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A troglomorphic spider from Java (Araneae, Ctenidae, *Amauropelma*)

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Abstract

A new troglomorphic spider from caves in Central Java, Indonesia, is described and placed in the ctenid genus *Amauropelma* Raven, Stumkat & Gray, until now containing only species from Queensland, Australia. Only juveniles and mature females of the new species are known. We give our reasons for placing the new species in *Amauropelma*, discuss conflicting characters, and make predictions about the morphology of the as yet undiscovered male that will test our taxonomic hypothesis. The description includes DNA barcode sequence data.

Keywords

conservation, DNA barcode, Indonesia, Jonggrangan Limestone, troglobite

Introduction

We describe a new troglobitic spider taken from caves in Central Java, Indonesia. The species is a ctenid tentatively placed in the genus *Amauropelma*, which was established to accommodate 16 new species from Queensland, Australia by Raven et al. in 2001.

Ours is the first new *Amauropelma* species to be proposed since Raven et al.'s original description. We are writing this paper as the description of a single species known from one sex because it is a troglobite (and therefore of potential conservation interest) from a taxon for which good comparative descriptive data are available. Although few specimens have been collected, many more specimens have been observed and not collected out of prudent concern for the population. However, all of these observations were of either juveniles or mature females. Repeated attempts to target males have so far failed.

Methods

Characters described mostly follow Raven et al. (2001) to facilitate comparison with known species. Observations of vulva structures were made based on a dissected epigynum cleared in methyl salicylate (Holm 1962), positioned using a temporary slide mount (Coddington 1983), and viewed through a Leica DM2500 compound microscope. Other observations were made based on specimens in alcohol viewed through a Leica M165 C stereoscope. Photographs were made using a Nikon DS-Ri1 driven by NIS Elements software and mounted on either the DM2500 microscope or the M165 C stereoscope. Images from multiple focal planes were combined and edited in Auto-Montage software version 5.03. Additional processing of some images to adjust color, brightness, and contrast, and remove blemishes was performed using Adobe Photoshop CS5. Tarsal organ position expressed as a ratio of the distance from the proximal margin of the tarsus to the tarsal organ divided by the total length of the tarsus. All measurements in millimeters. Abbreviations given in Table 1.

Table 1. List of abbreviations used in the text and figures.

Spinnerets and somatic morphology:	
ALE	anterior lateral eye
ALS	anterior lateral spinneret
AME	anterior median eye
AT	anal tubercle
CD	copulatory duct
ET	epigynal tooth
fe	femur
me	metatarsus
p	prolateral
pa	patella
PLE	posterior lateral eye
PLS	posterior lateral spinneret
PME	posterior median eye
PMS	posterior median spinneret
r	retrolateral
S	spermatheca

Spinnerets and somatic morphology:	
ti	tibia
v	ventral
Institutional abbreviations:	
MZB	Museum Zoologicum Bogoriense, Bogor
RMNH	Netherlands Centre for Biodiversity Naturalis, Leiden

We used the Pensoft IPT Data Hosting Center to expose specimen occurrence records to the Global Biodiversity Information Facility (GBIF; http://data.gbif.org/welcome.htm). A KML (Keyhole Markup Language) file for viewing these same specimen occurrence records interactively in Google Earth (http://earth.google.com/) is available as electronic appendix A. In accordance with Pensoft's practice of semantic markup and publishing, the species described herein has been registered on ZooBank (http://zoobank.org/) and a species page has been submitted to the Encyclopedia of Life (http://www.eol.org/) and the wiki species-id (http://species-id.net/wiki/).

658 bases of cytochrome oxidase I were sequenced by the NCB Naturalis DNA barcoding facility using the following primers: LCO1490 (5'-GGTCAACAAATCATAAAGATATTGG-3') and HCO2198 (5'-TAAACTTCAGGGTGACCAAAAAATCA-3') (Folmer et al. 1994). Chromatogram data are available as electronic appendix B.

Taxonomy

***Amauropelma* Raven, Stumkat & Gray, 2001**
http://species-id.net/wiki/Amauropelma

Type species. *Amauropelma trueloves* Raven & Stumkat, 2001

Addendum to diagnosis. Tarsal organ position ranges from 0.125–0.77. Tarsi with or without adpressed trichobothria. Epigynum with soft or sclerotized lateral teeth. Tracheal spiracle distinct or indistinct. Otherwise, as in Raven et al. (2001).

***Amauropelma matakecil* Miller & Rahmadi, sp. n.**
urn:lsid:zoobank.org:act:180E7280-7D8D-4884-81FC-C8BE75FDD361
http://species-id.net/wiki/Amauropelma_matakecil
Figs 1–13

Material examined. Holotype: Indonesia, Central Java, Purworejo, Kaligesing, Tlogoguo Village, Somoroto: Gua Anjani [Anjani Cave], 7.73156°S, 110.11567°E, 672 m asl., 23 March 2009 (MZB.Aran.500, S. Harjanto), 1 #f.

Paratypes: Indonesia, Central Java, Purworejo, Kaligesing, Donorejo Village, Katerban: Gua Seplawan [Seplawan Cave], 7.7726°S, 110.111°E, 23 April 2010 (MZB.

Aran.501, S. Harjanto and C. Rahmadi), 1 #f; Indonesia, Central Java, Purworejo, Kaligesing, Donorejo Village, Katerban: Gua Nguwik [Nguwik Cave], 7.76907°S, 110.10334°E, 764 m asl., 9 May 2008 (RMNH.ARA.12434, S. Harjanto), 1 #f.

Additional material examined: Indonesia, Central Java, Purworejo, Kaligesing, Tlogoguo Village, Somoroto: Gua Anjani [Anjani Cave], 7.73156°S, 110.11567°E, 672 m asl., 23 April 2010 (RMNH.ARA.12436, S. Harjanto and C. Rahmadi), 2 juveniles; Gua Anjani [Anjani Cave], 7.73156°S, 110.11567°E, 672 m asl., 23 March 2009 (MZB.Aran.502, S. Harjanto), 1 juvenile.

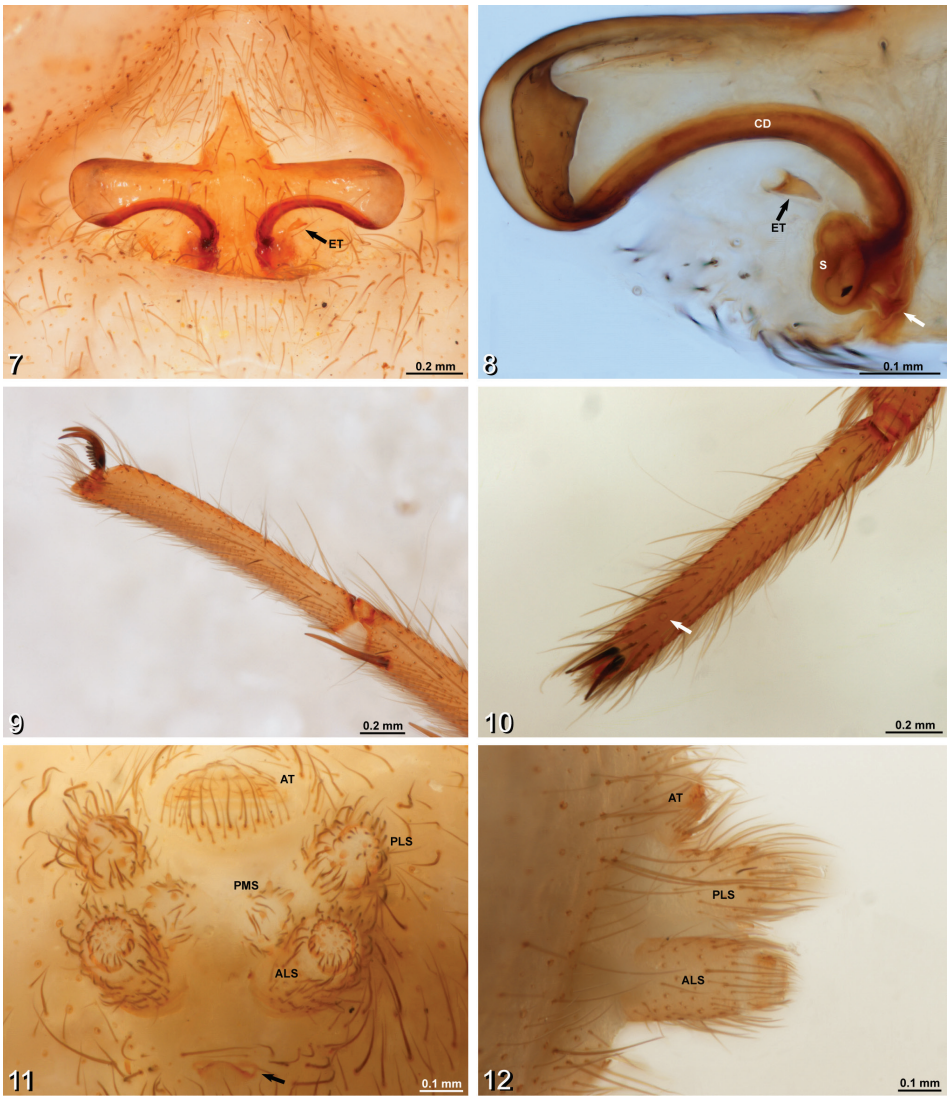
Etymology. The specific name is an adjective derived from "mata" meaning eyes and "kecil" meaning small from Bahasa Indonesia referring to the small eyes of the species. *Pronunciation note:* the letter “c” in Bahasa is pronounced like “ch” in English.

Diagnosis. Distinguished from other *Amauropelma* species by having more chelicerал teeth (4 promargin and 7 retromargin teeth, Fig. 4; other described species for which data were recorded range between 1–4 promargin and 4–6 retromargin teeth); by the relatively proximal position of the tarsal organs (Fig. 10); by the sclerotized epigynal teeth that do not conduct the copulatory ducts (Fig. 7; other *Amauropelma* have soft teeth containing the copulatory ducts); and by the shape of the epigynum, which has the lateral wings more long and narrow than other species (Fig. 7). Further distinguished from other *Amauropelma* species except *A. leo* Raven & Sumkat, 2001 by having small eyes (Fig. 2; large in other species except *A. undara*, which is a blind troglobite); distinguished from *A. leo* by the pale, troglomorphic color (Figs 1, 3); *A. leo* is a rainforest species and is not troglomorphic.

Description. Female (holotype, MZB.Aran.500): Carapace 3.40 long, 2.20 wide. Abdomen 4.12, long 2.64 wide. Total length 7.7. Carapace with fine setae. Fovea a narrow groove. Chilum divided (Fig. 2). Endites slightly converging, labium longer than wide (Fig. 4). *Color.* Overall pale, chelicerae and ocular region darker (Figs 1, 3). *Eyes.* Vestigial, eye rows recurved forming 2.4.2 pattern, ALE>AME=PME>PLE, AME on small common tubercle, ALE and PME form slightly procurved row, PME closer together than PME-ALE, PME slightly more widely spaced than AME, eye group = 0.40 of carapace width (Figs 2, 3). *Chelicerae.* Large, partially porrect with lateral boss. Retromargin with 5 large distal and 2 small proximal teeth; promargin with 4 teeth, the third (counting proximally from the base of the fang) is the smallest (Fig. 4). *Pedipalp.* Tarsal claw with series of basal teeth. With two large ventral distal setae (ca. Silva Dávila 2003: fig. 28d). *Legs.* Formula 4123. Paired tarsal claws with series of basal teeth, claw tufts present, weak scopula present on tarsi and metatarsi I and II (Fig. 9). Retrocoxal hymen present on leg I. Trochanters deeply notched (Fig. 5). Tarsal organs slightly raised, dome-like, more distal on legs I and II than III and IV (I: 0.77. II: 0.73. III: 0.66. IV: 0.67). Macrosetae: I: fe p1d3; pa 0; ti v2.2.2.2.2; me v3.3.3; ta 0. II: fe d3r1; pa 0; ti v2.2.2.2.2; me v3.3.3; ta 0. III: fe p4d3r4; pa p1r1; ti v2.2.2p1.1d1.1 r1.1; me v2.2.2p1.1.2r1.1.2; ta 0. IV: fe p3d3r1; pa r1; ti v2.2.2p1.1d1.1r1.1; me v1.1.1.1.2p1.1.1d0.1.2r1.1.1. *Spinnerets.* Ecribellate, colulus absent, lateral spinnerets cylindrical with short apical segment, ALS separated by about their width, PLS and PMS with a number of large, conspicuous spigots (Figs 11, 12). *Epigynum.* Sclerotized

Figures 1–6. *Amauropelma matakecil* sp. n. **1** female habitus **2–6** habitus of female holotype (MZB. Aran.500) **1** Portrait of live specimen in natural habitat from Gua Nguwik, Central Java (Photo S. Harjanto) **2** Anterior view **3** Dorsal view **4** Ventral view showing labium, endites, and chelicerae **5** Ventral view showing sternum, coxae, and trochanters **6** Left pedipalpal, retrolateral view.

plate with long, narrow lateral wings with concave posterior margins. Epigynal teeth sclerotized, arise posterior to lateral wings (Fig. 7). Copulatory openings on dorsal surface near lateral margins of wings, follow posterior margin of wings to reniform spermathecae (Fig. 8).



Figures 7–12. *Amauropelma matakecil* sp. n., female holotype (MZB.Aran.500) **7** Epigynum, ventral view. Note that the right epigynal tooth has broken off leaving a round hole; the tooth itself is lying unattached near the epigastric furrow **8** Vulva, dorsal view, left side, cleared, white arrow indicates fertilization duct **9** Right tarsus, leg I, prolateral view **10** Left tarsus, leg I, dorsal view, arrow indicates tarsal organ **11** Spinnerets, anal tubercle, and tracheal spiracle, posterior view, arrow indicates tracheal spiracle **12** Spinnerets, lateral view. ALS, anterior lateral spinneret; AT, anal tubercle; CD, copulatory duct; ET, epigynal tooth; PLS, posterior lateral spinneret; PMS, posterior median spinneret; S, spermatheca.

Natural History. In Seplawan Cave, *A. matakecil* was found on the cave floor hiding under crevices in dry mud.

Distribution. *Amauropelma matakecil* is known only from three caves in the Jonggrangan Limestone, part of the Menoreh Hills in the District of Kaligesing, Purworejo

Figure 13. Map of Java, Indonesia, showing records of *Amauropelma matakecil* sp. n. as yellow circles in Central Java. Base map source: Google Earth.

Regency, Central Java, near the border with Yogyakarta Province (Fig. 13). The Jonggrangan Limestone is located from 574–878 m above sea level (Bemellen 1949). This karst formation is a fossil reef with thicknesses up to 200 m at the southern margin of the Jonggrangan Plateu (Bemellen 1949). The formation dates from the Middle to Late Miocene (Sulistyaningrum and Rahardjo 2010). Karst makes up a very small area of the Menoreh hills, about 15 km^2. The nearest neighboring limestone formations are the Gombong Selatan (about 72 km to the west) and the Gunung Sewu Karst (about 42 km to the east).

Remarks. The cave spider fauna of Java is not well known. The only other spider documented from a cave in Java that we are aware of is *Althephus javanensis* Deeleman-Reinhold, 1995 (Ochyroceratidae). This species is not strongly troglomorphic, exhibiting neither eye reduction nor reduced pigmentation, although legs in specimens from caves are considerably longer than in specimens from the surface. As reported by Rahmadi (2011), *A. matakecil* is the most remarkable cave spider so far known from Java due to its large size, reduced eyes, and potential conservation importance. Karst formations in Java are highly threatened by human activities such as limestone mining and habitat conversion.

DNA Barcode. AACGTTATATTTAATATTTGGAGCTTGATCTGC
TATAATAGGAACGGCTATAAGAATATTAATTCGAATAGAGTTAGGA
CATTCTGGAAGATTATTAAGTAATGATCATTTGTATAATGTGATTGT
TACTGCTCATGCATTTGTTATAATTTTTTTTTATGGTGATGCCAATTT

TAATTGGAGGTTTTGGAAATTGATTAGTTCCTTTAATATTAGGAGCTC
CGGATATATCGTTTCCTCGAATAAATAATTTGTCTTTTTGATTGTTAC
CTCCTTCTTTGTTTTTGTTGTTTATATCTTCTATAGTTGAAATGG
GAGTAGGAGCTGGATGAACTATTTATCCCCCTTTAGCTTCTAGAATTG
GTCATGTGGGAAGATCTATGGATTTTGCTATTTTTTCTTTACATT
TAGCTGGAGCTTCTTCTATTATAGGGGCGGTAAATTTTATTTCTAC
GATTGTAAATATACGTTTATTAGGAATAAGAATAGAAAGGGTTCCTT
TATTTGTGTGATCTGTATTTATTACTGCTGTTTTATTATTATTATCTT
TACCTGTTTTAGCGGGAGCTATTACTATGTTATTGACGGATCGAAATTT
TAATACTTCTTTTTTTTGACCCTGCAGGGGGAGGGGATCCTATTT
TATTTCAACATTTGTTT (MZB.Aran.501, GenBank accession number JQ277219).

Among identified spiders accessible at the time of writing (October 2011) through the NCBI database (http://blast.ncbi.nlm.nih.gov/Blast.cgi), *A. matakecil* blasts most closely with the pisaurid genus *Dolomedes* Latreille, 1804. This despite the presence in GenBank of the homologous locus for several ctenid spiders (e.g., Crews and Gillespie 2010). However, its closest matches are several still unidentified spiders in the International Barcode of Life (iBOL) database.

Discussion

The species described here appears to fit best in the genus *Amauropelma* based on several characters including the eye arrangement (Fig. 2), the presence of only the superior tarsal claws (no inferior tarsal claw; Fig. 9), the leg spination pattern, the presence of two ventral distal macrosetae on the female pedipalp (ca. Silva Dávila 2003: fig. 28d), and lateral wings and posterior teeth on the epigynum (Fig. 7). However, *A. matakecil* exhibits characteristics that are not typical of *Amauropelma* and none of the above characters are unique to *Amauropelma*.

The form of the epigynum is also similar to the genera *Thoriosa* Simon (from West Africa and nearby Atlantic islands) and some *Trogloctenus* Lessert (from Congo and Réunion). Silva Dávila's (2003) phylogenetic analysis placed *Thoriosa* close to *Amauropelma* and an incertae sedis species from Lombok Island, Indonesia; *Trogloctenus* was not included in that analysis due to a lack of non-type material in collections. *Amauropelma* including our new species differs from *Thoriosa* and *Trogloctenus* by the eye arrangement. *Thoriosa* has the median ocular area wider posteriorly than anteriorly (Benoit 1976: figs 1, 4); in *Amauropelma* including our new species, the median ocular area is as wide anteriorly as posteriorly. In the type species of *Trogloctenus*, the clypeus is about seven AME diameters (Benoit 1976: fig. 12); in *Amauropelma*, the clypeus ranges from less than one to about two AME diameters. A second species of *Trogloctenus* has no eyes so this character is inapplicable, but in this species the lateral wings of the epigynum are not so pronounced and posterior teeth are apparently absent (Ledoux 2004: fig. 9B). The loss of the inferior tarsal claw, the presence of two ventral

distal macrosetae on the female pedipalp (ca. Silva Dávila 2003: fig. 28d) and the leg spination pattern are all found in multiple ctenid genera including *Thoriosa*.

There are also some characteristics that conflict with *Amauropelma*. The epigynal teeth of the new species are hard rather than soft. The copulatory openings appear to be associated with the anteriomesal part of the lateral wings of the epigynum rather than with the epigynal teeth (Fig. 8). The claw tufts are less dense than in other *Amauropelma* species (Fig. 9). The position of the tarsal organs is much more distal than that reported for other *Amauropelma* species (Fig. 10). Note that the tarsal organ of *Janusia* Gray is described as subdistal and distal to trichobothria (Gray 1973; see below). The tracheal spiracle is small but easy to see because of a narrow sclerotized margin (Fig. 11; Raven et al. 2001 reported the tracheal spiracle of *Amauropelma* indistinct). Raven et al. (2001) described the labium as longer than wide. Based on illustrations (Raven et al. 2001: fig. 5C, 21G), this condition is amplified in the new species (labium length 1.3 times the width; Fig. 4). Adpressed trichobothria were not observed on the tarsi of our new species, as reported by Raven et al. for *Amauropelma* (e.g., Raven et al. 2001: fig. 3f) but are apparently present on the tibiae. It seems clear that there are several ctenid lineages closely related to *Amauropelma* that would benefit from revision and more extensive illustration.

One other troglobitic *Amauropelma* is known. *Amauropelma undara* Raven & Stumkat from lava tubes in Queensland is completely blind, in contrast to our new species which has vestigial eyes. Another ctenid known from caves that shares characteristics with our new species is the genus *Janusia* (see Raven et al. 2001). This genus contains only one described species from Western Australia but the existence of possibly congeneric undescribed species has been reported (Gray 1973; Raven et al. 2001). Our new species can be separated from *Janusia muiri* Gray in part by the presence of a small inferior tarsal claw in *Janusia* (no inferior tarsal claw in *Amauropelma*) and by the presence of only three teeth on the superior tarsal claws (ca. 7 in our new species; Fig. 7).

Based on the characteristics of other *Amauropelma* species, we predict that the male when discovered will be found to exhibit no tibial crack on the legs, will have retrolateral processes on the palpal patella and tibia, will have an apically coniform cymbium without a dorsal scopula, will have a palpus with a cup-shapped median apophysis, a hyaline conductor, an embolus in the form of a large hook-shaped plate, and other anatomical details in common with known *Amauropelma* species. If these predictions are not borne out with the eventual discovery of the male, the generic position of this species may have to be reconsidered. The male of *Janusia* has not been described, but based on a broken embolus extracted from the reproductive tract of a female, the embolus is thin and coil-like (Gray 1973).

Acknowledgments

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their help with the DNA sequencing. Charles Griswold originally suggested that this species might belong to *Amauropelma* and Robert Raven concurred. Special thanks to Diana Silva Dávila, Robert Raven, and an anonymous reviewer for constructive comments on earlier drafts of the manuscript. Thanks also to Darrell Ubick and Joel Ledford for helpful discussion about the possible affinities of this taxon and to Tamas Szuts for help with access to literature from remote locations. Thanks to Teodor Georgiev for help using the Pensoft IPT Data Hosting Center.

References

Bemellen RW van (1949) The Geology of Indonesia, volume 1A. Martinus Nijhoff, The Hague, 602 pp.

Benoit PLG (1976) Etudes sur les Ctenidae africains (Araneae) II. Les genres *Thoriosa* Simon et *Troglоctenus* Lessert. Revue de Zoologie Africaine 90: 221–227.

Coddington JA (1983) A temporary slide mount allowing precise manipulation of small structures. Verhandlungen naturwissenschaften vereins Hamburg (NF) 26: 291–292.

Crews SC, Gillespie RG (2010) Molecular systematics of *Selenops* spiders (Araneae: Selenopidae) from North and Central America: implications for Caribbean biogeography. Biological Journal of the Linnean Society 101: 288–322. doi: 10.1111/j.1095-8312.2010.01494.x

Deeleman-Reinhold CL (1995) The Ochyroceratidae of the Indo-Pacific region (Araneae). Raffles Bulletin of Zoology, Supplement 2: 1–103.

Folmer O, Black M, Hoeh W, Lutz R, Vrijenhoek R (1994) DNA primers for the amplification of mitochondrial cytochrome c oxidase subunit I from diverse metazoan invertebrates. Molecular Marine Biology and Biotechnology 3: 294–299.

Gray MR (1973) Cavernicolus spiders from the Nullarbor Plain and South-West Australia. Journal of the Australian Entomological Society 12: 207–221. doi: 10.1111/j.1440-6055.1973.tb01661.x

Holm Å (1962) The spider fauna of the East African mountains. Part I: Fam. Erigonidae. Zoologiska Bidrag Från Uppsala 35: 19–204.

