-spiniform seta (Fig. 2J2) and subdistal serrate-tipped spiniform seta (Fig. 2J3); inner ventral region with distal rounded bulge. Palp article 1 naked; article 2 with one (right) or zero (left) outer and four inner simple setae; article 3 with ten inner simple setae; article 4 with nine distal and one mid-outer simple setae. Epignath (Fig. 2K) narrow, curved, with fine setae distally.

Cheliped (Fig. 3A, A1) broadly articulated with cephalothorax via sclerite (Fig. 2B); sclerite extending to posterior margin of cephalothorax. Basis almost as long as wide, with slight free posterior portion and outer dorsal simple seta. Merus with ventral simple seta. Carpus as long as propodus including fixed finger, with one dorsodistal and two ventral simple setae. Propodal palm longer than fixed finger, with one outer and four inner simple setae at insertion of dactylus. Fixed finger with two simple setae on ventral margin; cutting surface with four outer and one inner simple setae, and outer lamellar expansion; triangular claw present. Dactylus (note: proximal portion partly broken in Fig. 3A, A1) as long as fixed finger, with inner subproximal simple seta; cutting surface with two subproximal simple setae; unguis fused to dactylus.

Pereopod 1 (Fig. 3B) with length ratio of basis, ischium, merus, carpus, propodus, and dactylus–unguis 1.00:0.07:0.41:0.29:0.63:0.57. Coxa with simple seta. Basis cylindrical, length 3.56 times width, with simple seta and two PSS in dorsosubproximal region. Ischium with ventral simple seta. Merus with two ventrodistal simple setae being half as long as width of merus. Carpus with four distal simple setae. Propodus with four subdistal simple setae. Dactylus with subproximal simple seta. Unguis 1.11 times as long as dactylus, naked. Pereopod 2 (Fig. 3C) with length ratio of articles from basis to dactylus–unguis 1.00:0.05:0.25:0.28:0.50:0.55. Coxa with simple seta. Basis cylindrical, narrow, length 3.41 times width, with one simple seta and PSS in dor-

Table 1. Comparison of selected characters among species of *Teleotanais*. Abbreviations: Mxp, maxilliped; Mxp.e, maxillipedal endite; STCSS, serrate-tipped curved-spiniform seta; STSS, serrate-tipped spiniform seta; —, no data. *Long, longer than merus width; short, half as long as width of merus.

Character	Species				
	<i>T. madara</i> sp. nov.	<i>T. gerlachi</i>	<i>T. gerlachi sensu</i> Sieg (1976)	<i>T. indiaensis</i>	<i>T. warragamba</i>
Pigmentation on antennule	Present	Present	—	Absent	Present
No. of mid-inner simple setae on antennular article 2	1	0	1	1	0
No. of distal simple setae on antennal article 3	1	1	1	2	2
Distal STCSS in inner dorsal region of Mxp.e	Present	Absent	Absent	Absent	Absent
Subdistal STSS in inner dorsal region of Mxp.e	Present	Absent	Absent	Absent	Absent
No. of distal spiniform setae on Mxp.e	2–3	3	3	3	2
No. of mid-outer simple setae on Mxp palp article 4	1	1	1	0	1
No. of ventral simple setae on fixed finger	1–2	2	3	2	2
No. of subproximal simple setae on cutting surface of chelipedal dactylus	2	1	2	0	1
Length of ventrodistal simple setae on pereopod-1 merus ^a	Short	Short	Long	Short	Long
Dactylus–unguis of pereopods 4–6	Articulate	Articulate	Fused	Articulate	Articulate
Uropod–endopod–article number	2	2	2	2	1
No. of ventral setae on basal article of uropod	2	1	2	2	0

so-subproximal region. Ischium with ventral simple seta. Merus with ventrodistal simple seta. Carpus with three distal simple setae. Propodus with four subdistal simple setae. Dactylus with subproximal simple seta. Unguis as long as dactylus, naked. Pereopod 3 (Fig. 3D) with length ratio of articles from basis to dactylus–unguis 1.00:0.09:0.27:0.35:0.59:0.70. Similar to pereopod 2, except basis without dorsal simple seta. Pereopod 4 (Fig. 3E) with length ratio of articles from basis to dactylus–unguis 1.00:0.03:0.42:0.24:0.41:0.28. Coxa present, with simple seta. Basis thick, length 2.53 times width, with two dorsosubproximal and two ventrodistal PSS. Ischium with ventral simple seta (note: hinge between ischium and merus disjointed in Fig. 3E). Merus with two ventrosubdistal spiniform setae. Carpus with dorsodistal simple seta and three distal spiniform setae. Propodus with three dorsosubdistal simple setae, dorsal PSS, and two ventrosubdistal spiniform setae. Dactylus with dorsal simple seta. Unguis naked. Pereopod 5 (Fig. 3F) with length ratio of articles from basis to dactylus–unguis 1.00:0.06:0.49:0.35:0.50:0.39. Similar to pereopod 4, except coxa naked, basis without PSS, and ischium with two ventral simple setae. Pereopod 6 (Fig. 3G) with length ratio of articles from basis to dactylus–unguis 1.00:0.07:0.27:0.37:0.37:0.34. Similar to pereopod 4, except coxa naked, basis without ventrodistal PSS, propodus with nine dorsodistal simple setae, and dactylus with two dorsal simple setae (note: distal portion of carpus partly broken in Fig. 3G).