Ledoux J-C (2004) Araignées de l'île de La Réunion: I. Hahniidae, Ctenidae, Thomisidae et Clubionidae (Araneae). Revue Arachnologique 14: 159–191.

Rahmadi C (2011) The biospeleology of Java Caves, Indonesia: A Review. Proceeding of Asian Trans-Disciplinary Karst Conference 2011, Yogyakarta-Indonesia: 241–250.

Raven RJ, Stumkat K, Gray MR (2001) Revisions of Australian ground-hunting spiders: I. *Amauropelma* gen. nov. (Araneomorphae: Ctenidae). Records of the Western Australian Museum, Supplement 64: 187–227.

Silva Dávila D (2003) Higher-level relationships of the spider family Ctenidae (Araneae: Ctenoidea). Bulletin of the American Museum of Natural History 274: 1–86. doi: 10.1206/0003-0090(2003)274<0001:HLROTS>2.0.CO;2

Sulistyaningrum D, Rahardjo W (2010) Identification and paleoecology of coraline fossils (Cnidaria: Anthozoa) from Jonggrangan limestone, western slope of Kucir Hill,West Progo area, Yogyakarta Special Province. Proceedings, Indonesian Petroleum Association Thirty-Fourth Annual Convention & Exhibition, May 2010, 9 pp.

Appendix A

Specimen records of *Amauropelma matakecil.* (doi: 10.3897/zookeys.163.2265.app1) File format: KML (Keyhole Markup Language) version 2.1 for GoogleEarth.

Explanation note: The KML file can be opened using GoogleEarth (http://earth.google.com/) to display an interactive map showing the specimen occurrence data for *Amauropelma matakecil*.

Click on placemarks to reveal specimen data and a hyperlink to the species page on the Encyclopedia of Life (http://www.eol.org/).

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Appendix B

DNA barcode. (doi: 10.3897/zookeys.163.2265.app2) File format: SPF (Sequencher Project File).

Explanation note: Chromatograms for the DNA barcode sequence of *Amauropelma matakecil*.

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Commensal Leucothoidae (Crustacea, Amphipoda) of the Ryukyu Archipelago, Japan. Part I: ascidian-dwellers

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Abstract

Commensal leucothoid amphipods have been collected from the branchial chambers of their ascidian hosts throughout the Ryukyu Archipelago, Japan. Seven new species are described in two genera with valuable location data and host records. An identification key to ascidian-dwelling Leucothoidae of the Ryukyu Archipelago is provided.

Keywords

Leucothoidae, Ryukyu, Okinawa, Japan, new species, commensal, *Leucothoe amamiensis*, *Leucothoe elegans*, *Leucothoe nathani*, *Leucothoe obuchii*, *Leucothoe trulla*, *Leucothoe vulgaris*, *Paranamixis thomasi*

Introduction

The Leucothoidae are a family of marine gammaridean amphipods that can be found inhabiting sessile invertebrate hosts worldwide. The family currently contains 139 species in five genera and can be divided into two clades (White 2011). The anamixid clade inhabits tropical to warm temperate waters and exhibits extreme sexual dimorphism.

Terminal males are referred to as anamorphs and subterminal males and females are referred to as leucomorphs (Thomas and Barnard 1983). This clade contains the genera *Anamixis* Stebbing, 1897, *Nepanamixis* Thomas, 1997, and *Paranamixis* Schellenberg, 1938. The leucothoid clade inhabits tropical to polar waters and exhibits minimal to moderate sexual dimorphism. This clade contains the genera *Leucothoe* Leach, 1814 and *Paraleucothoe* Stebbing, 1899.

Leucothoids are typically found as endocommensal associates of sponges, ascidians or bivalve mollusks, where they utilize the feeding current produced by their hosts to feed. All genera exhibit extended parental care with members of the anamixid clade being potentially eusocial. Anamixids exhibit two of the three criteria for eusociality presented by Michener (1969). They have colonies with overlapping generations and an organized caste system with different morphologies. The third criterion, having reproduction restricted to certain individuals, has yet to be confirmed in the Leucothoidae (White 2010).

There are currently seven Leucothoidae species and one leucomorph reported from Japan (*Anamixis* sp., Hirayama, 1985 (leucomorph); *Leucothoe alata* (Barnard, 1959); *Leucothoe bidens* Hirayama, 1985; *Leucothoe nagatai* Ishimaru, 1985; *Leucothoe pacifica* Nagata, 1963; *Leucothoe stylifera* Stimpson, 1856; *Paranamixis aberro* Hirayama, 1983; *Paranamixis misakiensis* Thomas, 1997). The leucomorph is not connected to an anamorph and is, therefore, not considered a valid species (White 2011). All currently described Japanese leucothoids are reported from mainland Japan, with no species documented from the Ryukyu Archipelago. Of these seven species, only *L. nagatai* has been reported with its host. *Leucothoe stylifera* has never been illustrated; its type locality is simply Japan and it has no associated host or depth record. This lack of detailed host and locality records extends to leucothoid species reported worldwide.

The Ryukyu Archipelago consists of over 900 islands and islets between mainland Japan and Taiwan (Fig. 1) and is an area that has not been investigated for most amphipod families including leucothoids. The triple junction of the Philippine, Pacific, and Eurasian plates provides an interesting biogeographic study area, bringing together three potentially different sets of species. Roberts et al. (2002) states that Indo-Pacific reefs are the most diverse areas in the world with high levels of endemicity. The Ryukyu Archipelago is considered a center of endemism, perhaps due to the Kuroshio Current moving waters from tropical to temperate latitudes (Roberts et al. 2002; Hughes et al. 2002). There are currently recognized biogeographic boundaries within the Ryukyu Archipelago; the Hachisuka, Watase, and Miyake lines (Fig. 1). These boundaries apply to terrestrial organisms such as insects, mammals, reptiles, amphibians, and birds due to the past connection of the island chain to the Eurasian continent by land bridges (Kizaki and Oshiro 1977; 1980; Ota et al. 2004). Whether these boundaries apply to marine species is unknown. It is possible the boundaries may apply to marine species with restricted distributions, such as peracarid crustaceans that lack a dispersive pelagic larval stage.

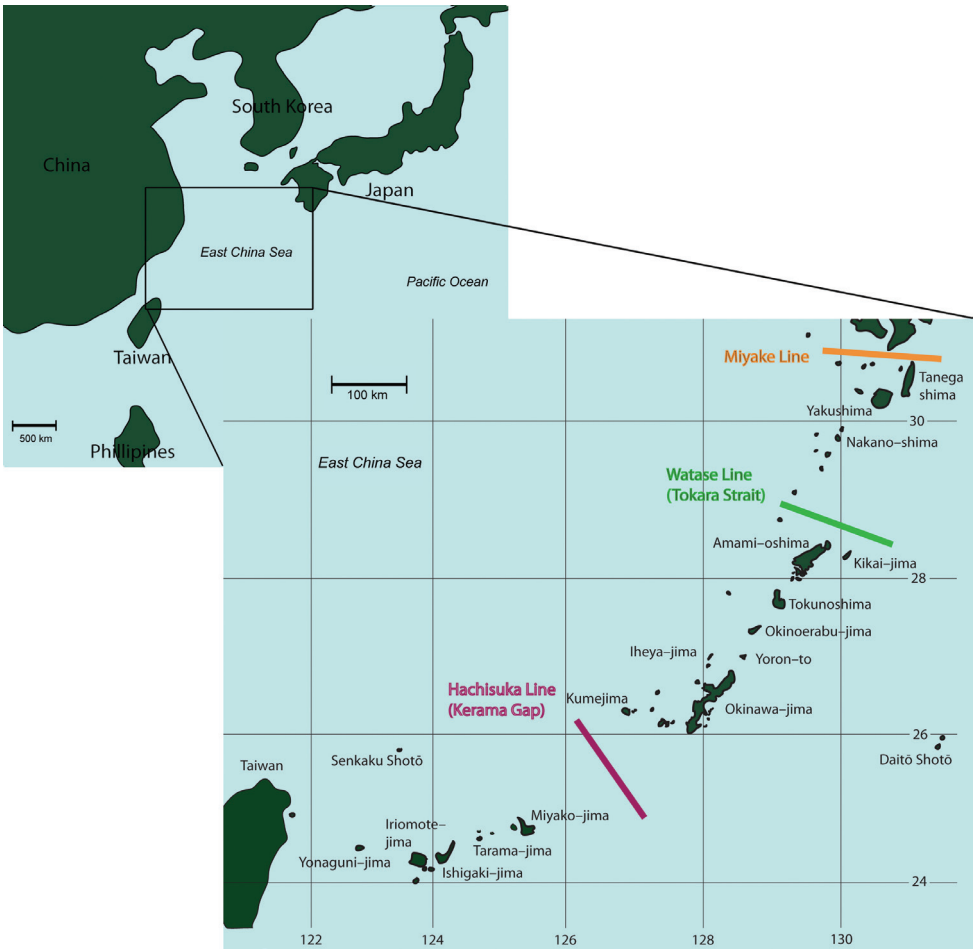

Figure 1. Map of the Ryukyu Archipelago, Japan.

Methods

Specimens were collected via snorkeling and SCUBA at 47 locations throughout the Ryukyu Archipelago: Ishigaki–jima Island (4), Iriomote–jima Island (4), Okinawa–jima Island (21), Yoron–to Island (2), Okinoerabu–jima Island (2), Tokunoshima Island (4), Amami–oshima Island (6), and Yakushima Island (4) (Fig. 2). Table 1 lists the collection localities numbered in Fig. 2. Detailed station data are available in Supplementary Table 1. Whole ascidians were collected in zip-lock plastic bags and brought back to the laboratory. The ascidians were then dissected and commensal leucothoid amphipods were removed from the branchial chambers. Amphipods were preserved in 2% seawater buffered formalin for morphological analysis and 99% ethanol for molecular studies.

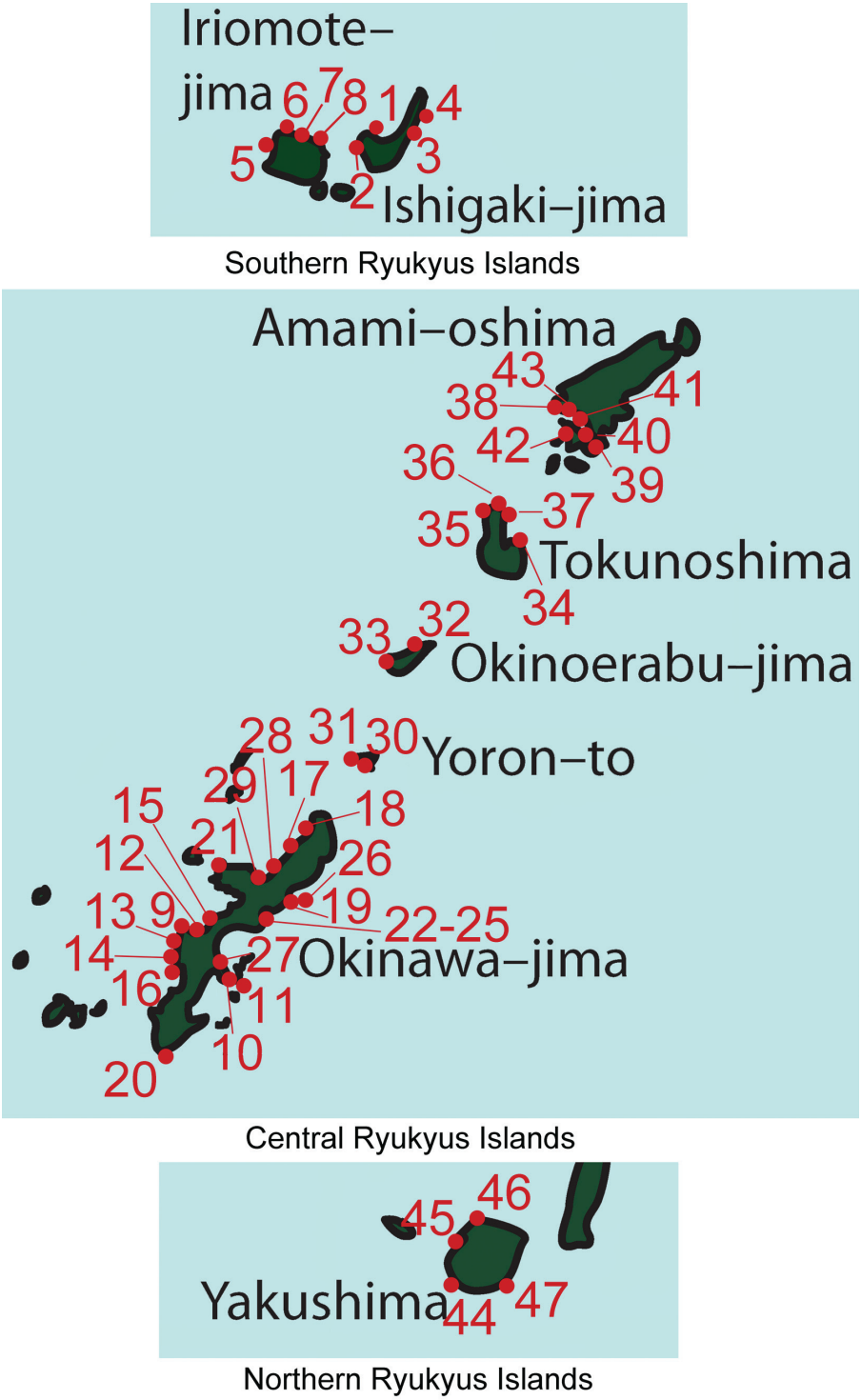

Figure 2. Map of collection localities in the Ryukyu Archipelago, Japan.

Table 1. Collection localities numbered in Fig. 2.

Southern Ryukyu Islands	
1	Kibura Bay, Ishigaki–jima Island, Okinawa
2	Sukoji Beach, Ishigaki–jima Island, Okinawa
3	Inoda Beach, Ishigaki–jima Island, Okinawa
4	Ibaruma, Ishigaki–jima Island, Okinawa
5	S of Hoshitate, Iriomote–jima Island, Okinawa
6	Channel between Iriomote–jima Island and Hatoma–jima Island, Okinawa
7	Blue Hole, Iriomote–jima Island, Okinawa
8	River drainage east of Funauki Port, Iriomote–jima Island, Okinawa
Central Ryukyu Islands	
9	Zanpa Cape, Okinawa–jima Island, Okinawa
10	Route 10 Bridge, Okinawa–jima Island, Okinawa
11	Hamahiga–jima Island, Okinawa
12	Maeda Point, Okinawa–jima Island, Okinawa
13	Toguchi Beach, Okinawa–jima Island, Okinawa
14	Mizugama, Okinawa–jima Island, Okinawa
15	Manza, Okinawa–jima Island, Okinawa
16	Sunabe Seawall, Okinawa–jima Island, Okinawa
17	Yona, Okinawa–jima Island, Okinawa
18	Zatsun, Okinawa–jima Island, Okinawa
19	Teniya Beach, Okinawa–jima Island, Okinawa
20	Odo, Okinawa–jima Island, Okinawa
21	Bise, Okinawa–jima Island, Okinawa
22	Chiribishi, Oura–wan Bay, Okinawa–jima Island, Okinawa
23	Kita–nakase, Oura–wan Bay, Okinawa–jima Island, Okinawa
24	Tettou–mae–oki, Oura–wan Bay, Okinawa–jima Island, Okinawa
25	Umi-saboten, Oura–wan Bay, Okinawa–jima Island, Okinawa
26	Teniya, Okinawa–jima Island, Okinawa
27	Uken, Kin Bay, Okinawa–jima Island, Okinawa
28	Shioya Bay, Okinawa–jima Island, Okinawa
29	Haneji Bay, Okinawa–jima Island, Okinawa
30	Ukatchi Coast, Yoron–to Island, Kagoshima
31	Shinaha Coast, Yoron–to Island, Kagoshima
32	Wanjo Beach, Okinoerabu–jima Island, Kagoshima
33	Naikina, Okinoerabu–jima Island, Kagoshima
34	Kaminomine, Tokunoshima Island, Kagoshima
35	Tete, Tokunoshima Island, Kagoshima
36	Omonawa, Tokunoshima Island, Kagoshima
37	San, Tokunoshima Island, Kagoshima
38	Shirahama Beach, Amami–oshima Island, Kagoshima
39	Kuse, Kakeroma–jima Island, Kagoshima
40	Sanakuiwa, Amami–oshima Island, Kagoshima
41	Boat dock, Amami–oshima Island, Kagoshima
42	Nominoura Oku, Kakeroma–jima Island, Kagoshima

43	Konase Kurosaki, Amami–oshima Island, Kagoshima
Northern Ryukyu Islands	
44	Kurio, Yakushima Island, Kagoshima
45	Yoshida, Yakushima Island, Kagoshima
46	Isso, Yakushima Island, Kagoshima
47	Haruta, Yakushima Island, Kagoshima

Other sampling efforts included isolating entire sponges in zip-lock plastic bags for dissection in the laboratory or capturing amphipods individually in situ, using a modified squirt bottle. Coral rubble samples were also taken, elutriated, and sieved on location using both saltwater and formalin washes. Samples were sorted immediately and amphipods were preserved as previously stated.

Specimens used for morphological analyses were transferred to glycerin, dissected, mounted on slides, and illustrated using a Nikon® Y-IDT drawing tube attached to a Nikon® Eclipse 50I compound microscope. Pencil drawings were scanned and digitally inked in Adobe® Illustrator using a Wacom® Tablet, following the methods of Coleman (2003).

Descriptions are of males with sexually dimorphic characters described in a separate section. Terminology used in descriptions follows White and Thomas (2009) with 'proximal margin' of the carpus and dactylus referring to the margins closing on the propodus. Setae nomenclature follows Oshel and Steele (1988) where possible without having SEM images for the specimens described here. All setae are simple, unless noted.

Type material is deposited in The University of the Ryukyus Museum (Fujukan), with the prefix RUMF for museum numbers. Additional material has been deposited in The National Museum of Nature and Science in Tokyo, with the prefix NSMT for museum numbers.

Scale bars in figures represent 0.1 mm unless noted.

Figure legend: Hd, head; Mx, maxilla; Md, mandible; Xpd, maxilliped; LL, lower lip; UL, upper lip; G, gnathopod; P, pereopod; T, telson; U, uropod; L, left; R, right; l, lateral; m, medial; +, enlarged.

Taxonomy

Leucothoe Leach, 1814

http://species-id.net/wiki/Leucothoe

Generic diagnosis. Eyes, if present, generally well developed with 10 or more ocelli. Mandibles lacking molars, palp three articulate; right lacinia mobilis smaller than left. Maxilliped inner plates fused, palp 4–articulate; outer plates not reaching apex of palp article 1. Coxa 1–4 relatively equal in widths. Pereopods 5–7 bases generally expanded. Minimal to no sexual dimorphism.

***Leucothoe amamiensis* sp. n.**
urn:lsid:zoobank.org:act:33B0D200-A04A-4CA1-BFEA-5710AA382B05
http://species-id.net/wiki/Leucothoe_amamiensis
Figs 3, 4

Type material. Holotype male, 5.9 mm, RUMF-ZC-1654, Sanakuiwa, Amami–oshima Island patch reef (28°06'58"N, 129°22'01"E), in branchial chamber of solitary ascidians, *Pyura microcosmus* (Savigny, 1816), 10 m, K.N. White, col., 19 March 2011 (KNWAmami2H). Paratype female, 4.7 mm, RUMF-ZC-1655, same station data as holotype.

Type locality. Sanakuiwa, Amami–oshima Island, Japan (28°06'58"N, 129°22'01"E).

Additional material examined. 1 specimen, NSMT-Cr21813, KNWAmami2E; 3 specimens, RUMF-ZC-1656, KNWAmami2H; 10 specimens, RUMF-ZC-1657, KNWAmami3A; 33 specimens, NSMT-Cr21814, KNWAmami3C; 2 specimens, RUMF-ZC-1698, KNWAmami47J.

Diagnosis (male). Mandibular palp article 2 with 17 setae. Right mandible lacinia mobilis with 2 distal rows of dentition. Coxae 1–4 with several short lateral facial setae. Gnathopod 1 coxa with 1 long medial facial seta. Gnathopod 2 basis anterior margin with 19 short and medium setae; carpus with large subdistal tooth; propodus mediofacial setal row displaced to palm. Epimeron 1 with anteroventral tuft of setae. Telson with plumose facial setae and simple marginal setae, apex truncate.

Description (male). Head. Anterior margin rounded, anterodistal margin evenly rounded; ventral cephalic keel anterior margin excavate, anteroventral margin quadrate with a simple cusp, ventral margin oblique; eyes with more than 10 ommatidia, round. Antenna 1 0.3 × body length, flagellum 8–articulate, peduncle article 1 width less than 2 × article 2, accessory flagellum 1–articulate, aesthetascs present. Antenna 2 0.3 × body length, slightly shorter than antenna 1, flagellum 3–articulate. Mandibular palp ratio of articles 1–3 1.0: 3.5: 1.5, article 2 with 17 setae, article 3 with 2 distal setae, incisors strongly dentate; left mandible with 14 raker spines, lacinia mobilis large, strongly toothed; right mandible with 15 raker spines, lacinia mobilis small, weakly dentate, with 2 rows of dentition. Upper lip asymmetrically lobate, anterior margin setose. Lower lip inner lobes fused, bare; outer lobes with moderate gape, anterior margins setose. Maxilla 1 palp 2–articulate with 3 distal slender setae; outer plate with 7 distal robust setae and 3 distal slender setae. Maxilla 2 inner plate with 2 robust and 7 slender distal setae, short row of facial setae; outer plate with 11 distal marginal setae, facial setae present. Maxilliped inner plates distal margin with v-shaped indentation, with short robust setae; outer plate inner margin smooth, reaching 0.3 × palp article 1, with simple and setulate-serrate marginal setae, facial setae present; palp article 4 subequal in length with article 3, distally acute.

Pereon. Coxae 1–4 relative widths 1.0: 1.0: 0.7: 1.4. Gnathopod 1 coxa smooth, with tiny marginal setae, anterodistal margin produced, subquadrate, posterior margin excavate, medial and lateral facial setae present; basis distally expanded, anterior

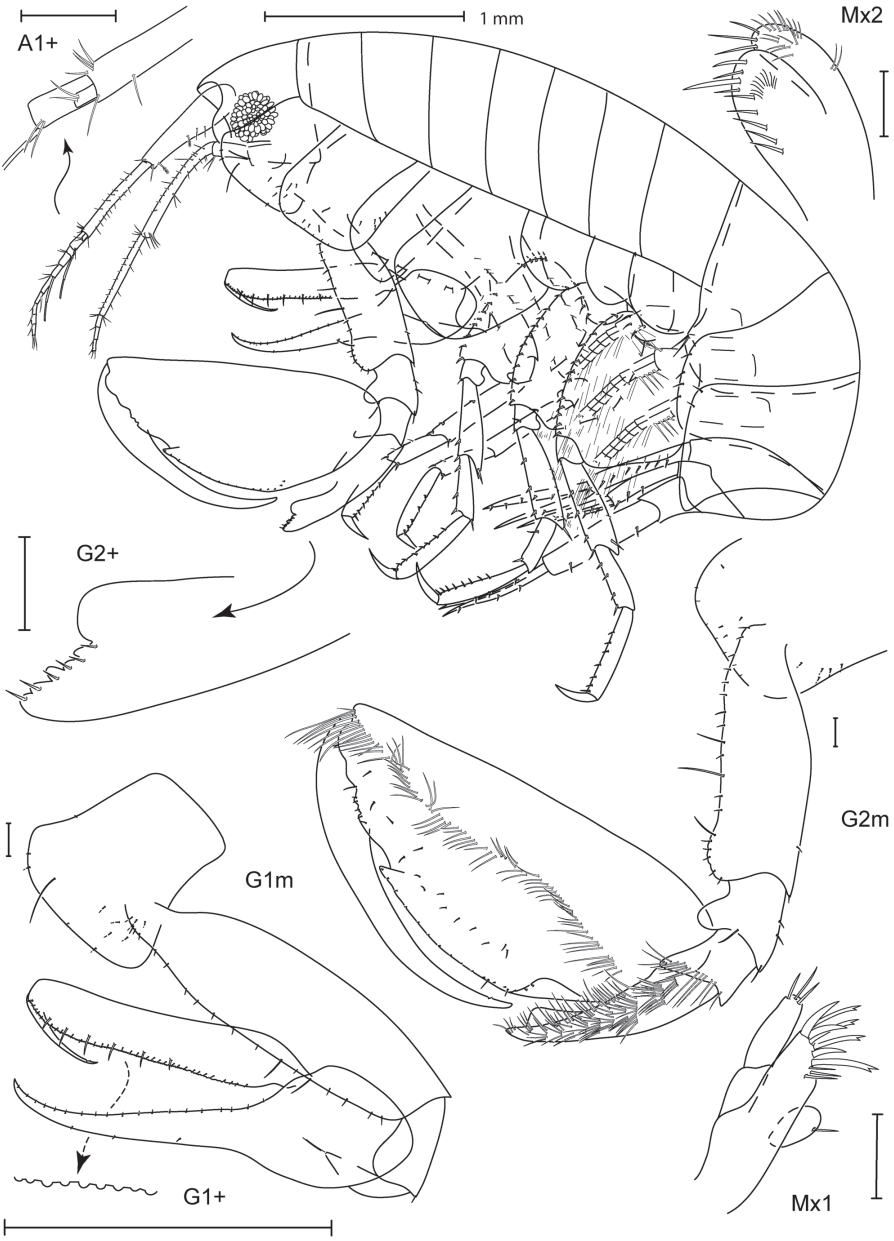

Figure 3. *Leucothoe amamiensis* sp. n., holotype male, 5.9 mm, RUMF-ZC-1654.

margin with 18 setae, posterior margin bare; ischium with 1 posterodistal seta; carpus linear, length 9.1 × width, proximal margin smooth, distal margin with 3 short setae; propodus straight, palm dentate with 6 proximal setae; dactylus smooth, reaching 0.3 × propodus length. Gnathopod 2 coxa longer than broad, subequal in length with coxa

3, smooth, with tiny marginal setae, anterodistally rounded, distal margin straight, posterior margin straight, lateral facial setae present; basis distally expanded with 3 small anterior tubercles, anterior margin with 19 short and medium setae, posterior margin with 2 short setae; ischium with posterior, distal, and posterodistal setae; carpus 0.3 × propodus length, curved, with large subdistal tooth, anterior margin smooth; propodus with 1 mediofacial setal row displaced to palm, reaching 0.8 × propodus length, with 1 row of submarginal setae, posterior margin smooth, palm convex with 3 small and 1 major tubercle, indentation near distal end of dactylus; dactylus curved, proximal margin smooth with 1 seta, anterior margin distally subacute, reaching 0.6 × propodus length. Pereopod 3 coxa length 1.8 × width, anterodistal corner overriding distal face of coxa 2, extending below it, smooth, with tiny marginal setae, anterior margin straight, distal margin oblique, posterior margin straight, lateral facial setae present. Pereopod 4 coxa smooth, with tiny marginal setae, anterior margin tapered, distal margin produced, posterior margin excavate, lateral facial setae present. Pereopods 5–7 coxae facial setae present; bases width length ratios 1: 1.4, 1: 1.3, 1: 1.3, posterior margins smooth, setose.

Pleon. Epimeron 1 with tuft of anteroventral setae, epimera 2–3 with ventral setae; epimeron 3 posteroventral corner subquadrate, produced. Uropods 1–3 relative lengths 1.0: 0.9: 1.1. Uropod 1 peduncle and outer ramus subequal in length with inner ramus; inner ramus with 6 robust setae; outer ramus with 2 robust setae. Uropod 2 peduncle 0.8 × inner ramus length; outer ramus 0.7 × inner ramus length; inner ramus with 5 robust setae; outer ramus with 3 robust setae. Uropod 3 peduncle 1.1 × inner ramus length; outer ramus subequal in length with inner ramus; inner and outer rami each with 3 robust setae. Telson 2.7 × longer than wide, with plumose facial setae and simple marginal setae, apex truncate.

Female (sexually dimorphic characters). Gnathopod 1 basis proximally expanded, anterior margin with 13 short setae, posterior margin with 16 short posterior setae; ischium with posterior seta; carpus distal margin with 4 short setae; propodus palm with 5 proximal setae. Gnathopod 2 basis without tubercles, anterior margin with 26 short and long setae, posterior margin with 12 short setae; ischium with 14 posterior setae, 3 anterior setae, and 2 posterodistal setae; carpus with small subdistal tooth; propodus palm with small tubercles.

Etymology. After 'Amami' and referring to the type locality of this species.

Ecology. In branchial chamber of solitary ascidians, *Rhopalaea circula* Monniot & Monniot, 2001 (Fig. 18F); *Pyura microcosmus* (Fig. 18D); and coral rubble.

Relationships. *Leucothoe amamiensis* is similar to *Leucothoe commensalis* Haswell, 1879, *Leucothoe wuriti* Thomas and Klebba, 2007, *Leucothoe epidemos* White and Thomas, 2009, and *Leucothoe thula* White and Thomas, 2009 in having a rounded head, single seta on the medial surface of coxa 1, a long gnathopod 1 dactylus, and a displaced gnathopod 2 mediofacial setal row. It is similar to *Leucothoe articulosa* Montagu, 1804, *Leucothoe incisa* (Robertson, 1893), and *Leucothoe procera* (Bate, 1857) in having gnathopod 2 carpus with a large subapical tooth. *Leucothoe amamiensis* is similar to *Leucothoe occulta* Krapp-Schickel, 1975 in having coxae with facial setae.

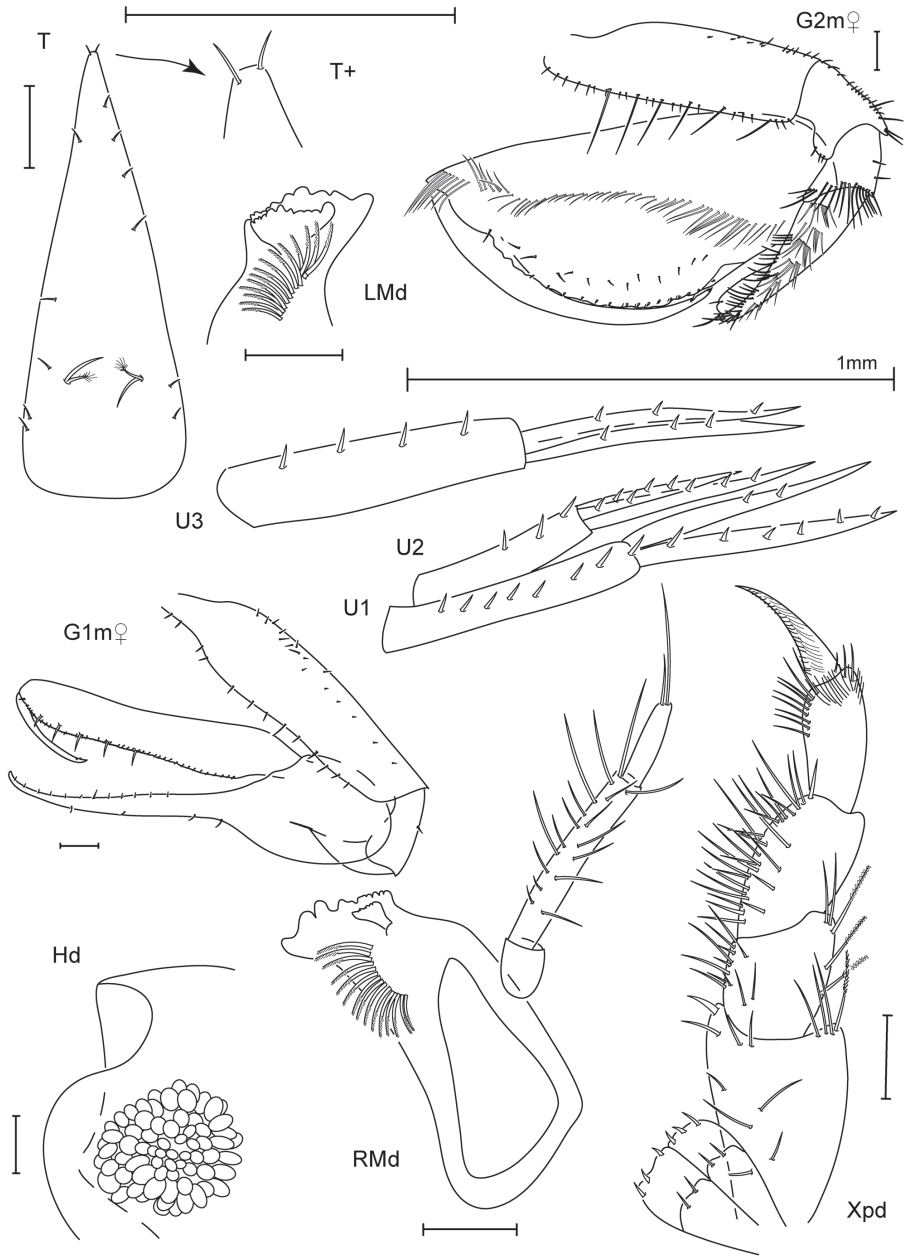

Figure 4. *Leucothoe amamiensis* sp. n., holotype male, 5.9 mm, RUMF-ZC-1654; paratype female, 4.7 mm, RUMF-ZC-1655.

Leucothoe amamiensis differs from these species in having two rows of dentition on the right mandibular lacinia mobilis, a heavily setose gnathopod 2 basis, and a telson with plumose facial setae and simple marginal setae, and truncate apex.

Remarks. *Leucothoe amamiensis* has a pink-orange striped color pattern (Fig. 17B). This species appears to be endemic to Amami–oshima Island.

Distribution. East China Sea: Amami–oshima Island, Kagoshima, Japan.

***Leucothoe elegans* sp. n.**

urn:lsid:zoobank.org:act:9113E46D-8259-463F-BBF9-9BBB2FAA5ED4
http://species-id.net/wiki/Leucothoe_elegans
Figs 5, 6

Type material. Holotype male, 4.5 mm, RUMF-ZC-1658, Isso, Yakushima Island patch reef (30°27'29"N, 130°29'22" E), in grey-purple hard sponge, 10–12 m, K.N. White, col., 27 May 2011 (KNWYaku3A). Paratype female, 5.7 mm, RUMF-ZC-1659, same station data as holotype.

Type locality. Isso, Yakushima Island, Japan (30°27'29"N, 130°29'22"E).

Additional Material Examined. 8 specimens, NSMT-Cr21815, KNWYaku3B; 4 specimens, RUMF-ZC-1660, KNWYaku3L; 3 specimens, RUMF-ZC-1661, KNWYaku5C; 3 specimens, RUMF-ZC-1662, KNWOkinawa54A; 16 specimens, NSMT- Cr 21816, KNWOkinawa54I; 2 specimens, RUMF-ZC-1699, KNWOkinawa54I.

Diagnosis (male). Mandibular palp article 2 robust, with 4 setae. Right mandible lacinia mobilis distal margin with 3 rows of dentition. Maxilliped outer plate inner margin tuberculate. Eye large, covering most head. Gnathopod 1 basis proximally widened; carpus elongate. Gnathopod 2 propodus with one submarginal row of robust setae; dactylus proximal margin with 2 setae, distal margin with spine; epimeron 3 posteroventral margin with small sinus.

Description (male). Head. Anterior margin truncate, anterodistal margin evenly rounded; ventral cephalic keel anterior margin transverse, anteroventral margin rounded, ventral margin straight; eyes with more than 10 ommatidia, large, round. Antenna 1 0.2 × body length, flagellum 6–articulate, peduncle article 1 width less than 2 × article 2, accessory flagellum 2–articulate. Antenna 2 0.2 × body length, subequal in length with antenna 1, flagellum 4–articulate. Mandibular palp ratio of articles 1–3 1.0: 3.5: 1.6, article 2 robust with 4 setae, article 3 with 2 distal setae, incisors strongly dentate; left mandible with 12 raker spines, lacinia mobilis large, strongly toothed; right mandible with 12 raker spines, lacinia mobilis small, weakly dentate, with 3 rows of dentition. Upper lip asymmetrically lobate, anterior margin bare. Lower lip inner lobes fused, setose, with facial setae; outer lobes with moderate gape, anterior margins setose. Maxilla 1 palp 1–articulate with 3 distal setae; outer plate with 6 distal robust setae and 5 distal slender setae. Maxilla 2 inner plate with 3 robust distal setae and 5 slender distal setae; outer plate with 4 robust distal marginal setae and 21 marginal setae. Maxilliped inner plates distal margin with arc-shaped indentation, with short robust setae and long plumose setae; outer plate inner margin tuberculate, reaching 0.2

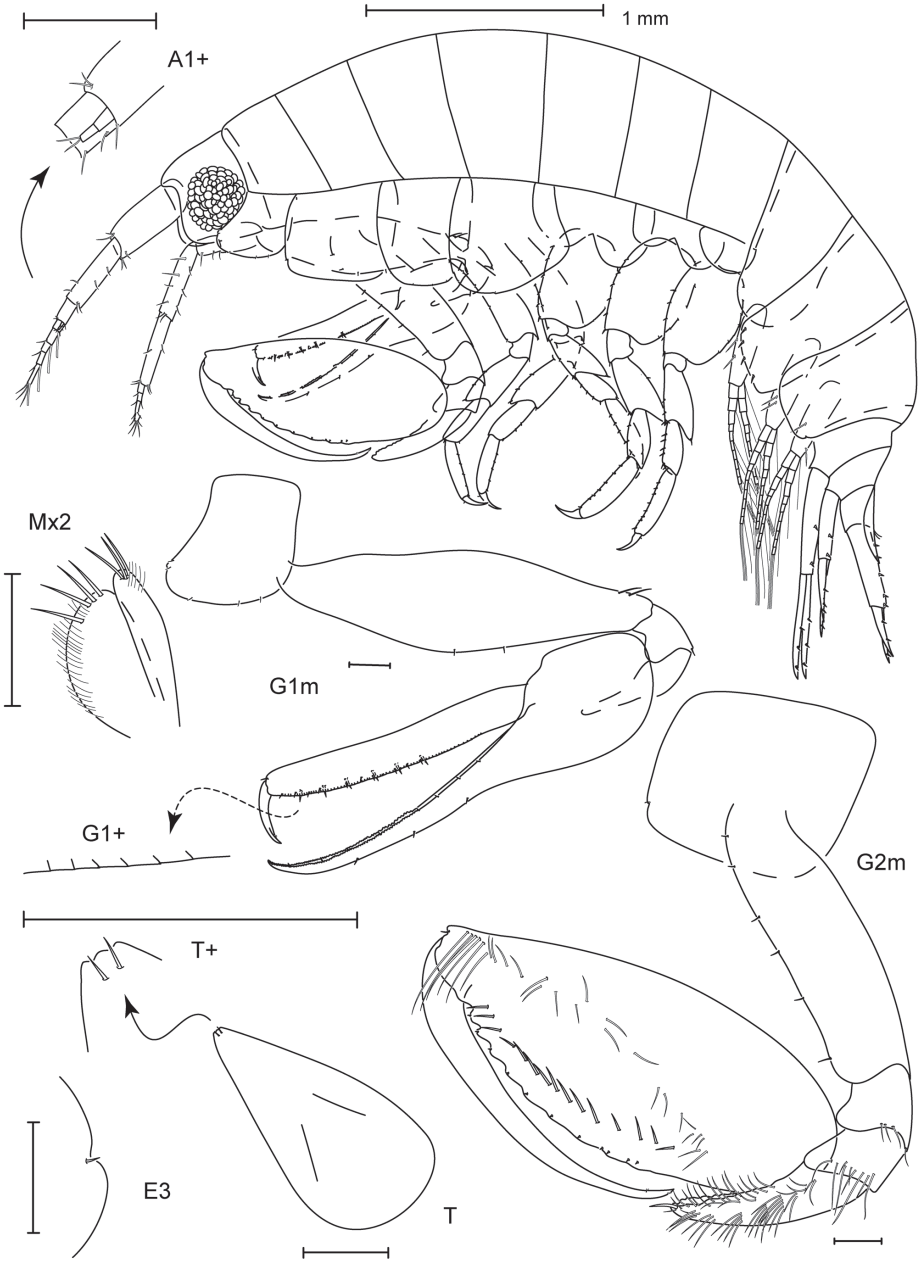

Figure 5. *Leucothoe elegans* sp. n., holotype male, 4.5 mm, RUMF-ZC-1658.

× palp article 1, inner plate plumose marginal setae; palp article 4 subequal in length with article 3, distally acute.

Pereon. Coxae 1–4 relative widths 1.0: 1.6: 1.4: 1.7. Gnathopod 1 coxa smooth, with tiny marginal setae, anterodistal margin produced, subquadrate with cusp, distal

margin rounded, posteroventral margin narrowly rounded, facial setae absent; basis centrally expanded, anterior margin with 2 short setae, posterior margin with 2 medium setae; ischium bare; carpus linear, length 14.2 × width, proximal margin dentate, distal margin with 3 short setae; propodus curved, palm dentate with 6 distal setae; dactylus with linear striation and 1 short seta, reaching 0.2 × propodus length. Gnathopod 2 coxa broader than long, subequal to coxa 3, smooth, with tiny marginal setae, anterior margin expanded anteriorly with cusp, anterodistally subquadrate, distal margin straight, posterior margin straight, facial setae absent; basis distally expanded, anterior margin with 6 short setae, posterior margin bare; ischium with 3 distal setae and 1 posterodistal seta; carpus 0.3 × propodus length, curved, distally tapered, anterior margin dentate; propodus with 1 mediofacial setal row displaced to palm, reaching 0.7 × propodus length, with 1 row of robust submarginal setae, posterior margin smooth, palm convex with 4 major tubercles; dactylus curved, proximal margin smooth with 2 setae, distal margin with 1 tooth, anterior margin distally acute, reaching 0.7 × propodus length. Pereopod 3 coxa length 1.1 × width, anterodistal corner overriding distal face of coxa 2, extending below it, smooth, with tiny marginal setae, anterior margin expanded, distal margin slightly convex with cusps, posterior margin straight, facial setae absent. Pereopod 4 coxa smooth, with tiny marginal setae, anterior margin produced with cusp, distal margin evenly rounded, posterior margin excavate, facial setae absent. Pereopods 5–7 coxae facial setae absent; bases oval, width length ratios 1: 1.3, 1: 1.4, 1: 1.4; posterior margins serrate, setose.

Pleon. Epimera 1–2 with ventral setae, epimeron 3 bare; epimeron 3 posteroventral corner with small sinus, subquadrate. Uropods 1–3 relative lengths 1.0: 0.7: 0.7; inner and outer rami lined with short marginal setae. Uropod 1 peduncle and outer ramus subequal in length with inner ramus; inner and outer rami each with 3 robust setae. Uropod 2 peduncle 0.9 × inner ramus length; outer ramus 0.8 × inner ramus length; inner and outer rami each with 2 robust setae. Uropod 3 peduncle 1.5 × inner ramus length; outer ramus 0.9 × inner ramus length; inner and outer rami each with 2 robust setae. Telson 1.9 × longer than wide, without facial or marginal setae, apex very weakly tridentate.

Female (sexually dimorphic characters). Gnathopod 1 basis anterior margin with 3 short setae, posterior margin with 15 medium setae; ischium with 1 posterodistal seta; carpus distal margin with 4 short setae; propodus palm with 9 distal setae. Gnathopod 2 propodus with longer robust submarginal setae.

Etymology. After the Latin 'elegans', meaning tasteful, choice, fine, and referring to the elegant, elongate gnathopod 1 of males and females of this species.

Ecology. In branchial chamber of solitary ascidian, *Rhopalaea circula* (Fig. 18F); grey/purple hard sponge; dark red chimney sponge; orange flame sponge; purple brown soft sponge; and orange stubby sponge.

Relationships. *Leucothoe elegans* is similar to *Leucothoe germanalcyone* Hirayama, 1992 in having an enlarged eye; similar to *Leucothoe flammosa* Thomas and Klebba, 2007 and *Leucothoe uschakovi* Gurjanova, 1951 in having an elongate gnathopod 1 with a centrally widened basis; and similar to *L. nagatai* in having short antennae, nar-

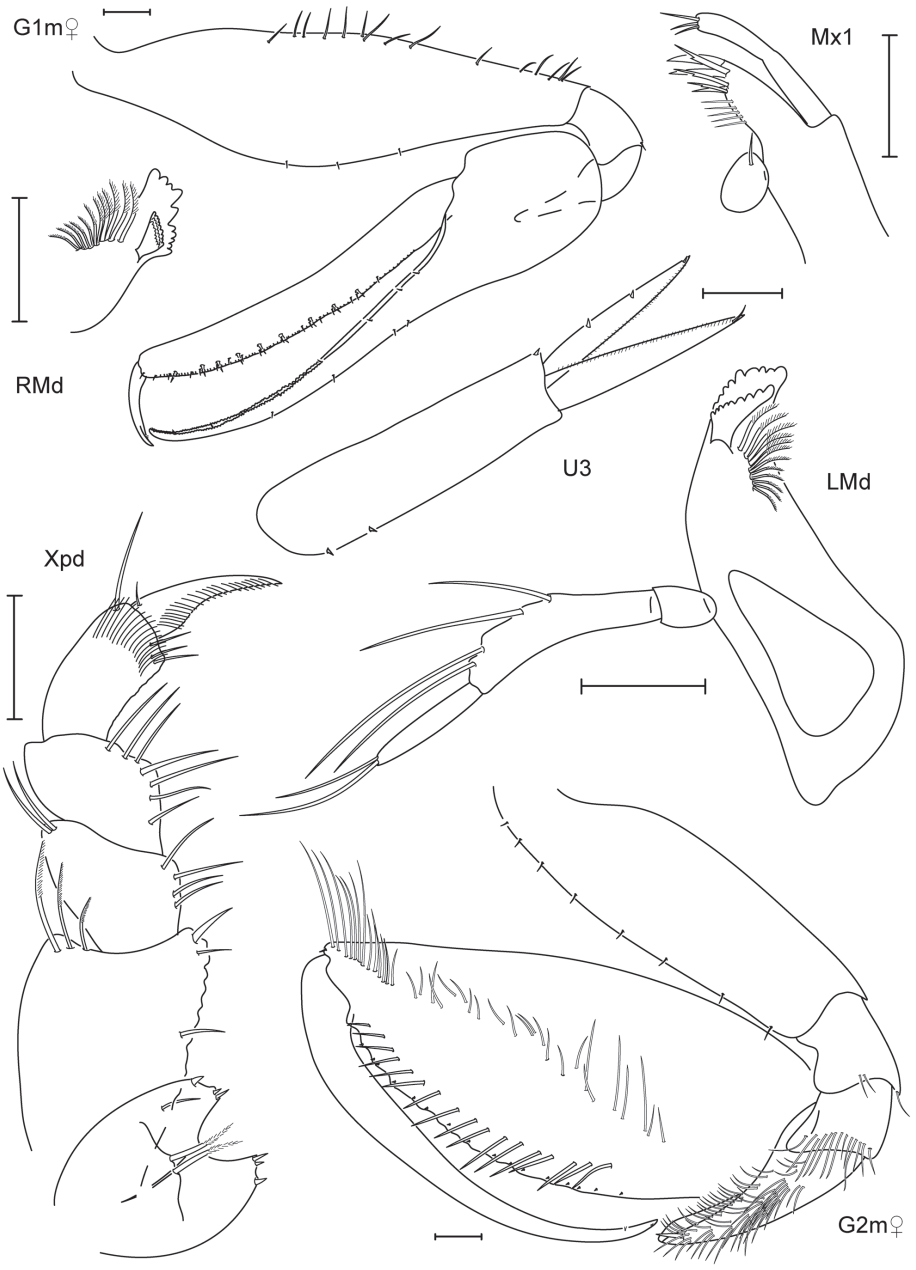

Figure 6. *Leucothoe elegans* sp. n., holotype male, 4.5 mm, RUMF-ZC-1658; paratype female, 5.7 mm, RUMF-ZC-1659.

row pereopod 5–7 bases, and a sinuous epimeron 3. *Leucothoe elegans* differs from these species in having a dentate right mandible lacinia mobilis, female gnathopod 1 with many posterior setae, and gnathopod 2 propodus with submarginal row of robust setae.