Pleopod 1 (Fig. 3H1, H2) with basal article bearing inner plumose seta. Endopod with one inner and nine outer plumose setae, and distal step-tipped seta. Exopod 1.11 times as long as endopod, with 19 outer plumose setae. Pleopods 2–5 similar to pleopod 1, except for numbers of plumose setae on outer margin of endopod and exopod, and pleopod 5 endopod having two inner plumose setae.

Uropod (Fig. 3I) biramous. Basal article with two ventrodistal simple setae. Endopod biarticulate; article 1 with dorsodistal simple seta; article 2 with four distal simple setae. Exopod biarticulate; article 1 with distal simple seta; article 2 with two distal simple setae.

Variation and stability. In addition to the holotype, three female paratypes were dissected and data were obtained for the same 13 characters as listed in Table 1. Among the four specimens, the character states for eleven of the characters were identical (*T. madara* column, Table 1); the exceptions were the number of distal spiniform setae on the maxillipedal endite (two on the right endite in the holotype; three in the others), and the ventral simple setae on the fixed finger (one in ICHUM-5845; two in the others).

Genetic information. Part of the COI gene (652 nt, translating into 217 amino acids) was determined from the holotype female. The three sequences in the INSD most similar to the COI sequence, as determined by BLAST searches (Altschul *et al.* 1990), were from two insect and one spider species (INSD accession numbers KJ837447, JF411102, and DQ353285; 77.57–78.62% in identity scores) but their query cover was only 41–65%. To date, no other teleotanaid nucleotide sequences have been deposited in public databases (DDBJ 2019).

Distribution. So far known only from the type locality.

Remarks. *Teleotanais madara* sp. nov. is the fourth nominal species in this genus. It is unique among *Teleotanais* species in having distal serrate-tipped curved-spiniform and subdistal serrate-tipped spiniform setae in the inner dorsal region of the maxillipedal endite (Fig. 2J1–3; Table 1). *Teleotanais madara* resembles *T. gerlachi* and *T. gerlachi sensu* Sieg (1976) in having a biarticulate uropodal endopod, antennal article 3 with a single distal simple seta, and maxillipedal palp article 4 with a mid-outer simple seta. *Teleotanais madara* differs from *T. gerlachi* in having a mid-inner simple seta on antennular article 2 (absent in *T. gerlachi*) and in having two ventral setae on the basal article of the uropod (one in *T. gerlachi*) (Lang 1956). *Teleotanais madara* differs from *T. gerlachi sensu* Sieg (1976) in the following characters (character states of the latter in parentheses): chelipedal fixed finger with one or two simple setae (three); ventrodistal simple setae on the pereopod-1 merus half as long as width of merus (as long as width of merus); and an articulate (fused) dactylus–unguis in pereopods 4–6 (Sieg 1976).

The number of distal spiniform setae [“spines” in Bamber (2008)] on the maxillipedal endite, one of characters that Bamber (2008) used to differentiate among congeners, varied in a single specimen of *T. madara* (ICHUM-5844; Fig. 2J, J1), suggesting that this numeric character be used with caution in species discrimination in *Teleotanais*.

Larsen *et al.* (2013: p. 238) described antennal article 1 in *T. indiaensis* as “naked and fused with cephalothorax.” This state was also observed in four specimens of *T. madara* (Fig. 2L: arrowhead). Information on this character is lacking for *T. gerlachi*, *T. gerlachi sensu* Sieg (1976), and *T. warragamba* (Lang 1956; Sieg 1976; Bamber 2008).

Bird and Larsen (2009: p. 153) added “Pereopod 4–6 coxae ... absent” to the diagnosis of Teleotanaidae, after Bamber (2008). These coxae were, however, found in the type species, *T. gerlachi* (Lang 1956: p. 258, fig. 43.20–22). Sieg (1976), Bamber (2008), and Larsen *et al.* (2013) did not mention this character. In four specimens of *T. madara*, we confirmed the presence of coxae on all pereopods. The presence of this character in *T. madara* and in the type species raises the possibility that this character (pereopods 4–6 bearing coxae) is present in all species in Teleotanaidae but has failed to be observed in several species.

We collected specimens of *T. madara* from the mud on mangrove roots. Larsen *et al.* (2013) suggested *Teleotanais* may have a special affinity for mangrove habitats, and this certainly may apply to *T. madara*.

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