Remarks. *Leucothoe elegans* is translucent ivory in color (Fig. 17C). This species has only been collected on Yakushima Island and from Shioya Bay, on the east coast of Okinawa–jima Island, Okinawa.

Distribution. East China Sea: Okinawa–jima Island, Okinawa and Yakushima Island, Kagoshima, Japan.

***Leucothoe nathani* sp. n.**

urn:lsid:zoobank.org:act:ECB34479-0D69-4027-8604-CE98C89F809B
http://species-id.net/wiki/Leucothoe_nathani
Figs 7, 8

Type material. Holotype male, 4.8 mm, RUMF-ZC-1663, Mizugama reef wall (26°21'35"N, 127°44'22"E), in branchial chamber of solitary ascidian, *Herdmania* of Lahille, 1888, 7–9 m, N.S. White col., 26 February 2011 (KNWOkinawa34J). Paratype female, 6.3 mm, RUMF-ZC-1664, same station data as holotype.

Type locality. Mizugama, Okinawa, Japan (26°21'35"N, 127°44'22"E).

Additional Material Examined. 2 specimens, RUMF-ZC-1665, KNWOkinawa34J; 1 specimen, KNWOkinawa42G.

Diagnosis (male). Maxilla 1 palp 1–articulate, margins constricted. Maxilliped outer plate reaching 0.4 × length of palp article 1. Male gnathopod 1 basis posterodistally expanded; carpus basally inflated; dactylus very short, reaching 0.1 × propodus length. Gnathopod 2 propodus mediofacial setal row very robust with tufts of setae, palm with 4 long tubercles and 1 large indentation.

Description (male). Head. Anterior margin rounded, anterodistal margin evenly rounded; ventral cephalic keel anterior margin excavate, anteroventral margin subquadrate, ventral margin straight; eyes with more than 10 ommatidia, oval. Antenna 1 0.3 × body length, flagellum 6–articulate, peduncle article 1 width less than 2 × article 2, accessory flagellum absent, aesthetascs present. Antenna 2 0.3 × body length, subequal in length with antenna 1, flagellum 5–articulate. Mandibular palp ratio of articles 1–3, 1.0: 3.8: 1.8, article 2 with 6 setae, article 3 with 2 distal setae, incisors strongly dentate; left mandible with 10 raker spines, lacinia mobilis large, strongly toothed; right mandible with 9 raker spines, lacinia mobilis small, weakly dentate. Upper lip asymmetrically lobate, anterior margin setose. Lower lip inner lobes fused, bare; outer lobes with moderate gape, anterior margins setose. Maxilla 1 palp 1–articulate, margins constricted, with 4 distal setae; outer plate with 6 distal robust setae and 3 distal slender setae. Maxilla 2 inner plate with 3 short distal robust setae, 3 distal slender setae, and facial setae; outer plate 3 distal serrate robust setae, 7 marginal slender setae, and facial setae. Maxilliped inner plates distal margin with v-shaped indentation, with short robust setae and long setae, with facial setae; outer plate inner margin smooth, reaching 0.4 × length of palp article 1, with 6 distal setae and 1 distal robust seta, facial setae present; palp article 4 elongate, distally acute.

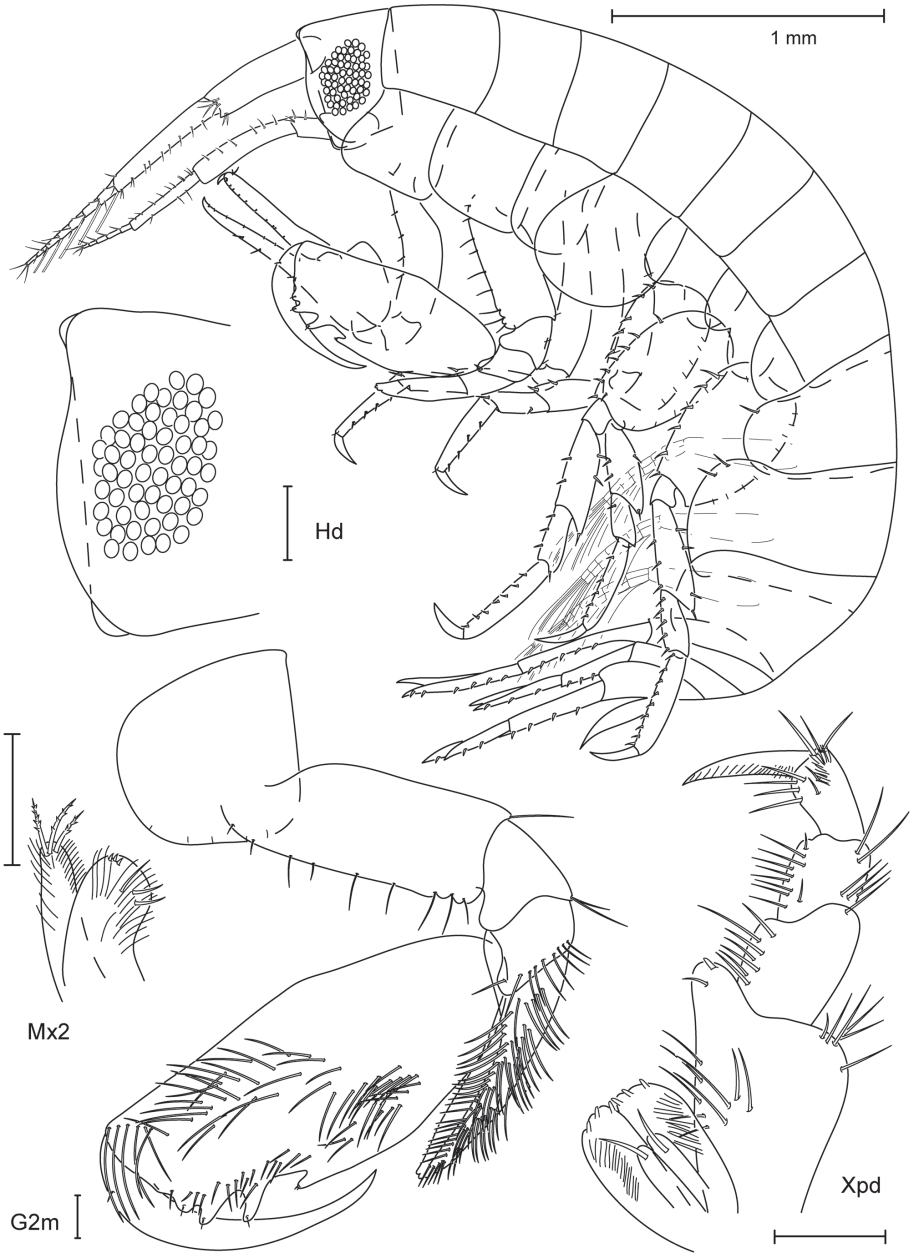

Figure 7. *Leucothoe nathani* sp. n., holotype male, 4.8 mm, RUMF-ZC-1663.

Pereon. Coxae 1–4 relative widths 1.0: 1.0: 0.8: 1.4. Gnathopod 1 coxa smooth, with tiny marginal setae, anterodistal corner produced, subtriangular, distal margin straight, posterior margin excavate, facial setae absent; basis posterodistally expanded, anterior margin with 5 short setae, posterior margin bare; ischium bare; carpus basally

inflated, length 7.6 × width, proximal margin smooth, distal margin with 4 medium setae; propodus straight, palm smooth with 10 distal setae; dactylus smooth, reaching 0.1 × propodus length. Gnathopod 2 coxa equally as long as broad, subequal in length with coxa 3, smooth, with tiny marginal setae, anterodistally rounded, distal margin straight, posterior margin straight, facial setae absent; basis distally expanded, stout, with 3 small anterodistal tubercles, anterior margin with 9 short-medium length setae, posterior margin with 1 seta; ischium with 2 posterodistal setae; carpus 0.4 × propodus length, straight, distally tapered, anterior margin dentate; propodus with 1 mediofacial setal row displaced to palm, reaching 0.7 × propodus length, with 1 row of submarginal setae, posterior margin smooth, palm convex with 4 major tubercles; dactylus recurved, proximal margin smooth, bare, anterior margin distally acute, reaching 0.5 × propodus length. Pereopod 3 coxa length 1.4 × width, anterodistal corner overriding distal face of coxa 2, not extending below it, smooth, bare, anterior margin straight, distal margin oblique, posterior margin straight, facial setae absent. Pereopod 4 coxa smooth, bare, anterior margin produced, distal margin evenly rounded, posterior margin tapered, facial setae absent. Pereopod 5 coxa facial seta present, pereopods 6–7 coxae facial setae absent; bases oval, width length ratios 1:1.6, 1:1.6, 1:1.5, posterior margins smooth, setose.

Pleon. Epimera 1–2 with ventral setae, epimeron 3 bare; epimeron 3 posteroventral corner rounded. Uropods 1–3 relative lengths 1.0: 0.6: 0.8; inner and outer rami lined with short marginal setae. Uropod 1 peduncle 1.1 × inner ramus length; outer ramus subequal in length with inner ramus; inner ramus with 6 robust seate; outer ramus with 3 robust setae. Uropod 2 peduncle 0.7 × inner ramus length; outer ramus 0.8 × inner ramus length; inner ramus with 1 robust seta; outer ramus with 3 robust seate. Uropod 3 peduncle 1.4 × inner ramus length; outer ramus subequal in length with inner ramus; inner and outer rami each with 1 robust seta. Telson 2.2 × longer than wide, apex weakly tridentate.

Female (sexually dimorphic characters). Gnathopod 1 basis anterior margin with 15 short setae; carpus linear, distal margin with 7 longer setae. Gnathopod 2 basis anterior margin with 21 short setae; carpus anterior margin smooth; dactylus with two proximal setae.

Etymology. Named for Nathan Stuart White, amphipod collector extraordinaire, who collected the type specimens of this species. Nathan has provided tremendous support and assistance throughout all sampling efforts in the Ryukyu Archipelago.

Ecology. In branchial chamber of solitary ascidian, *Herdmania* (Fig. 18A) and compound ascidian, *Clavelina* of Savigny, 1816 (Fig. 18C).

Relationships. *Leucothoe nathani* is similar to *L. nagatai* in having short antennae, an elongate maxilliped outer plate inner margin, a short gnathopod 1 dactyl, a heavily setose gnathopod 2 propodus medial surface, and narrow pereopod 5-7 bases. This species differs in having a smooth maxilliped outer plate inner margin, slenderner gnathopod 1 carpus (length 7.6 × width compared to length 6.6 × width in *L. nagatai*), and a longer telson (2.2 × longer than wide compared to 1.8 × longer than wide in *L. nagatai*).

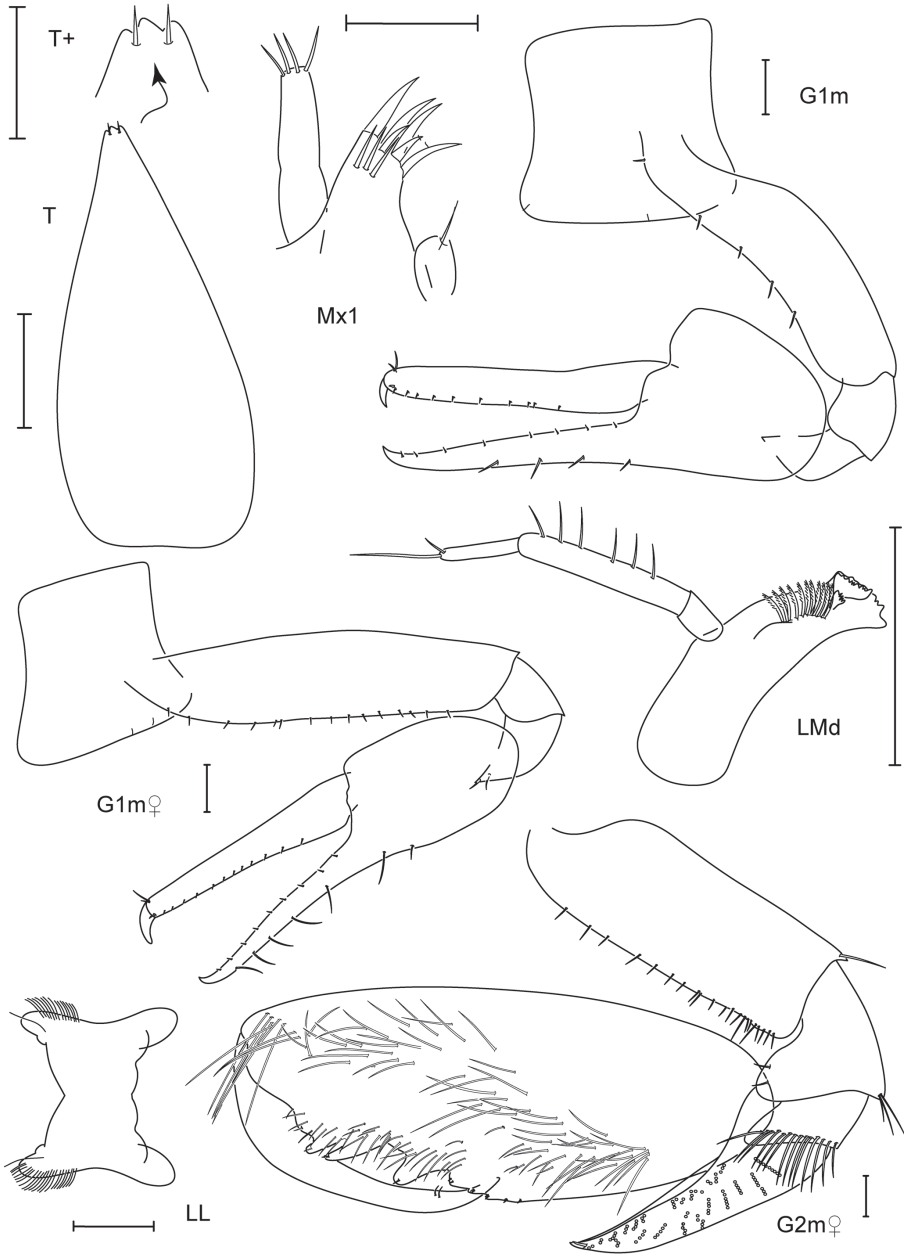

Figure 8. *Leucothoe nathani* sp. n., holotype male, 4.8 mm, RUMF-ZC-1663; paratype female, 6.3 mm, RUMF-ZC-1664.

Remarks. *Leucothoe nathani* is orange in color with robust dark orange stripes along pereonites (Fig. 17D). This species has been collected from only one location in February and April, two of the coldest months on Okinawa–jima Island.

Distribution. East China Sea: Okinawa–jima Island, Japan.

***Leucothoe obuchii* sp. n.**
urn:lsid:zoobank.org:act:590FEF5F-1261-4F6E-B4F5-07B7940CD81B
http://species-id.net/wiki/Leucothoe_obuchii
Figs 9, 10

Type material. Holotype male, 4 mm, RUMF-ZC-1666, Tettou–mae–oki, Oura–wan Bay (26°32'43"N, 128°02'56"E), muddy sand slope, in branchial chamber of solitary ascidian *Rhopalaea* of Phillippi, 1843 (clear with black and yellow lines), 24 m, M. Obuchi, col., 4 March 2011 (KNWOkinawa37A). Paratype female, 3.8 mm, RUMF-ZC-1667, same station data as holotype.

Type locality. Tettou–mae–oki, Oura–wan Bay, Okinawa, Japan (26°32'43"N, 128°02'56"E).

additional material examined. 5 specimens, RUMF-ZC-1668, KNWAmami3F; 2 specimens, NSMT-Cr21817, KNWOkinawa48A; 2 specimens, NSMT –Cr21818, KNWYaku3K; 1 specimen, NSMT –Cr21819, KNWYaku5N.

Diagnosis (male). Maxilla 1 palp 1–articulate. Maxilliped outer plate inner margin tuberculate, reaching 0.7 × palp article 1. Gnathopod 1 basis centrally widened; carpus with 4 long distal setae; propodus inflated; dactylus short, reaching 0.2 × propodus length. Pereopods 5–7 bases narrow, oval; epimeron 3 posteroventral margin with small sinus.

Description (male). Head. Anterior margin rounded, anterodistal margin evenly rounded; ventral cephalic keel anterior margin transverse, anteroventral margin rounded, ventral margin excavate; eyes with more than 10 ommatidia, oval. Antenna 1 0.3 × body length, flagellum 7–articulate, peduncle article 1 width less than 2 × article 2, accessory flagellum 1–articulate, aesthetascs present. Antenna 2 0.2 × body length, shorter than antenna 1, flagellum 3–articulate. Mandibular palp ratio of articles 1–3 1.0: 2.5: 1.2, article 2 and 3 each with 2 distal setae, incisors strongly dentate; left mandible with 7 raker spines, lacinia mobilis large, strongly toothed; right mandible with 8 raker spines, lacinia mobilis small, weakly dentate. Upper lip asymmetrically lobate, anterior margin setose. Lower lip inner lobes fused, setose; outer lobes with moderate gape, anterior margins setose, with facial setae. Maxilla 1 palp 1–articulate with 3 distal setae; outer plate with 6 distal robust setae and 3 distal slender setae. Maxilla 2 inner plate with 4 distal and 4 marginal setae; outer plate with 5 robust distal setae and 4 marginal setae. Maxilliped inner plates distal margin with v-shaped indentation, with short robust setae; outer plate inner margin tuberculate, reaching 0.7 × palp article 1, with 1 simple distal seta; palp article 4 subequal in length with article 3, distally acute.

Pereon. Coxae 1–4 relative widths 1.0: 1.5: 1.2: 1.8. Gnathopod 1 coxa smooth, bare, anterodistal corner produced, subquadrate with cusp, distal margin straight, posterior margin excavate, facial setae absent; basis centrally widened, anterior margin with 2 short setae, posterior margin with 2 short setae; ischium bare; carpus linear, length 7.1 × width, proximal margin dentate, distal margin with 4 long setae; propodus curved, slightly inflated, palm smooth with 3–5 distal setae; dactylus smooth, reaching 0.2 × propodus length. Gnathopod 2 coxa broader than long, subequal to

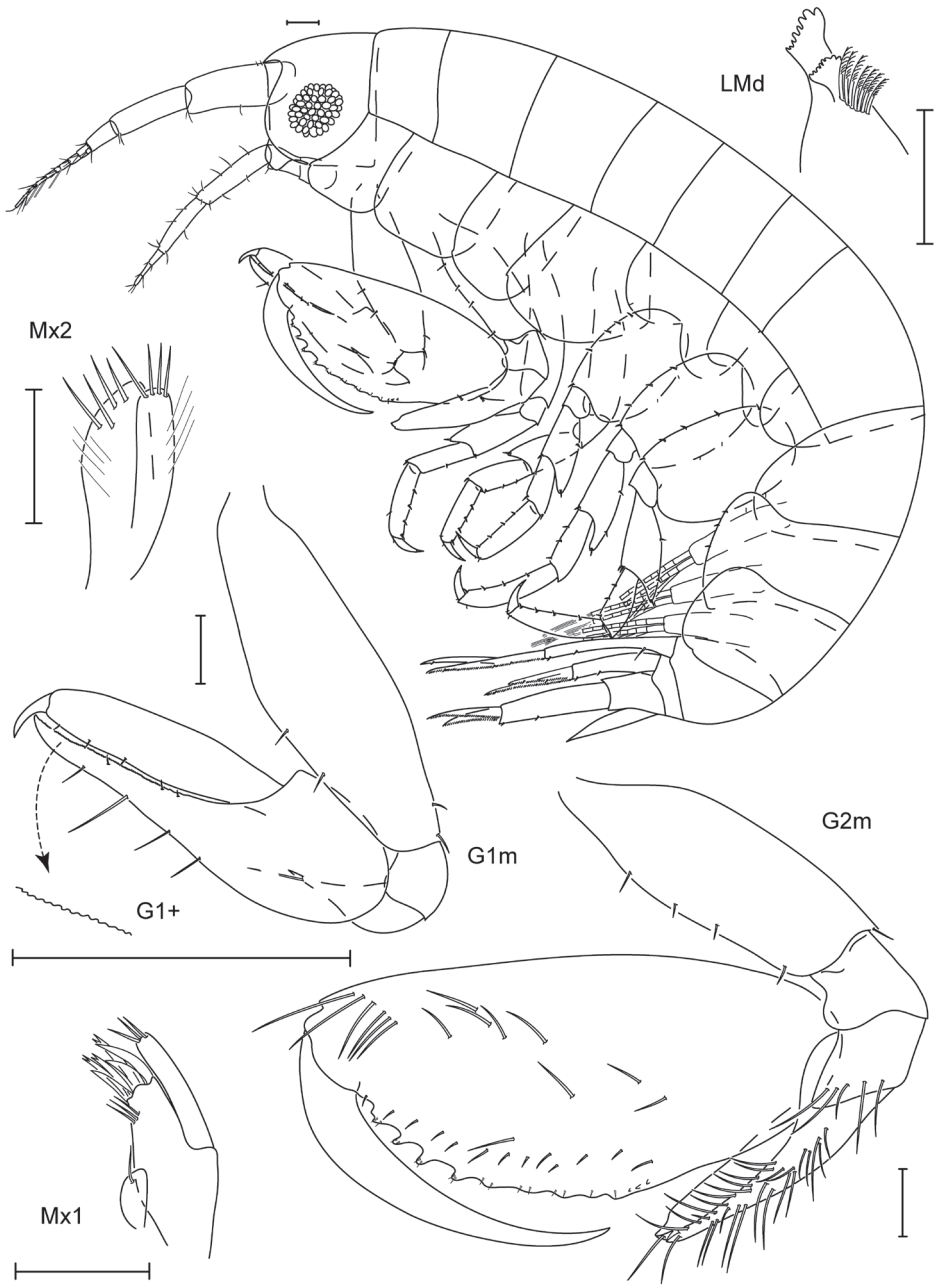

Figure 9. *Leucothoe obuchii* sp. n., holotype male, 4.0 mm, RUMF-ZC-1666.

coxa 3, smooth, bare, anterodistally rounded, distal margin straight, posterior margin straight, facial setae absent; basis distally expanded, anterior margin with 4 setae, posterior margin bare; ischium bare; carpus 0.4 × propodus length, straight, distally tapered, anterior margin with indentation; propodus with 1 mediofacial setal row

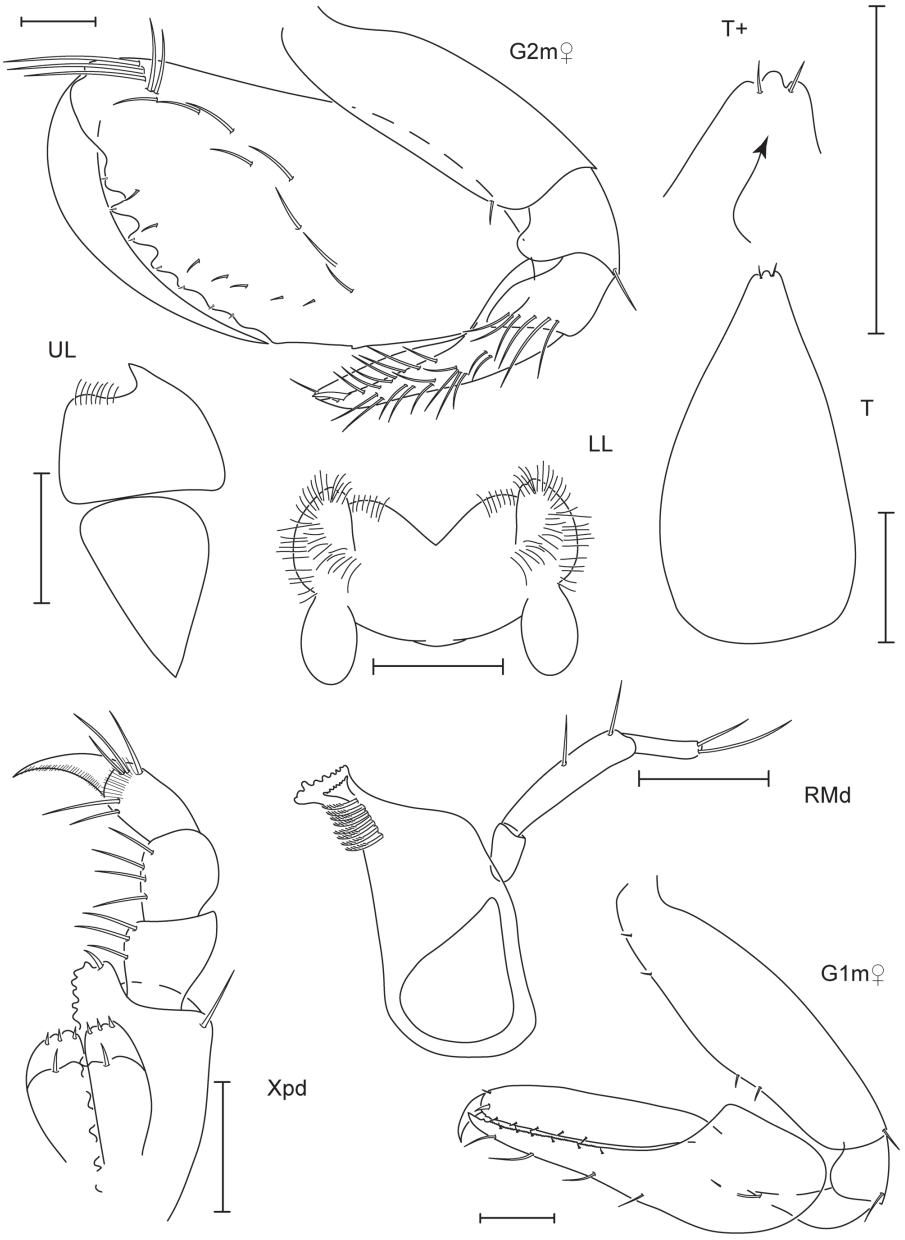

Figure 10. *Leucothoe obuchii* sp. n., holotype male, 4.0 mm, RUMF-ZC-1666; paratype female, 3.8 mm, RUMF-ZC-1667.

displaced below midline, reaching 0.7 × propodus length, with 1 row of submarginal setae, posterior margin smooth, palm convex with 4 major tubercles; dactylus curved, proximal margin smooth, bare, anterior margin distally acute, reaching 0.4 × propodus length. Pereopod 3 coxa length 1.2 × width, anterodistal corner overriding

distal face of coxa 2, extending below it, smooth, bare, anterior margin expanded, distal margin straight, posterior margin straight, facial setae absent. Pereopod 4 coxa smooth, bare, anterior margin tapered with cusp, distal margin evenly rounded, posterior margin tapered, facial setae absent. Pereopods 5–7 coxae facial setae absent; bases oval, width length ratios 1: 1.5, 1: 1.5, 1:1.5, posterior margins smooth, setose.

Pleon. Epimeron 1 bare; epimera 2–3 with ventral setae; epimeron 3 posteroventral corner slightly sinuous, rounded. Uropods 1–3 relative lengths 1.0: 0.7: 0.7; inner and outer rami lined with short marginal setae. Uropod 1 peduncle and outer ramus subequal in length with inner ramus; inner ramus with 1 robust seta; outer ramus with 3 robust setae. Uropod 2 peduncle subequal in length with inner ramus; outer ramus 0.8 × inner ramus length; inner ramus with 1 robust seta; outer ramus with 2 robust setae. Uropod 3 peduncle 1.4 × inner ramus length; outer ramus 0.8 × inner ramus length; inner and outer rami without robust setae. Telson 1.9 × longer than wide, apex weakly tridentate.

Female (sexually dimorphic characters). Gnathopod 1 basis anterior margin with 4 setae, posterior margin with 1 posterodistal seta. Gnathopod 2 basis anterior margin with 1 seta; carpus anterior margin smooth.

Etymology. Named for "General" Masami Obuchi, who collected the type specimens of this species. Dr. Obuchi has provided invaluable sampling and logistical support for this research in the Ryukyu Archipelago.

Ecology. In branchial chamber of solitary ascidians, *Rhopalaea* (Fig. 18B) and *Rhopalaea circula* (Fig. 18F); and coral rubble.

Relationships. *Leucothoe obuchii* is similar to *L. nagatai* in having short antennae, an elongate tuberculate maxilliped outer plate inner margin, a short gnathopod 1 dactyl, and narrow pereopod 5-7 bases. This species differs in having a much less setose gnathopod 2 propodus medial surface. *Leucothoe nagatai* has robust tufts of mediofacial setae covering most of the proximal surface of the propodus compared to single mediofacial and submarginal setal rows in *L. obuchii*.

Remarks. *Leucothoe obuchii* is opaque ivory in color (Fig. 17E). In most collections of this species there was one specimen at the base of the branchial chamber of each ascidian collected. Rarely, there were one large and one small amphipod living together.

Distribution. East China Sea: Okinawa–jima Island (Okinawa), Tokunoshima Island, Amami–oshima Island, and Yakushima Island (all Kagoshima), Japan.

Leucothoe trulla sp. n.

urn:lsid:zoobank.org:act:211A291A-EBDE-47F1-86F6-3BE9D376049D
http://species-id.net/wiki/Leucothoe_trulla
Figs 11, 12

Type material. Holotype male, 4.3 mm, RUMF-ZC-1669, Inoda Beach patch reef (24°27'46"N, 124°15'13"E), coral rubble, K.N. White col. 20 April 2011 (KNWIshigaki3G). Paratype female, 4.4 mm, RUMF-ZC-1670, same station data as holotype.

Type locality. Inoda Beach, Ishigaki, Japan (24°27'46"N, 124°15'13"E).

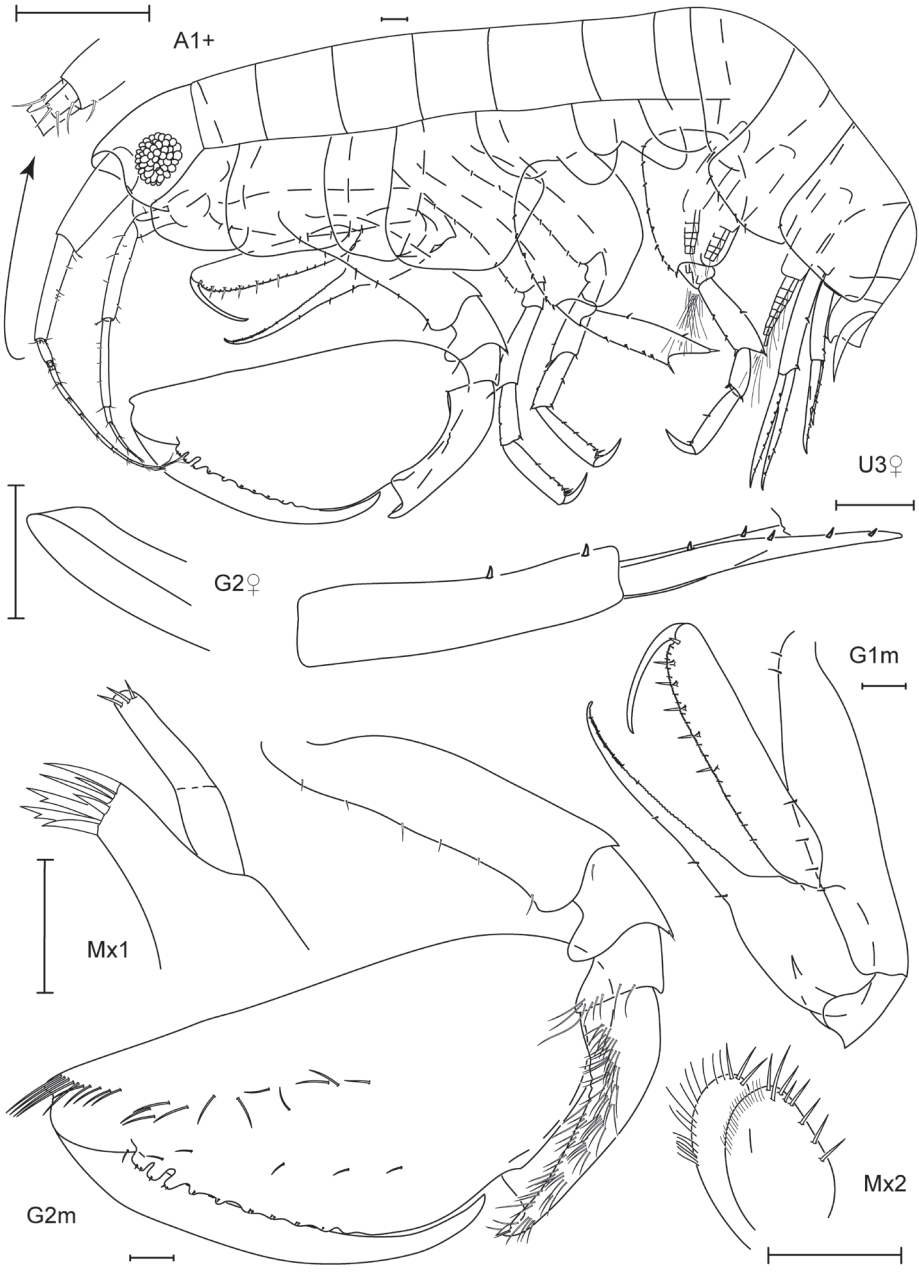

Figure 11. *Leucothoe trulla* sp. n., holotype male, 4.3 mm, RUMF-ZC-1669; paratype female, 4.4 mm, RUMF-ZC-1670.

Additional material examined. 2 specimens, RUMF-ZC-1671, KNWIriomote4A; 3 specimens, NSMT –Cr21820, KNWIshigaki3G.

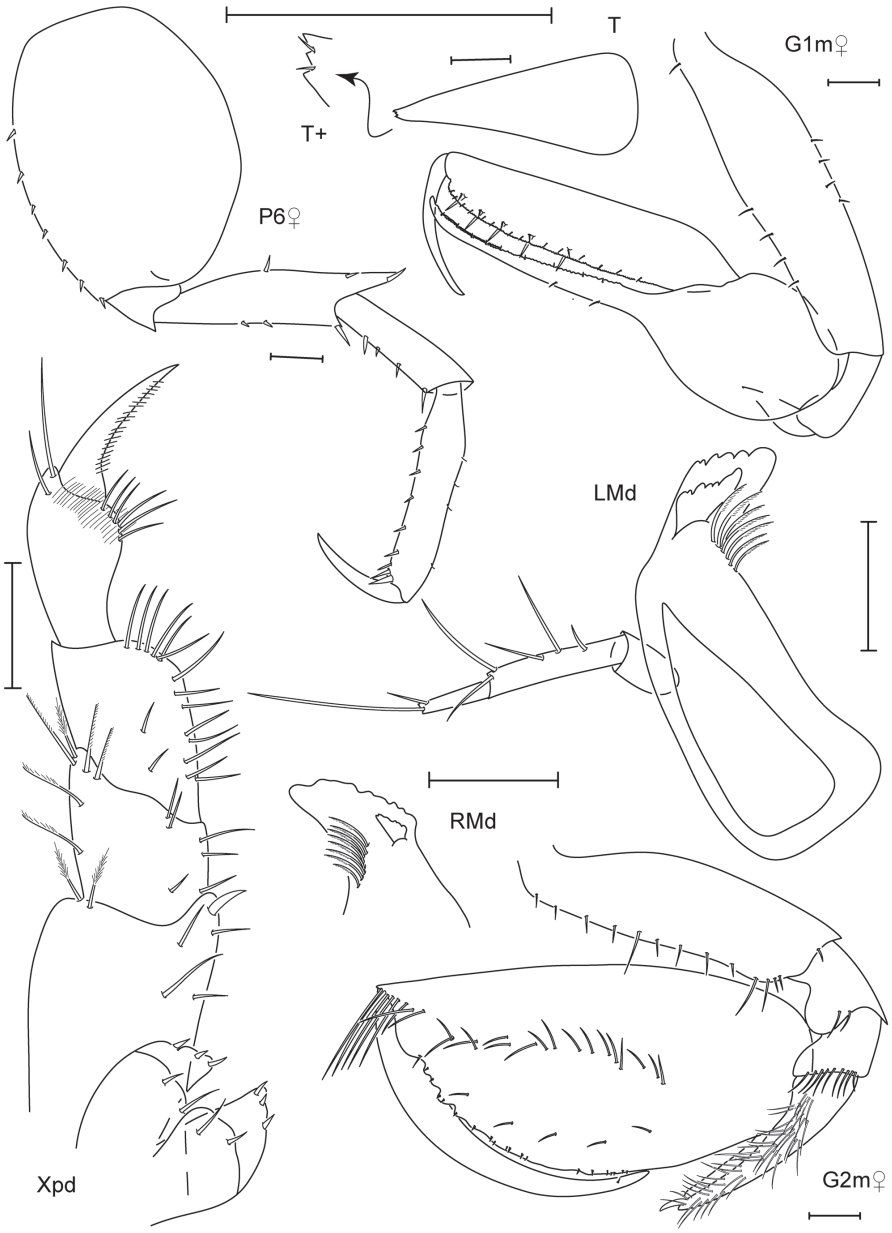

Figure 12. *Leucothoe trulla* sp. n., holotype male, 4.3 mm, RUMF-ZC-1669; paratype female, 4.4 mm, RUMF-ZC-1670.

Diagnosis (male). Maxilla 1 palp 1–articulate, margins constricted. Gnathopod 1 coxa posterior margin distally serrate. Gnathopod 2 coxa distal margin serrate; carpus distally truncate, spoon-like; propodus mediofacial setal row displaced to midline.

Description (male). Head. Anterior margin rounded, anterodistal margin evenly rounded; ventral cephalic keel anterior margin excavate, anteroventral margin rounded with an anteriorly projecting cusp, ventral margin straight; eyes with more than 10 ommatidia, round. Antenna 1 0.4 × body length, flagellum 10–articulate, peduncle article 1 width less than 2 × article 2, accessory flagellum 1–articulate, aesthetascs present. Antenna 2 0.3 × body length, shorter than antenna 1, flagellum 5–articulate. Mandibular palp ratio of articles 1–3, 1.0: 2.7: 1.4, article 2 with 5–6 setae, article 3 with 2 distal setae, incisors weakly dentate; left mandible with 7 raker spines, lacinia mobilis large, strongly toothed; right mandible with 7 raker spines, lacinia mobilis small, weakly dentate. Upper lip asymmetrically lobate, anterior margin setose. Lower lip inner lobes fused, bare; outer lobes with moderate gape, anterior margins setose. Maxilla 1 palp 1–articulate, margins constricted, with 3 distal setae; outer plate with 7 distal robust setae. Maxilla 2 inner plate with 5 distal setae, 3 marginal setae, and facial setae; outer plate with 4 robust distal setae and 15 marginal setae. Maxilliped inner plates distal margin with v-shaped indentation, with short robust setae and short setae; outer plate inner margin smooth, reaching 0.2 × length of palp article 1, with simple and plumose marginal setae, facial setae absent; palp article 4 subequal in length with article 3, distally acute.

Pereon. Coxae 1–4 relative widths 1.0: 1.3: 1.1: 1.8. Gnathopod 1 coxa smooth, with tiny marginal setae, smooth, anterodistal margin produced, subquadrate with cusp, distal margin straight, posterior margin excavate, distally serrate, facial setae absent; basis linear, anterior margin with 6 setae, posterior margin bare; ischium bare; carpus linear, length 19.8 × width, proximal margin dentate, distal margin with 3 short setae; propodus straight, palm dentate with 5 distal setae; dactylus smooth, reaching 0.4 × propodus length. Gnathopod 2 coxa longer than broad, subequal to coxa 3, smooth, with tiny marginal setae, distal margin serrate, anterodistally rounded, distal margin straight, posterior margin straight, facial setae absent; basis distally expanded, anterior margin with 6 short setae, posterior margin bare; ischium bare; carpus 0.3 × propodus length, curved, distally truncate, spoon-like, anterior margin smooth; propodus with 1 slightly displaced mediofacial setal row, reaching 0.6 × propodus length, with 1 row of submarginal setae, posterior margin smooth, palm convex with 3 major and 2 minor tubercles; dactylus curved, proximal margin smooth, bare, anterior margin distally subacute, reaching 0.7 × propodus length. Pereopod 3 coxa length 1.3 × width, anterodistal corner overriding distal face of coxa 2, extending below it, smooth, bare, anterior margin straight, distal margin oblique, posterior margin straight, facial setae absent. Pereopod 4 coxa smooth, bare, anterior margin straight, distal margin evenly rounded, posterior margin excavate, facial setae absent. Pereopods 5–7 coxae facial setae absent; bases slightly posteriorly tapered, width length ratios 1: 1.3, 1: 1.3, 1: 1.4; posterior margins smooth, bare.

Pleon. Epimera 1–3 with ventral setae; epimeron 3 posteroventral corner rounded. Uropods 1–2 relative lengths 1.0: 0.8. Uropod 1 peduncle 0.9 × inner ramus length; outer ramus 0.9 × inner ramus length; inner ramus with 5 robust seta; outer ramus with 8 robust setae. Uropod 2 peduncle 0.9 × inner ramus length; outer ramus 0.7 ×

inner ramus length; inner and outer rami each with 4 robust setae. Uropod 3 missing. Telson 2.3 × longer than wide, apex weakly tridentate.

Female (sexually dimorphic characters). Gnathopod 1 basis anterior margin with 5 setae, posterior margin with 4 setae; carpus distal margin with 2 short setae. Gnathopod 2 basis anterior margin with 13 short and medium setae; ischium with 2 distal setae; carpus truncate, not spoon-like; propodus palm with smaller tubercles. Uropod 3 peduncle 0.7 × inner ramus length; outer ramus broken; inner and outer rami with robust setae.

Etymology. After the Latin 'trulla', meaning 'stirring spoon, skimmer' and referring to the spoon-like carpus on male gnathopod 2.

Ecology. In branchial chamber of solitary ascidian, *Herdmania* (Fig. 18A); and coral rubble.

Relationships. *Leucothoe trulla* is similar to *L. commensalis*, *L. wuriti*, *L. epidemos*, and *L. thula*. The members of this "*L. commensalis* group" share a rounded head, long gnathopod 1 dactylus, a displaced gnathopod 2 propodus mediofacial setal row, and wide pereopod 5-7 bases. This species is also similar to *L. alata*, *Leucothoe dentata* Ledoyer, 1973, *Leucothoe denticulata* Costa, 1853, *L. epidemos*, *Leucothoe lihue* Barnard, 1970, *Leucothoe rudicula* White and Thomas, 2009, and *Leucothoe tolkieni* Vinogradov, 1990 in having a spoon-like gnathopod 2 carpus. This species differs from all of these species in having a ventral cephalic keel with an excavate anterior margin; constricted margins on the maxilla 1 palp, a serrate coxa 1 posteroventral margin; a serrate distal coxa 2 margin; and a rounded epimeron 3 posteroventral corner.

Remarks. *Leucothoe trulla* has faint pink-red stripes along pereonite edges and a slightly darker "saddleback" color in the middle (Fig. 17F). This species is endemic to the southern Ryukyu Islands.

Distribution. East China Sea: Ishigaki–jima Island and Iriomote–jima Island, Okinawa, Japan.

Leucothoe vulgaris sp. n.

urn:lsid:zoobank.org:act:C8E57473-2175-403A-93E4-77F590BF5EBC
http://species-id.net/wiki/Leucothoe_vulgaris
Figs 13, 14

Type material. Holotype male, 4.8 mm, RUMF-ZC-1672, Zanpa Cape reef wall (26°26'27.19"N, 127°43'03"E), in branchial chamber of solitary ascidian, *Pyura* of Molina, 1782, 10–30 m, K.N. White and N.S. White col., 13 December 2010 (KNWOkinawa23A). Paratype female, 4.2 mm, RUMF-ZC-1673, same station data as holotype.

Type locality. Zanpa Cape, Okinawa, Japan (26°26'27"N, 127°43'03"E).

Additional Material Examined. 1 specimen, RUMF-ZC-1674, KNWOkinawa12F ; 1 specimen, RUMF-ZC-1675, KNWOkinawa11E ; 1 specimen, RUMF-ZC-1676, KNWJap10-9-8A ; 1 specimen, RUMF-ZC-1677, KNWOkinawa14H; 1

specimen, RUMF-ZC-1678, KNWOkinawa16E; 1 specimen, RUMF-ZC-1679, KNWOkinawa21F; 2 specimens, RUMF-ZC-1680, KNWOkinawa26A; 2 specimens, RUMF-ZC-1681, KNWOkinawa24B; 1 specimen, RUMF-ZC-1682, KNWOkinawa25F; 3 specimens, RUMF-ZC-1683, KNWOkinawa27C; 2 specimens, RUMF-ZC-1684, KNWOkinawa27B; 1 specimen, RUMF-ZC-1685, KNWOkinawa29A; 2 specimens, RUMF-ZC-1686, KNWOkinawa29E; 1 specimen, RUMF-ZC-1687, KNWOkinawa31D; 1 specimen, RUMF-ZC-1688, KNWOkinawa36B; 1 specimen, RUMF-ZC-1689, KNWOkinawa36F ; 1 specimen, NSMT-Cr21821, KNWOkinawa37E; 2 specimens, NSMT –Cr21822, KNWOkinawa38A; 1 specimen, NSMT –Cr21823, KNWOkinawa39M; 12 specimens, NSMT –Cr21824, KNWOkinawa42F ; 1 specimen, NSMT - Cr21825, KNWIshigaki4E; 3 specimens, NSMT - Cr21826, KNWIriomote2A; 3 specimens, NSMT - Cr21827, KNWIriomote2D; 2 specimens, NSMT - Cr21828, KNWYaku3P; 1 specimen, NSMT - Cr21829, KNWYaku3Q; 2 specimens, NSMT - Cr21830, KNWOkinawa51B; 2 specimens, NSMT - Cr21831, KNWIshigaki2E; 8 specimens, NSMT - Cr21832, KNWIriomote2I ; 8 specimens, NSMT - Cr21833, KNWIriomote3D ; 1 specimen, NSMT - Cr21834, KNWYaku1L.

Diagnosis (male). Mandibular palp article 2 with 15 setae. Right mandible lacinia mobilis with dentate surface. Upper lip epistome with marginal setae. Gnathopod 1 coxa with 1 long medial seta. Gnathopod 2 carpus distally truncate, expanded; propodus mediofacial setal row displaced below midline. Pereopods 5–7 bases posteriorly tapered. Epimeron 1 with anteroventral tuft of setae. Telson apex with strong point.

Description (male). Head. Anterior margin rounded, anterodistal margin evenly rounded; ventral cephalic keel anterior margin excavate, anteroventral margin subquadrate, ventral margin straight; eyes with more than 10 ommatidia, round. Antenna 1 0.3 × body length, flagellum 9–articulate, peduncle article 1 width less than 2 × article 2, accessory flagellum absent, aesthetascs absent. Antenna 2 0.3 × body length, subequal in length with antenna 1, flagellum 3–articulate. Mandibular palp ratio of articles 1–3, 1.0: 3.4: 1.5, article 2 with 15 setae, article 3 with 2 distal setae, incisors strongly dentate; left mandible with 12 raker spines, lacinia mobilis large, strongly toothed; right mandible with 11 raker spines, lacinia mobilis small, with dentate surface. Upper lip asymmetrically lobate, anterior margin setose; epistome with marginal setae. Lower lip inner lobes fused, with facial setae; outer lobes with moderate gape, anterior margins setose. Maxilla 1 palp 2–articulate with 4 distal setae; outer plate with 7 distal robust setae and 4 distal slender setae. Maxilla 2 inner plate with 7 robust distal setae and 10 slender distal setae; outer plate with 3 robust distal setae and 13 slender marginal setae. Maxilliped inner plates distal margin with v-shaped indentation, with short robust setae and long setae; outer plate inner margin smooth, reaching 0.2 × length of palp article 1, with 4 distal setae and 1 distal spine, facial setae absent; palp article 4 subequal in length with article 3, distally acute.

Pereon. Coxae 1–4 relative widths 1.0: 1.1: 0.8: 1.5. Gnathopod 1 coxa smooth, with tiny marginal setae, smooth, anterodistal margin produced, subquadrate, serrate, distal margin straight, posterior margin excavate, medial facial seta present; basis proximally widened, anterior margin with 6 short setae, posterior margin bare; ischium

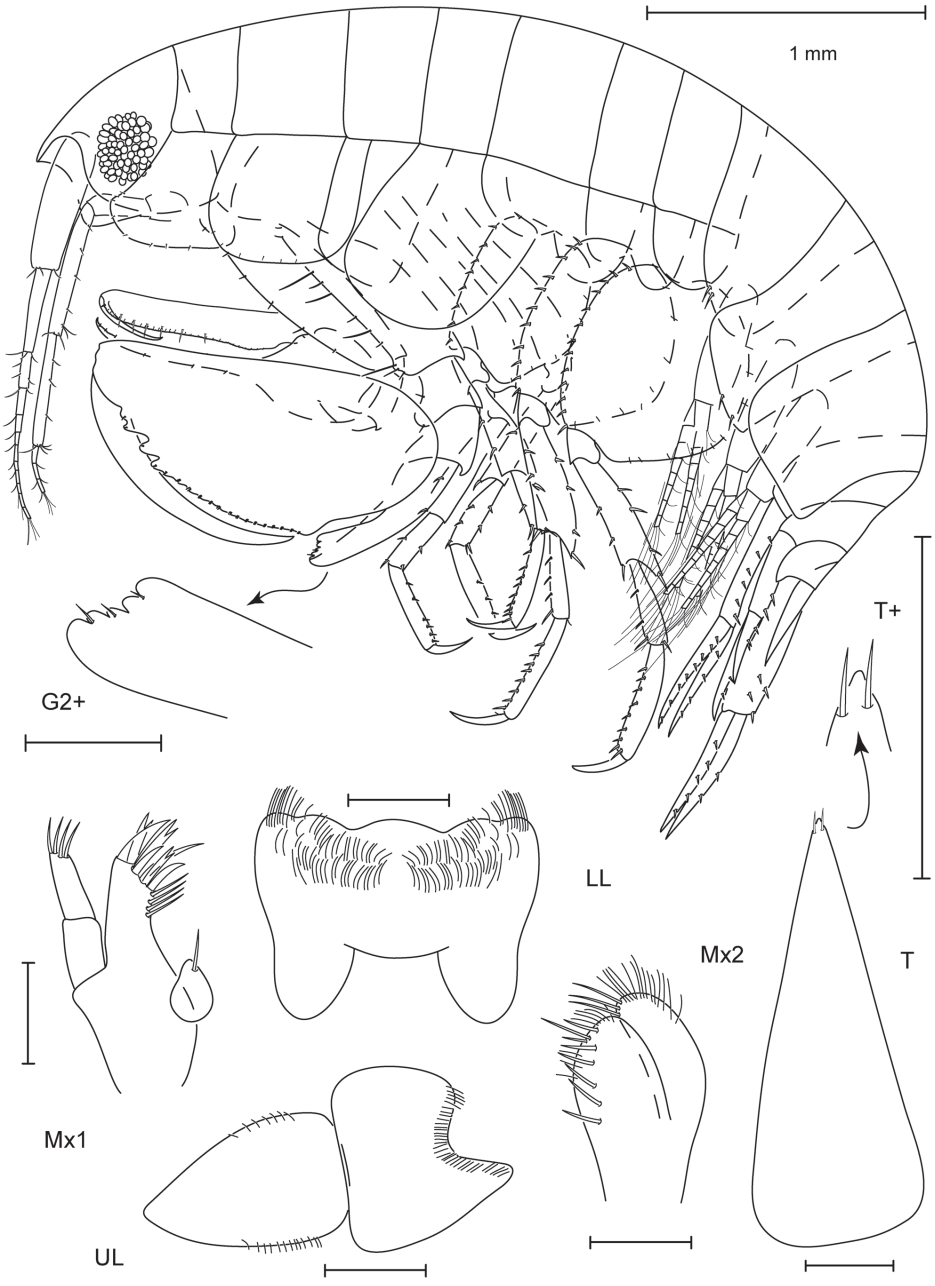

Figure 13. *Leucothoe vulgaris* sp. n., holotype male, 4.8 mm, RUMF-ZC-1672.

bare; carpus linear, length 14.2 × width, proximal margin dentate, distal margin with 3 short setae; propodus straight, palm dentate with 6 distal setae; dactylus smooth, reaching 0.3 × propodus length. Gnathopod 2 coxa broader than long, subequal to coxa 3, smooth, with tiny marginal setae, anterodistally rounded, distal margin straight,

posterior margin straight, facial setae absent; basis linear, with two small anterodistal tubercles, anterior margin with 11 short and long setae, posterior margin bare; ischium with 2 anterior setae; carpus 0.3 × propodus length, curved, distally truncate, expanded, anterior margin dentate; propodus with 1 mediofacial setal row displaced below midline, reaching 0.8 × propodus length, with 1 row of submarginal setae, posterior margin smooth, palm convex with 3 major tubercles; dactylus curved, proximal margin smooth, bare, anterior margin distally subacute, reaching 0.6 × propodus length. Pereopod 3 coxa length 1.5 × width, anterodistal corner overriding distal face of coxa 2, extending below it, smooth, with tiny marginal setae, anterior margin straight, distal margin oblique, posterior margin straight, facial setae absent. Pereopod 4 coxa smooth, bare, anterior margin produced, distal margin evenly rounded, posterior margin excavate, facial setae absent. Pereopods 5–7 coxae facial setae absent; bases posteriorly tapered, width length ratios 1: 1.3, 1: 1.3, 1: 1.1; posterior margins smooth, setose.

Pleon. Epimeron 1 with tuft of anteroventral setae, epimeron 2 with ventral setae, epimeron 3 bare; epimeron 3 posteroventral corner subquadrate. Uropods 1–3 relative lengths 1.0: 0.8: 1.1. Uropod 1 peduncle and outer ramus subequal in length with inner ramus; inner ramus with 4 robust seta; outer ramus with 8 robust setae. Uropod 2 peduncle 0.7 × inner ramus length; outer ramus 0.6 × inner ramus length; inner ramus with 3 robust seta; outer ramus with 2 robust setae. Uropod 3 peduncle 1.1 × inner ramus length; outer ramus 0.9 × inner ramus length; inner ramus with 2 robust seta; outer ramus with 5 robust setae. Telson 2.5 × longer than wide, apex with strong point.

Female (sexually dimorphic characters). Gnathopod 1 basis anterior margin with 10 short setae; carpus distal margin with 4 short setae; propodus palm with 4 distal setae. Gnathopod 2 basis without tubercles, anterior margin with 13 short and long setae; ischium proximal ridge of 3 setae, 1 distal seta, and 1 posterodistal seta; carpus distal end slightly expanded; propodus palm with smaller tubercles.

Etymology. After the Latin 'vulgaris', meaning 'common, commonplace' and referring to the widespread distribution and the apparent lack of host specificity of this species.

Ecology. In branchial chamber of solitary ascidians, *Pyura* sp.(Fig. 18E); *Pyura microcosmus* (Fig. 18D); *Rhopalaea circula* (Fig. 18F); compound ascidians, *Clavelina* sp. (Fig. 18C); purple hard sponge with small holes; *Haliclona* of Grant, 1836 (blue sponge); *Callyspongia* of Duchassaing & Michelotti, 1864 (beige sponge); and coral rubble.

Relationships. *Leucothoe vulgaris* is part of the "*L. commensalis* group" in the same aspects that *L. trulla* is similar (see 'Relationships' under *L. trulla*). *Leucothoe vulgaris* differs from these species in having a setose epistome (smooth in reports of all *Leucothoe* species), a dentate surface on right mandible lacinia mobilis, and a telson with a strong point (most *Leucothoe* species have a tridentate apex).

Remarks. *Leucothoe vulgaris* has a distinct red "saddleback" color pattern found in ascidian-dwelling leucothoids worldwide and yellow antennae (Fig. 17A). This species is widespread throughout the Ryukyu Archipelago, inhabiting many species of ascidians and sponges.

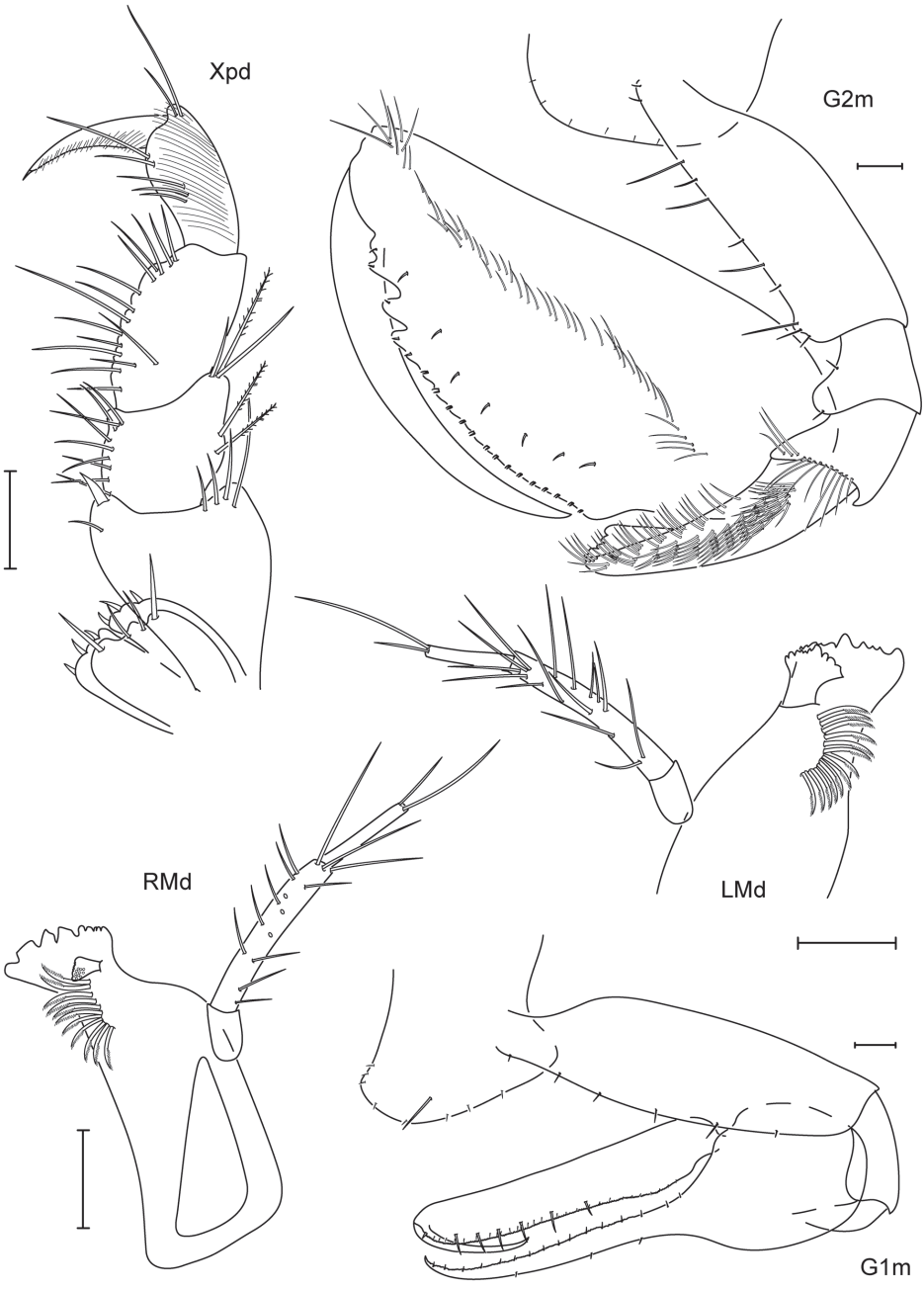

Figure 14. *Leucothoe vulgaris* sp. n., holotype male, 4.8 mm, RUMF-ZC-1673.

Distribution. East China Sea: Okinawa–jima Island, Iriomote–jima Island, Ishigaki–jima Island (all Okinawa), Okinoerabu–jima Island, Yoron–jima Island, Tokunoshima Island, Amami–oshima Island, and Yakushima Island (all Kagoshima), Japan.

***Paranamixis* Schellenberg, 1838**
http://species-id.net/wiki/Paranamixis

Generic diagnosis. (Anamorph males) Antennae relatively long. Eyes with 10 or more ocelli. Maxilliped inner plates generally fused or vestigial; outer plates lacking inner lobes. Coxa 1 greatly reduced, remainder of gnathopod 1 absent, occasionally a small vestige in transformational males.

***Paranamixis thomasi* sp. n.**
urn:lsid:zoobank.org:act:92DBD2E7-7C94-40BF-8595-A67059E2231E
http://species-id.net/wiki/Paranamixis_thomasi
Figs 15, 16

Type material. Holotype male, 2.6 mm, RUMF-ZC-1690, Sunabe Seawall reef (26°19'25"N, 127°44'43"E), coral rubble, 7–10 m, K.N. White and N.S. White col., 5 October 2010 (KNWOkinawa12D). Paratype male, 2.6 mm, RUMF-ZC-1692, Toguchi Beach patch reef (26°21'47"N, 127°44'12"E), coral rubble, 1–3 m, K.N. White and N.S. White col., 3 February 2011 (KNWOkinawa28B). Paratype female, 2.3 mm, RUMF-ZC-1691, same station data as holotype.

Type locality. Sunabe Seawall, Okinawa, Japan (26°19'25"N, 127°44'43"E).

Additional Material Examined. 2 anamorphs, 15 leucomorphs, RUMF-ZC-1693, KNWOkino1B; 2 anamorphs, 19 leucomorphs, NSMT - Cr21835, KNWJap10-9-8A; 1 anamorph, 3 leucomorphs, RUMF-ZC-1694, KNWOkinawa20A; 1 anamorph, 12 leucomorphs, NSMT- Cr21836, KNWOkinawa14G; 1 leucomorph, RUMF-ZC-1700, KNWOkinawa14G; 14 leucomorphs, RUMF-ZC-1695, KNWTokuno4F; 1 anamorph, RUMF-ZC-1696, KNWOkinawa36D; 1 anamorph, RUMF-ZC-1697, KNWOkinawa38D; 1 anamorph, NSMT - Cr21837, KNWIshigaki4J; 1 anamorph, RUMF-ZC-1694, KNWOkinawa47F.

Diagnosis (male). Terminal anamorph head with lateral ridge, anterodistal margin quadrate with cusp. Maxilliped inner plates with small cleft. Coxa 1 anterodistally subtriangular, bi-cuspidate; gnathopod 1 absent. Gnathopod 2 coxa anterior margin expanded with cusp; basis with anterodistal serrate ridge; propodus with 2 mediofacial setal rows, posterior margin serrate; dactylus proximal margin with 1 tubercle and 2 plumose setae. Sub-terminal female Head. Anterior margin truncate. Mandibular palp 1-articulate. Gnathopod 1 carpus terminal ornamentation consisting of 2 serrate blades; propodus palm with 7 sets of 3 setae. Gnathopod 2 propodus palm with 6 major tubercles.

Description (Anamorph male). Head with lateral ridge. Anterior margin oblique, anterodistal margin quadrate with cusp; ventral cephalic keel anterior margin excavate, anteroventral margin subquadrate, ventral margin excavate; eyes with more than 10 ommatidia, round. Antenna 1 0.4 × body length, flagellum 7–articulate, peduncle article 1 width less than 2 × article 2, accessory flagellum absent, aesthetascs present. Antenna 2

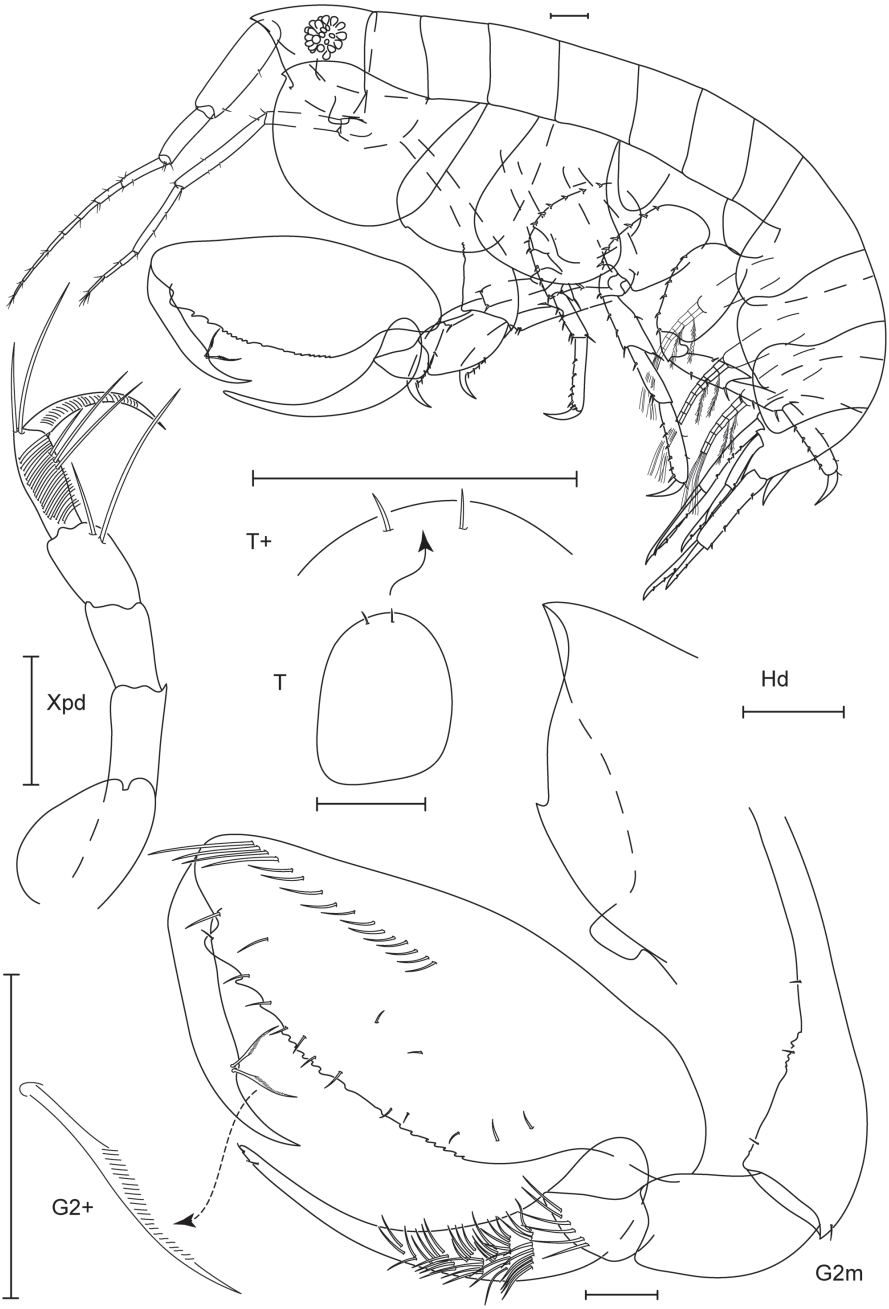

Figure 15. *Paranamixis thomasi* sp. n., holotype male, 2.6 mm, RUMF-ZC-1690.

0.4 × body length, subequal in length with antenna 1, flagellum 3–articulate. Mouthparts reduced. Maxilliped inner plates with small cleft, bare; outer plate inner margin smooth, reaching 0.1 × palp article 1, bare; palp 4–articulate, article 4 elongate, distally acute.

Pereon. Coxae 1–4 relative widths 1.0: 2.5: 1.6: 2.1. Gnathopod 1 coxa smooth, bare, anterodistal margin produced, subtriangular, bi-cuspidate, distal margin oblique, posterior margin straight, facial setae absent. Gnathopod 1 absent. Gnathopod 2 coxa broader than long, greatly enlarged, smooth, with tiny marginal setae, anterior margin expanded with cusp, anterodistally rounded, distal margin evenly rounded, posterior margin straight, facial setae absent; basis anterodistally expanded, with anterodistal serrate ridge, anterior margin 3 short setae, posterior margin bare; ischium bare; carpus 0.7 × propodus length, curved, distally tapered, anterior margin smooth; propodus with 2 mediofacial setal rows, primary mediofacial setal row above midline, reaching 0.4 × propodus length, secondary mediofacial setal row with 4 setae, with 1 row of submarginal setae, posterior margin serrate, palm convex with 3 major and several minor tubercles; dactylus curved, proximal margin with 1 tubercle and 2 plumose setae, anterior margin distally acute, reaching 0.4 × propodus length. Pereopod 3 coxa length 1.3 × width, anterodistal corner overriding distal face of coxa 2, not extending below it, smooth, with tiny marginal setae, anterior margin expanded, distal margin slightly convex with cusp, posterior margin straight, facial setae absent. Pereopod 4 coxa smooth, with tiny marginal setae, anterior margin produced, distal margin evenly rounded, posterior margin excavate, facial setae absent. Pereopods 5–7 coxae facial setae absent; bases width length ratios 1: 1.4, 1: 1.5, 1: 1.5; posterior margins smooth, setose.

Pleon. Epimera 1–2 with ventral setae, epimeron 3 bare; epimeron 3 posteroventral corner rounded. Uropods 1–3 relative lengths 1.0: 0.7: 0.9. Uropod 1 peduncle subequal in length with inner ramus; outer ramus 0.9 × inner ramus length; inner ramus with 1 robust seta; outer ramus with 4 robust setae. Uropod 2 peduncle 0.8 × inner ramus length; outer ramus 0.6 × inner ramus length; inner ramus with 3 robust setae; outer ramus with 2 robust setae. Uropod 3 peduncle 1.1 × inner ramus length; outer ramus length 0.6 × inner ramus length; inner ramus with 3 robust setae; outer ramus with 2 robust setae. Telson 1.3 × longer than wide, apex rounded.

Leucomorph (juvenile and sexually dimorphic characters). Head. Anterior margin truncate, anterodistal margin subquadrate; ventral cephalic keel anterior margin truncate, anteroventral margin produced, ventral margin straight; eyes with more than 10 ommatidia, round. Antenna 1 0.3 × body length, flagellum 8–articulate. Antenna 2 0.3 × body length, shorter than antenna 1, flagellum 3–articulate. Mandibles lacking molars, palp 1–articulate with 2 distal setae, incisors weakly dentate, left mandible with 5 raker spines, lacinia mobilis large; right mandible with 5 raker spines, lacinia mobilis small. Upper lip asymmetrically lobate, anterior margin setose. Lower lip inner lobes fused, bare; outer lobes with small gape, anterior margins setose. Maxilla 1 palp 1–articulate with 3 distal setae; outer plate with 2 distal robust setae, 6 distal setae. Maxilla 2 inner plate with 2 distal setae; outer plate with 2 distal setae, facial setae present. Maxilliped inner plates fused, distal margin with v-shaped indentation, with short robust setae; outer plate inner margin smooth, reaching 0.2 × palp article 1, with 4 simple marginal setae; palp 4–articulate, article 4 subequal in length with article 3, distally acute.

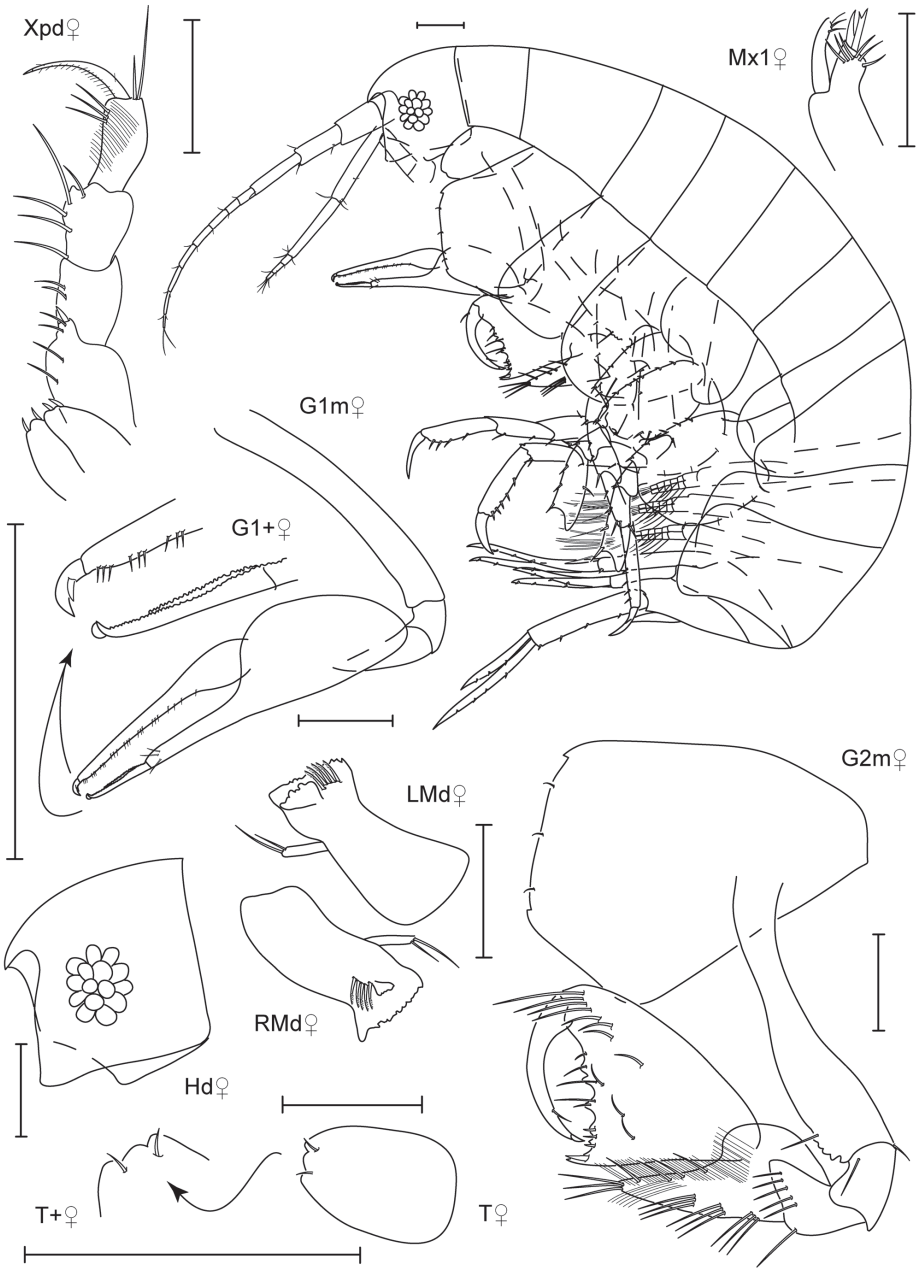

Figure 16. *Paranamixis thomasi* sp. n., paratype female, 2.3 mm, RUMF-ZC-1691.

Pereon. Coxae 1–4 relative widths 1.0: 1.4: 0.9: 1.4. Gnathopod 1 coxa smooth, bare, anterodistal margin rounded, distal margin oblique, posterior margin straight, facial setae absent; basis linear, anterior and posterior margins bare; ischium bare; carpus linear, length 16 × width, proximal margin smooth, with terminal serrate blades and

bulbous tip, distal margin with 1 short seta; propodus proximally inflated, palm smooth with 7 sets of 3 proximal setae; dactylus smooth, with large proximal spine, reaching 0.1 × propodus length. Gnathopod 2 coxa equally as long as broad, slightly larger than coxa 3, smooth, with tiny marginal setae, anterior margin expanded, anterodistally subquadrate with cusp, distal margin straight, posterior margin tapered with posteroventral cusp; basis distally expanded, with 4 small anterodistal tubercles; ischium with 1 posterodistal seta; carpus 0.4 × propodus length, straight, distally tapered, anterior margin smooth; propodus with 1 mediofacial setal row displaced to midline, reaching 0.4 × propodus length, with 1 row of submarginal setae, posterior margin smooth, palm subtriangular with 6 major tubercles; dactylus proximal margin smooth, setose, anterior margin distally acute, reaching 0.3 × propodus length. Pereopod 3 coxa length 1.8 × width, smooth, with tiny marginal setae, anterior margin straight, distal margin slightly convex, posterior margin straight, facial setae absent. Pereopod 4 coxa smooth, with tiny marginal setae, anterior margin straight, distal margin evenly rounded, posterior margin tapered, facial setae absent. Pereopods 5–7 coxae facial setae absent; bases width length ratios 1: 1.2, 1: 1.1, 1: 1.2, posterior margins smooth, setose.

Pleon. Epimera 1–2 with ventral setae; epimeron 3 bare, posteroventral corner subquadrate. Uropods 1–3 relative lengths 1.0: 0.7: 1.3. Uropod 1 peduncle 0.6 × inner ramus; outer ramus 0.9 × inner ramus; inner and outer rami each with 3 robust setae. Uropod 2 peduncle and outer ramus 0.6 × inner ramus; inner and outer rami each with 3 robust setae. Uropod 3 peduncle subequal in length with inner ramus; outer ramus 0.6 × inner ramus length; inner ramus with 4 robust setae; outer ramus with 3 robust setae. Telson 1.6 × longer than wide, apex tridentate.

Etymology. Named for Dr. James Darwin Thomas in recognition of his contribution to amphipod taxonomy, particularly regarding the Leucothoidae. Dr. T has been a mentor and friend for the past 10 years and the first author is very grateful for all his support.

Relationships. *Paranamixis thomasi* is similar to *P. aberro* in having a cuspate anteroventral head margin and an enlarged gnathopod 2 coxa. *Paranamixis thomasi* differs in having a serrate ridge on the gnathopod basis instead of a large tubercle and in having plumose setae on the dactylus. *Paranamixis thomasi* is similar to *P. misakiensis* in having the head with a lateral ridge, maxilliped outer plate with a small cleft, an enlarged gnathopod 2 coxa, and a serrate ridge on the gnathopod 2 basis anterior margin. *Paranamixis thomasi* differs from this species in having a single cusp on the anteroventral head margin, a smaller serrate ridge on the gnathopod 2 basis, and smooth gnathopod 2 carpus and dactylus inner margins.

Ecology. In the branchial chamber of the solitary ascidian, *Pyura* sp. (Fig. 18E); and coral rubble.

Remarks. Both anamorphs and leucomorphs are translucent with magenta-pink stripes along the pereonite edges (Figs 17G, H). When collected in an ascidian, one anamorph and two leucomorphs were collected together from one branchial chamber.

Distribution. East China Sea: Okinawa–jima Island, Ishigaki–jima Island, and Iriomote–jima Island (all Okinawa), Tokunoshima Island and Okinoerabu–jima Island (both Kagoshima), Japan.

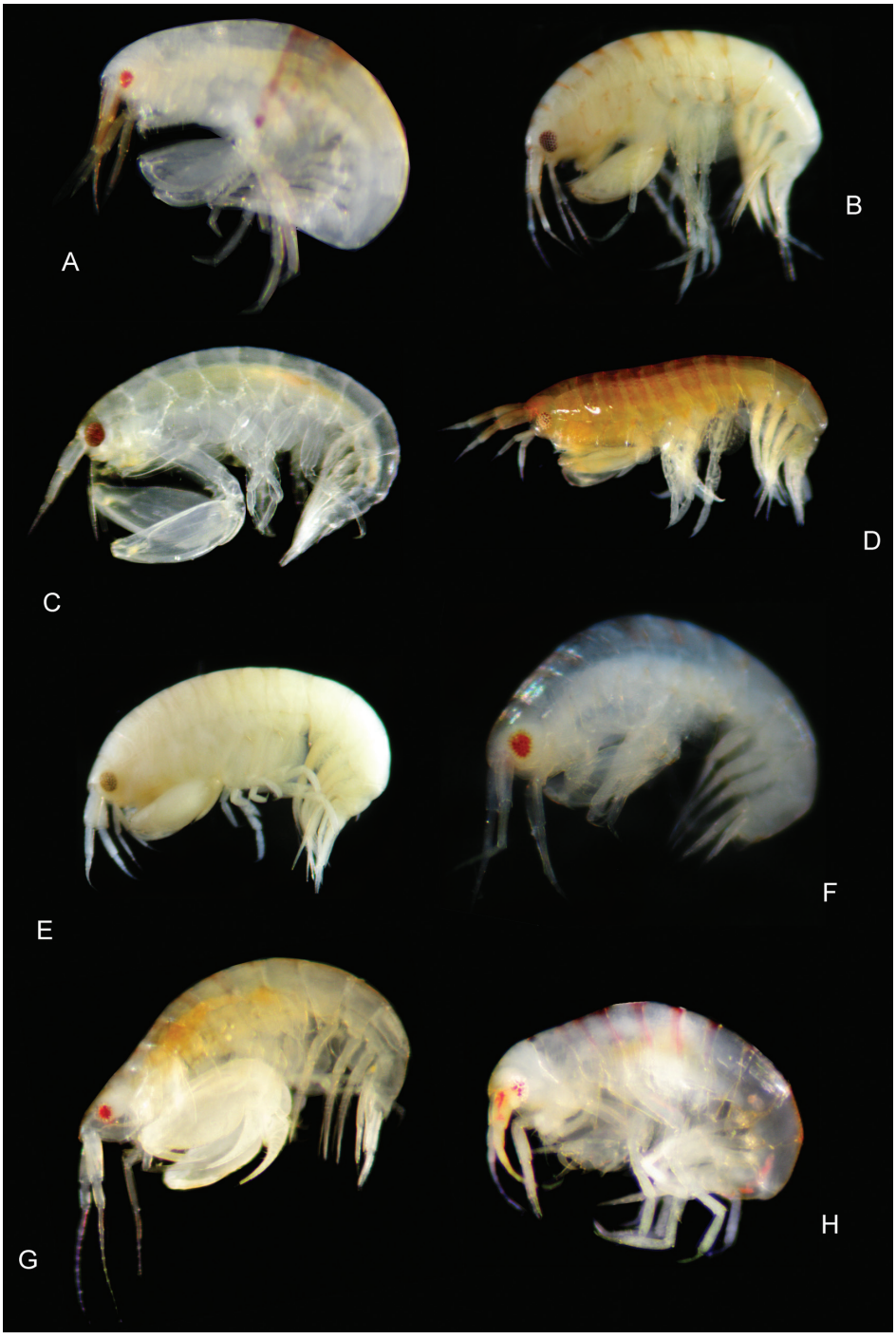

Figure 17. Color plate of new leucothoid amphipod species. **A** *Leucothoe vulgaris* sp. n. **B** *Leucothoe amamiensis* sp. n. **C** *Leucothoe elegans* sp. n. **D** *Leucothoe nathani* sp. n. **E** *Leucothoe obuchii* sp. n. **F** *Leucothoe trulla* sp. n. **G** *Paranamixis thomasi* sp. n. anamorph **H** *Paranamixis thomasi* sp. n. leucomorph

Identification Key to ascidian-dwelling Leucothoidae of the Ryukyu Archipelago

1 Extreme sexual dimorphism; gnathopod 1 absent in post-transformational males; gnathopod 1 carpus with terminal serrate blades in females and pre-transformational males.....***Paranamixis thomasi***

– Minimal sexual dimorphism; gnathopod 1 always present, without terminal ornamentation **2**

2 Gnathopod 1 dactylus reaching no more than 0.2 × propodus length; gnathopod 2 carpus distally tapered; pereopods 5–7 bases narrow, oval in shape....**3**

– Gnathopod 1 dactylus reaching at least 0.3 × propodus length; gnathopod 2 carpus distally truncate or with subdistal tooth; pereopods 5–7 bases wide, posteriorly tapered **5**

3 Anterior head margin truncate; gnathopod 1 propodus palm dentate; gnathopod 2 carpus reaching less than 0.4 × propodus length; pereopods 5–7 bases posteriorly serrate; female gnathopod 1 basis posterior margin with ~15 setae..... ***Leucothoe elegans***

– Anterior head margin rounded; gnathopod 1 propodus palm smooth; gnathopod 2 carpus reaching between 0.4 and 0.6 × propodus length; pereopods 5–7 bases posteriorly smooth ; female gnathopod 1 basis posterior margin bare or with 1 seta.....**4**

4 Antenna 1 accessory flagellum absent; maxilla 2 inner plate with serrate robust setae; maxilliped inner plate smooth; male gnathopod 1 basis distally expanded, carpus basally inflated, proximal margin smooth, propodus straight; gnathopod 2 propodus mediofacial setal row with dense tufts of setae ....***Leucothoe nathani***

– Antenna 1 accessory flagellum 1–articulate; maxilla 2 inner plate with simple robust setae; maxilliped outer plate inner margin tuberculate; male gnathopod 1 basis centrally widened, carpus linear, proximal margin dentate, propodus inflated; gnathopod 2 propodus mediofacial setal row sparse single setae .....***Leucothoe obuchii***

5 Maxilla 1 palp 1–articulate, margins constricted; mandibular palp article 2 with 5 distal setae; male gnathopod 2 carpus distally spoon-like, propodus mediofacial setal row reaching less than 0.7 × propodus length; telson apex tridentate..... ***Leucothoe trulla***

– Maxilla 1 palp 2-articulate; mandibular palp article 2 with 15–17 distal setae; male gnathopod 2 carpus not spoon-like distally or with subdistal tooth, propodus mediofacial setal row reaching greater than 0.7 × propodus length; telson apex strongly pointed or truncated **6**

6 Antenna 1 accessory flagellum absent; coxae 1–7 without facial setae; gnathopod 1 basis anterior margin with 6 setae, carpus proximal margin dentate; gnathopod 2 carpus distally truncate; telson apex strongly pointed ....***Leucothoe vulgaris***

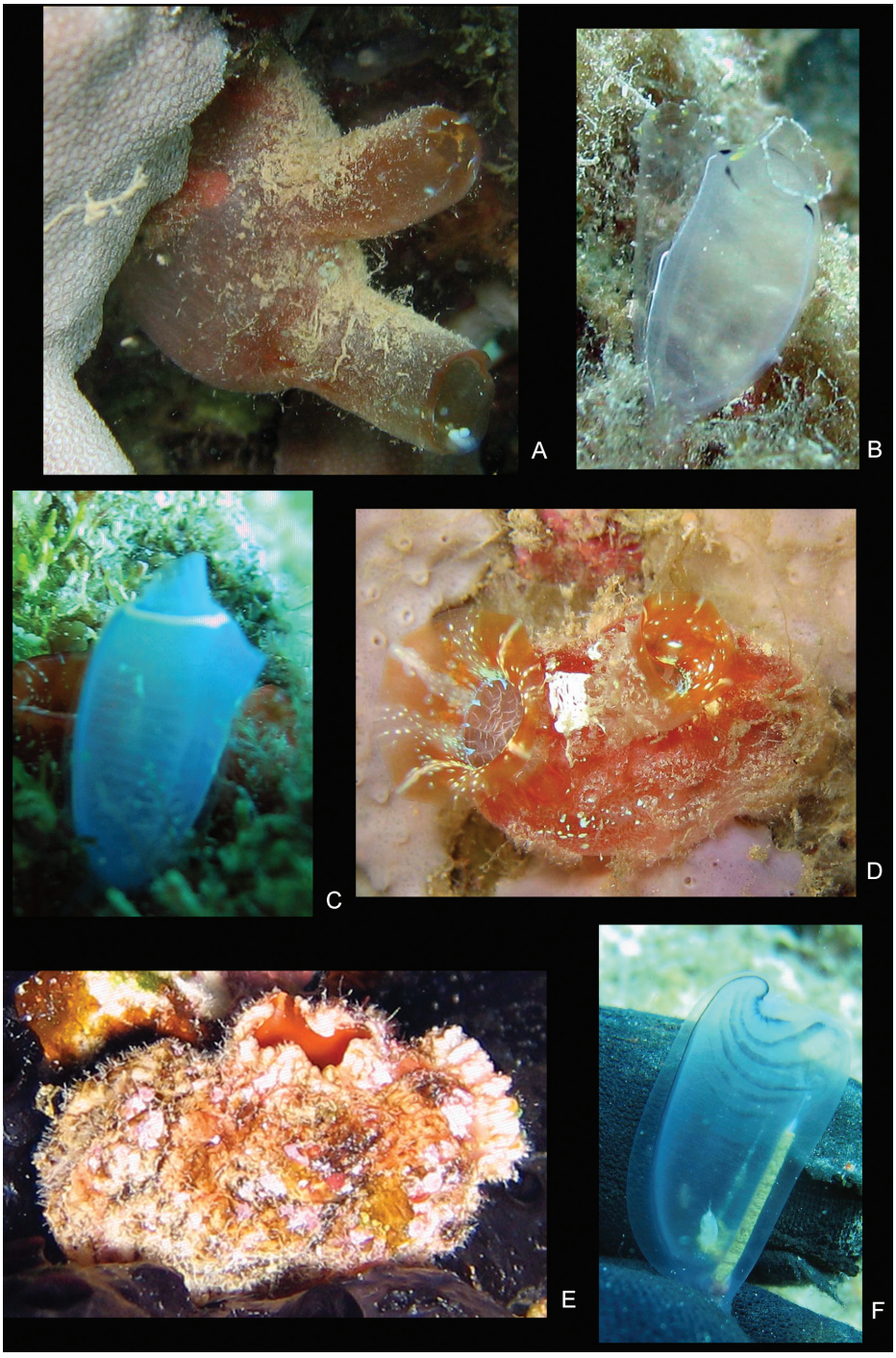

Figure 18. Color plate of ascidian hosts. **A** *Herdmania* of Lahille, 1888 **B** *Rhopalaea* of Phillippi, 1843 **C** *Clavelina* of Savigny, 1816 **D** *Pyura microcosmus* (Savigny, 1816) **E** *Pyura* of Molina, 1782 **F** *Rhopalaea circula* Monniot & Monniot, 2001.

– Antenna 1 accessory flagellum 1-articulate; coxae 1–7 with facial setae; gnathopod 1 basis anterior margin with 13–16 setae, carpus proximal margin smooth; gnathopod 2 carpus with large subdistal tooth; telson apex truncated ..... ***Leucothoe amamiensis***

Discussion

The six *Leucothoe* species described here share the displaced gnathopod 2 propodus mediofacial setal row, a character common to ascidian-dwelling species worldwide. It is likely that this character is an artifact of convergent evolution in species adapting to feeding within similar hosts rather than evidence of relationships between species. *Leucothoe amamiensis*, *L. elegans*, and *L. trulla* each have a small accessory flagellum on antenna 1. This character is unusual in leucothoid species and apparently much more common in Pacific species than in Caribbean species. It is particularly interesting because these three species have limited distributions in the Ryukyu Archipelago.

The currently recognized biogeographic boundaries (Hikida and Ota 1997; Ota 1998) do not appear to apply to leucothoid amphipods in the Ryukyu Archipelago despite their restricted distributions. There are some interesting distributional patterns evident in some species, while others, such as *L. vulgaris* and *P. thomasi*, are found throughout the entire archipelago. It is possible that these patterns in amphipod distributions are partly attributable to the ephemeral nature of their ascidian hosts. Numbers of ascidian species and individuals in the Ryukyu Archipelago appear to be much higher in the winter months than in the summer. A similar pattern is evident for leucothoid amphipods.

Interesting distributional patterns were observed in *Leucothoe obuchii*, which has been collected from Oura–wan Bay on the northeastern coast of Okinawa–jima Island as well as from two of the northernmost Ryukyu islands, Amami–oshima Island and Yakushima Island; and in *Leucothoe elegans*, which has only been collected from Yakushima Island and Shioya Bay on the northeastern coast of Okinawa–jima Island. Both Oura–wan and Shioya bays on the northeastern coast of Okinawa–jima Island are muddy and are ecologically very different from most of the environments on Okinawa–jima Island (Shokita et al. 2002; Naruse et al. 2009). These muddy bays also are very different from the coral reef habitats in the northern Ryukyu Islands that *L. obuchii* and *L. elegans* were collected from.

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References

Barnard JL (1959) Estuarine Amphipoda. In: Barnard JL, Reish DJ (Eds) Ecology of Amphipoda and Polychaeta of Newport Bay, California. Allan Hancock Foundation Publications Occasional Paper 21: 13–69.

Barnard JL (1970) Sublittoral Gammaridea (Amphipoda) of the Hawaiian Islands. Smithsonian Contributions to Zoology 34: 1–286. doi: 10.5479/si.00810282.34

Bate CS (1857) A synopsis of the British edriophthalmous Crustacea. Annals and Magazine of Natural History, series 2, 19: 135–152.

Coleman CO (2003) "Digital inking": how to make perfect line drawings on computers. Organisms Diversity and Evolution 3 Electronic Supplement 14: 1–14.

Costa A (1853) Relazione sulla memoria del Dottor Achille Costa, di ricerche su' crostacei amfipodi del regno di Napoli. Rendiconto della Societa Reale Borbonica, Accademia delle Scienze, new series 2: 167–178.

Duchassaing De Fondbressin P, Michelotti G (1864) Spongiaires de la mer Caraibe. Natuurkundige verhandelingen van de Hollandsche maatschappij der wetenschappen te Haarlem 21(2): 1–124.

Grant RE (1836) Animal Kingdom. In: Todd RB (Ed) The Cyclopaedia of Anatomy and Physiology. Volume 1. Sherwood, Gilbert, and Piper, London, 107–118.

Gurjanova E (1951) [Amphipoda Gammaridae from the seas of USSR and vicinity]. Opredeliteli Faune SSR Zoologicheskii Institut Akademii Nauk SSSR 41: 1–1029. [in Russian]

Haswell WA (1879) On Australian Amphipoda. Proceedings of the Linnean Society of New South Wales 4: 245–279.

Hikida T, Ota H (1997) Biogeography of reptiles in the subtropical East Asian Islands. In: Kue KY, Chen TH (Eds) Proceedings of the Symposium on the Phylogeny, Biogeography and Conservation of Fauna and Flora of East Asian Region, Taipei (Taiwan), 1997. Department of Biology, National Taiwan Normal University and National Science Counsil, ROC, 11–28.

Hirayama A (1983) Taxonomic studies on the shallow water Gamarridean Amphipoda of west Kyushu, Japan I. Acanthonotozomatidae, Ampeliscidae, Ampithoidae, Amphilochidae, Anamixidae, Argissidae, Atylidae, & Colomastigidae. Publications of the Seto Marine Biological Laboratory 28: 75–150.

Hirayama A (1985) Taxonomic studies on the shallow water Gammaridean Amphipoda of west Kyushu, Japan V. Leucothoidae, Liljeborgiidae, Lysisanassidae (*Prachynella, Aristias,*

Waldeckia, Ensayara, Lepidepecreum, Hippomedon, & Anonyx). Publications of Seto Marine Biological Laboratory 30: 167–212.

Hirayama A (1992) New species of Leucothoidae (Crustacea, Amphipoda) from Hong Kong. Asian Marine Biology 9: 111–116.

Hughes TP, Bellwood DR, Connolly SR (2002) Biodiversity hotspots, centers of endemicity, and the conservation of coral reefs. Ecology Letters 5: 775–784. doi: 10.1046/j.1461-0248.2002.00383.x

Ishimaru SI (1985) A new species of the genus *Leucothoe* (Amphipoda, Gammaridea, Leucothoidae) from Japan. Proceedings of the Japanese Society of Systematic Zoology 30: 46–52.

Kizaki K, Oshiro I (1977) [Paleogeography of the Ryukyu Islands]. Marine Science Monthly 9: 542–549. [in Japanese with English abstract]

Kizaki K, Oshiro I (1980) [The origin of the Ryukyu Islands]. In: Kizaki K (Ed) Natural history of the Ryukyus. Tsukiji–Shokan, Tokyo, 8–37. [in Japanese]

Krapp-Schickel T (1975) Revision of Mediterranean *Leucothoe* species (Crustacea, Amphipoda). Bollettino del Museo Civico di Storia Naturale di Verona 2: 91–118.

Lahille F (1888) Etude systématique des tuniciers. Comptes Rendu Association Française pour l'Avancement des Sciences 1887(2): 667–677.

Leach WE (1814) Crustaceology. In: Brewster D (Ed) The Edinburgh Encyclopedia, Blackwood, Edinburgh 7(2): 383–437.

Ledoyer M (1973) Etude systématique des Amphipodes recueillis a tuléar (Madagascar) lors d'une série de péches a la lumière. Comparison avec les phénomènes observés en Méditerranée. Tethys Supplement 5: 37–50.

Michener CD (1969) Comparative social behavior of bees. Annual Revue of Entomology 14: 299–342. doi: 10.1146/annurev.en.14.010169.001503

Molina GI (1782) Saggito sulla storia naturale del Chili. Animali del Chili, Bolonga, 367 pp.

Monniot F, Monniot C (2001) Ascidians from the tropical western Pacific Zoosystema 23(2): 201–383.

Montagu G (1804) Description of several marine animals found on the south coast of Devonshire. Transactions of the Linnean Society of London 7: 61–85. doi: 10.1111/j.1096-3642.1804.tb00282.x

Nagata K (1963) Two new Gammaridean amphipods (Crustacea) collected by the second cruise of the Japanese Expedition of Deep Sea (JEDS-2). Publications of Seto Marine Biological Laboratory 11: 1–5.

Naruse T, Fujita Y, Ng PKL (2009) A new genus and species of symbiotic crab (Crustacea: Brachyura: Pinnotheroidea) from Okinawa, Japan. Zootaxa 2053: 59–68.

Oshel PE, Steele DH (1988) Comparative morphology of amphipod setae, and a proposed classification of setal types. Crustaceana Supplement 13: 90–99.

Ota H (1998) Geographic patterns of endemism and speciation in amphibians and reptile of the Ryukyu Archipelgao, Japan, with special reference to their paleogeographical implications. Researches on Population Ecology 40: 189–204. doi: 10.1007/BF02763404

Ota H, Toda M, Masunaga G, Kikukawa A, Toda M (2004) Feral populations of amphibians and reptiles in the Ryukyu Archipelago, Japan. Global Environmental Research, 8(2): 133–143.

Phillippi A (1843) Rhopalaea ein neues genus der einfachen ascidian. Archiv für Anatomie und Physiologie 1: 45–47.

Shokita S, Nagai T, Fujita Y, Naruse T, Ito A, Nagamatsu T, Yamazaki T, Shinjo K, Nagata Y (2002) [Distribution and abundance of crustaceans in the Ohura River Mangrove Swamp of Okinawa–jima Island, Japan]. A Comprehensive Study for Mangrove Ecosystem in Okinawa, 73–86.

Roberts CM, McClean CJ, Veron JEN, Hawkins JP, Allen GR, McAllister DE, Mittermeier CG, Schueler DE, Spalding M, Wells F, Vynne C, Werner TB (2002) Marine biodiversity hotspots and conservation priorities for tropical reefs. Science 295: 1280–1284. doi: 10.1126/science.1067728

Robertson D (1893) A second contribution towards a catalogue of the Amphipoda and Isopoda of the Firth of Clyde and West of Scotland. Proceedings and Transactions of the Natural History Society of Glascow 3: 199–223.

Savigny JC (1816) Memoires sur les Animaux sans vertebres. Permiere partie. Description et classification des animaux invertebres et articules, connus sous les noms de Crustaces, d'Insectes, d'Annelides, etc. Chez Deterville, Paris, 84 pp.

Schellenberg A (1938) Litorale Amphipoden des tropischen Pazifiks nach Sammlungen von Prof. Bock (Stockholm), Prof. Dahl (Berlin) und Prof. Pietschmann (Wein). Kungliga Svenska Vetenskapsakademiens Handlingar Series 3 16: 1–105.

Stebbing TRR (1897) Amphipods from the Copenhagen Museum and Other Sources. Transactions of the Linnean Society of London, (2 Zoology) 7: 25–45.

Stebbing TRR (1899) Revision of Amphipoda (continued). Annals and Magazine of Natural History, series 7 4: 205–211.

Stimpson W (1856) Descriptions of some of the new marine invertebrate from the Chinese and Japanese Seas. Proceedings of the Academy of Natural Science of Philadelphia 7: 375–384.

Thomas JD (1997) Systematics, ecology, and phylogeny of the Anamixidae (Crustacea, Amphipoda). Records of the Australian Museum 49: 35–98. doi: 10.3853/j.0067-1975.49.1997.298

Thomas JD, Barnard JL (1983) Transformation of the *Leucothoides* morph into the *Anamixis* morph (Amphipoda). Journal of Crustacean Biology 3: 154–157. doi: 10.2307/1547860

Thomas JD, Klebba KN (2007) New species and host associations of commensal leucothoid amphipods from coral reefs in Florida and Belize (Crustacea, Amphipoda). Zootaxa 1494: 1–44.

Vinogradov GM (1990) [Pelagic amphipods (Amphipoda, Crustacea) from the south–eastern Pacific]. Akademija Nauk SSSR, Trudy Instituta Okeanologii 124: 27–104. [in Russian]

White KN (2010) Development of representative species-level molecular markers and morphological character analysis of leucothoid amphipods (Crustacea: Amphipoda). PhD thesis, Hattiesburg, Mississippi, USA: The University of Southern Mississippi.

White KN (2011) A taxonomic review of the Leucothoidae (Crustacea: Amphipoda). Zootaxa 3078: 1–113.

White KN, Thomas JD (2009) Leucothoidae. In: Lowry JK, Myers AA (Ed) Amphipoda (Crustacea, Peracarida) of the Great Barrier Reef, Australia. Zootaxa 2260: 494–555.

Appendix I

Detailed list of collection stations. (doi: 10.3897/zookeys.163.2003.app) File format: Excel spreadsheet (xls).

Explanation note: Appendix I contains station numbers, collection localities, sample descriptions, latitudes, longitudes, dates, depths, and collectors of each collection event.

Citation: White KN, Reimer JD (2012) Commensal Leucothoidae (Crustacea, Amphipoda) of the Ryukyu Archipelago, Japan. Part I: ascidian-dwellers. ZooKeys 163: 13–55. doi: 10.3897/zookeys.163.2003.app

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A new species and first record of the genus *Triacanthella* Schäffer, 1897 (Collembola, Poduromorpha, Hypogastruridae) for Africa

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Abstract

The first species of the genus *Triacanthella* to be recorded from Africa is described. *Triacanthella madiba* **sp. n.** belongs to the Southern Hemisphere group of the genus. It is morphologically closely related to *T. vogeli* Weiner & Najt, 1997 from Chile, and appears to be a gondwanian relict. The new species is also the first *Triacanthella* recorded from a guano habitat.

Keywords

South Africa, Western Cape, gondwanian relict, cave, guano

Introduction

The Cape Floristic Region in Western Cape Province of South Africa is the smallest Floral Kingdom in the world. Although its extraordinary rich flora has been well documented (Rebelo et al. 2006), studies have shown that its arthropods are not well

known (Pryke and Samways 2008). Recent and extensive sampling of the Collembolan fauna of this region, undertaken within a bilateral project between South Africa and France, provided a wealth of new taxa in all groups (Janion et al. 2011). One of the most interesting discoveries was that of a new species of *Triacanthella*, a genus unrecorded from Africa so far. Here we provide the description of this new South African species along with its biogeographical considerations.

The genus *Triacanthella* is phyletically isolated among Hypogastruridae both from a morphological and a molecular point of view (D'Haese 2002, 2003a, 2003b; Greenslade et al. 2011). It contains 22 species with an intriguing distribution, reflecting a complex and probably ancient history: six including the generotype are found in Europe and Asia, eight species in Australia and New-Zealand, seven species in South America and one species in North America. Almost all species are endemic or micro-endemic and restricted to narrow ecological niches (Salmon 1941; de Izarra 1971; Cassagnau and Deharveng 1974). They mostly occur in epigean habitats, from warm littoral habitats to permanently cold habitats of high Mediterranean mountains and humid and fresh lowland habitats in southern Australia and New-Zealand. The species *T. perfecta* Denis, 1926 has been found once in a cave in southern France, but its normal habitat is forest litter (Arbea and Jordana 1991). Christiansen and Bellinger (1980) also recorded *T. copelandi* (Wray, 1963) once from a cave, but its type locality is not given as a cave in the original description, and there has been no other records of the species so far. The presence of a *Triacanthella* species in the guano of an African cave is therefore a surprising and important discovery.

Materials and methods

The terminology used in the text follows D'Haese (2003a, b), and Fjellberg (1984, 1999) for mouthparts. Abbreviations used in description – **AIIIO**, organite of Ant. III; **Abd. I-VI**, abdominal segments, **Ant. I-IV**, antennal segments; **ms**, S-microchaeta; **S,** S-chaetae; **Th. I-III**, thoracic segments; **Md**, dorsal macrochaeta; **Mdl,** dorso-lateral macrochaeta; **hr**, anal valve chaetae.

Identification key to the Southern Hemisphere *Triacanthella* species

0 Sixth abdominal tergum with rosette-shaped tubercles, South America only...**1**
– Sixth abdominal tergum without rosette-shaped tubercles.....**5**
1 Empodium absent, claw without inner tooth.....**2**
– Empodium present (but rudimentary), claw with two inner teeth.....**3**
2 Ommatidia G similar in size to the other ommatidia, Argentina.....
..... ***Triacanthella michaelseni*** **Schäffer, 1897**

– Ommatidia H and G reduced compared to the other ommatidia, Argentina ..... ***Triacanthella rosae*** **Wahlgren, 1906**

3 Posterior anal spine less than half the size of the other two, dentes without apical lobe, Chile ..... ***Triacanthella vogeli*** **Weiner & Najt, 1997**

– Posterior anal spine at least half the size of the other two, dentes with distinct apical lobe..... **4**

4 Macrochaetae long, half tergite macrochaetal chaetotaxy = 7 / 2, 3, 3 / 4, 4, 4, 4, Chile and Argentina..... ***Triacanthella andina*** **Cassagnau & Rapoport, 1962**

– Macrochaetae short, half tergite macrochaetal chaetotaxy = 8 / 2, 4, 4 / 3, 3, 3, 3, Argentina..... ***Triacanthella najtae*** **de Izarra, 1971**

5 Posterior anal spine at least half the size of the other two **6**

– Posterior anal spine less than half the size of the other two..... **12**

6 Mucro reduced to a small projection (i.e. almost absent)..... **7**

– Mucro well developed..... **8**

7 Colour in alcohol pinkish, Campbell Island..... ***Triacanthella sorenseni*** **Salmon, 1949**

– Colour in alcohol whitish-yellowish, Campbell Island ..... ***Triacanthella alba*** **Carpenter, 1906**

8 Mucro simple and straight **9**

– Mucro more complex with two teeth **10**

9 All ommatidia equally developed, tibiotarsi with clavate tenent hair, Argentina ..... ***Triacanthella massoudi*** **Najt, 1973**

– Two ommatidia (G and H) absent, tibiotarsi without clavate tenent hair, Australia ..... ***Triacanthella violacea*** **Womersley, 1939**

10 Macrochaetae simple and smooth, New Zealand ..... ***Triacanthella rubra*** **Salmon, 1941**

– Macrochaetae serrated or brush-like..... **11**

11 All ommatidia equally developed, apical lobe absent on dentes, New Zealand ..... ***Triacanthella purpurea*** **Salmon, 1943**

– Two ommatidia (G and H) reduced, apical lobe present on dentes, New Zealand..... ***Triacanthella enderbyensis*** **Salmon, 1949**

12 Two ommatidia (G and H) reduced..... **13**

– All ommatidia equally developed **14**

13 Dentes reduced, empodium present (but rudimentary), Chile ..... ***Triacanthella clavata*** **(Willem, 1902)**

– Dentes normally developed, empodium absent, New Zealand ..... ***Triacanthella terrasilvatica*** **Salmon, 1943**

14 Mucro more complex with two teeth, colour whitish-yellowish in alcohol, claw without inner tooth, New Zealand ..... ***Triacanthella setacea*** **Salmon, 1941**

– Mucro with a distinct heel, colour pinkish in alcohol, claw with two inner teeth, South Africa..... ***Triacanthella madiba*** **sp. n.**

Species description

***Triacanthella madiba* sp. n.**
urn:lsid:zoobank.org:act:606016FB-A5C4-4B86-A9EC-E111EB7CCAEB
http://species-id.net/wiki/Triacanthella_madiba

Material. Holotype female and 17 paratypes (9 on slides and 8 in alcohol), South Africa: Western Cape, Cape Town, Table Mountain National Park, 10 March 2009, bat guano in Wynberg cave, extracted on Berlese-Tullgren funnel, (SAF-125, Louis Deharveng & Anne Bedos leg).

Holotype on slide and 9 paratypes (5 on slides and 4 in alcohol) in Iziko Museum (Cape Town, South Africa), 8 paratypes in Museum National d'Histoire Naturelle, Paris (4 on slides and 4 in alcohol).

Description. Colour orange to pink alive, pinkish in ethanol even after one year (Fig. 1). Length 1.9 – 2.5 mm. Habitus of Southern Hemisphere *Triacanthella* (Figs 1, 6A).

Dorsal integument ornamentation made of hemispherical and rather coarse secondary granules, with large areas devoid of secondary granules on head and tergites (Figs 2–3), symmetrically arranged; most noticeable are the long antero-axial one on head, those associated to classical suture zone of head (Fig. 2), the 1+1 amiboid ones on Th. II-III (Fig. 3A), and the triangular ones between Md and Mdl on Abd. I-III (Figs 3B-C); secondary granules smaller around these areas. Externally to ocular area is a large area where secondary granules are smaller and denser (Fig. 3D). Secondary granules larger along the axial zone (Fig. 3E). No rosette-like arrangement of secondary granules on Abd. VI. Ventral secondary granulation less coarse, more regular. Manubrium with secondary granules arranged in a characteristic linear pattern dorsally (Fig. 3F), and with large areas devoid of secondary granulation ventrally. Pseudopores not seen. Chaetotaxy characterized by a strong heterochaetosis dorsally and a moderate plurichaetosis on most body parts. Chaeta morphology described below, with macrochaetae, mesochaetae and S-chaetae on head and body, and various kinds of chaetae on antennae (Figs 4, 6C). No ordinary microchaetae except on praetarsus and genital plate.

Antennae almost as long as head diagonal. Six kinds of antennal chaetae: i) thickened subcylindrical S-chaetae of medium size (2 on Ant. III and 6 on Ant. IV); (ii) S-microchaetae (3 on Ant. III and 1 on Ant. IV) (Figs 4B–C); (iii) blunt chaetae very similar to the S-chaetae, but longer and usually slightly thinner (on Ant. IV); (iv) acuminate ordinary chaetae of various length, smooth or weakly serrated, 11–12, 13–17 and 26–30 on Ant I-III, a few on Ant. IV (Fig. 4D); (v) thin, straight and smooth truncated chaetae numerous ventrally on Ant. IV (Fig. 4A); (vi) one ventro-distal papillate chaeta. Sensory organ of AIIIO with two short S-chaetae lying in ovoid sockets (S3 and S4, Fig. 4B), two longer guard S-chaetae shorter than nearest mesochaetae (S2 and S5) and one very small dorso-external S-microchaeta (S1); integument granulation significantly coarser between and above S3 and S4 (Fig. 4B). Antennal segment IV with most chaetae as subcylindrical, thickened, blunt S-chaetae, the shortest ones slightly thicker and more bent, including a central group of six; apical bulb trilobed;

Figure 1. *Triacanthella madiba* sp. n., aspect and colour after one year in 95% ethanol.

subapical organite rounded, very small; a short ovoid-elongate S-microchaeta present dorso-externally (Figs 4C, 6B).

Eight ocelli on each side of the head, equal in size. Postantennal organ nearly equal in size to one ocellus, with 4 subequal vesicles (Fig. 2). Maxilla with a tridentate capitulum, a rounded basal flap and 6 variously fringed or ciliate lamellae (Figs 5C–D). Mandible head with 4 teeth on each side, the basal one slightly smaller on the left than on the right mandible (Figs 5A–B). Labrum chaetotaxy 4/4,5,4; labral chaetae distinctly longer than prelabral chaetae; labrum apical edge with a slight medial indentation; distal part with four irregular longitudinal ridges dorsally, and with subapical asymmetrical combs ventrally (Figs 5E–G); labral apical edge hemmed (Fig. 5G). Labium with 5–6 basomedian chaetae, 7 lateral chaetae, and a labial palp characterized by 7–8 proximal chaetae and a reduced number of distal chaetae (Fig. 5J): only 3 papillae, A,B,D; one ordinary chaeta (possibly e4, but with a socket) and 5 short, thickened, hyaline guards (a1, b1, b2, d2, Fig. 5I), with the fifth one probably the lateral process sensu Fjellberg (1999). Maxillary outer lobe with one basal chaeta and a simple palp; sublobal plate small, rounded and devoid of sublobal hairs. Clypeus with 15–16 chaetae (Fig. 5H). Postlabial chaetae 5+5.

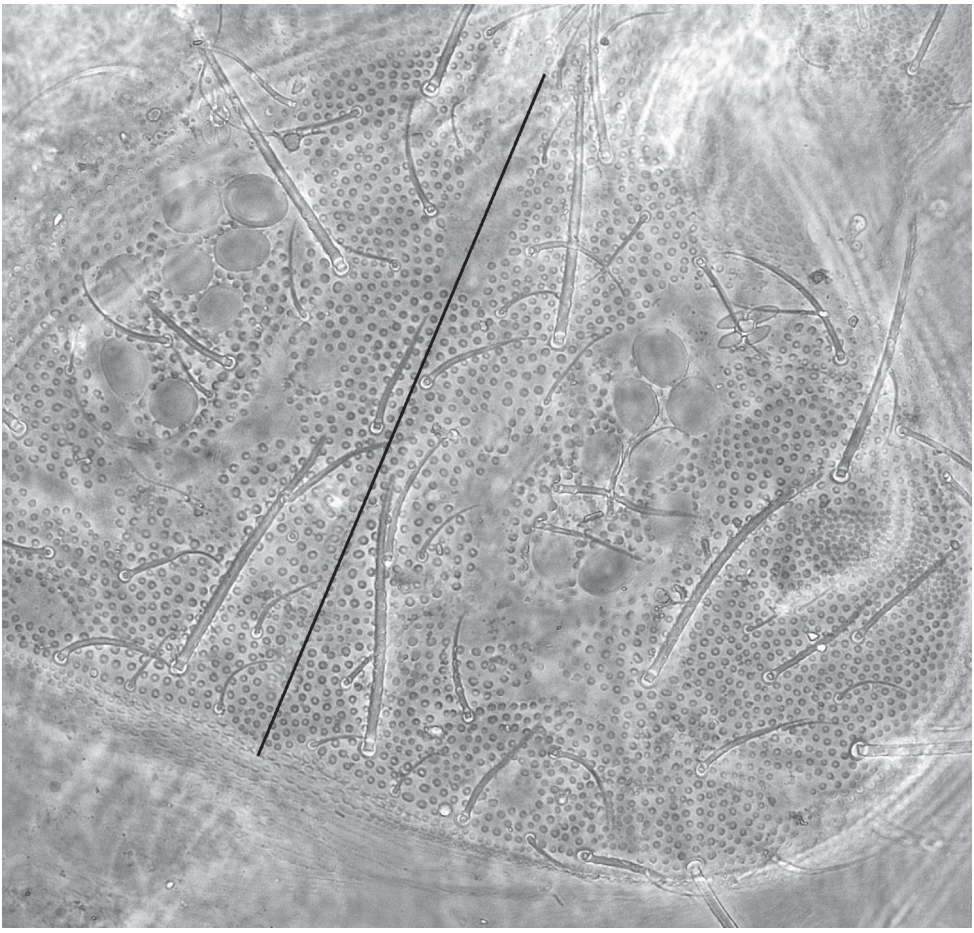

Figure 2. *Triacanthella madiba* sp. n., dorsal side of head.

Chaetotaxy of tergites illustrated on Fig. 6A. Dorsal clothing plurichaetotic and heterochaetotic, with frequent asymmetries among shortest mesochaetae. Macrochaetae long, bent, and densely ciliated unilaterally on 2/3 to most of their length; mesochaetae, less bent, acuminate, less strongly ciliated to almost smooth; S-chaetae, thin and smooth, shorter than macrochaetae (Figs 4E–G, 6C). Macrochaetae formula per half-tergite: 8/2,3,3/3,3,3,3(4),3. Number of chaetae between macrochaetae Md per half-tergite: 1-2,3-5,3-4/2-3,2-3,(1)-2,3,2-3 with many asymmetries. S-chaetae formula per half-tergite: 0,2,2/1,1,1,1,1; microchaeta ms absent. Abdomen VI chaetotaxy often asymmetrical, with one or two axial short mesochaetae; three anal spines on papillae, the posterior one less than half the length of the other two which are hook-like (Figs 6G–H).

No ventral chaetae on thoracic sternites. Number of ventral chaetae per half-tergite for Abd. II, III: 7, 13–17; anterior furcal subcoxa with 12–16 chaetae. All ventral chaetae are smooth ordinary chaetae. Lateral anal valves with 3 or 4 hr chaetae; upper anal valve with 7–9 hr chaetae.

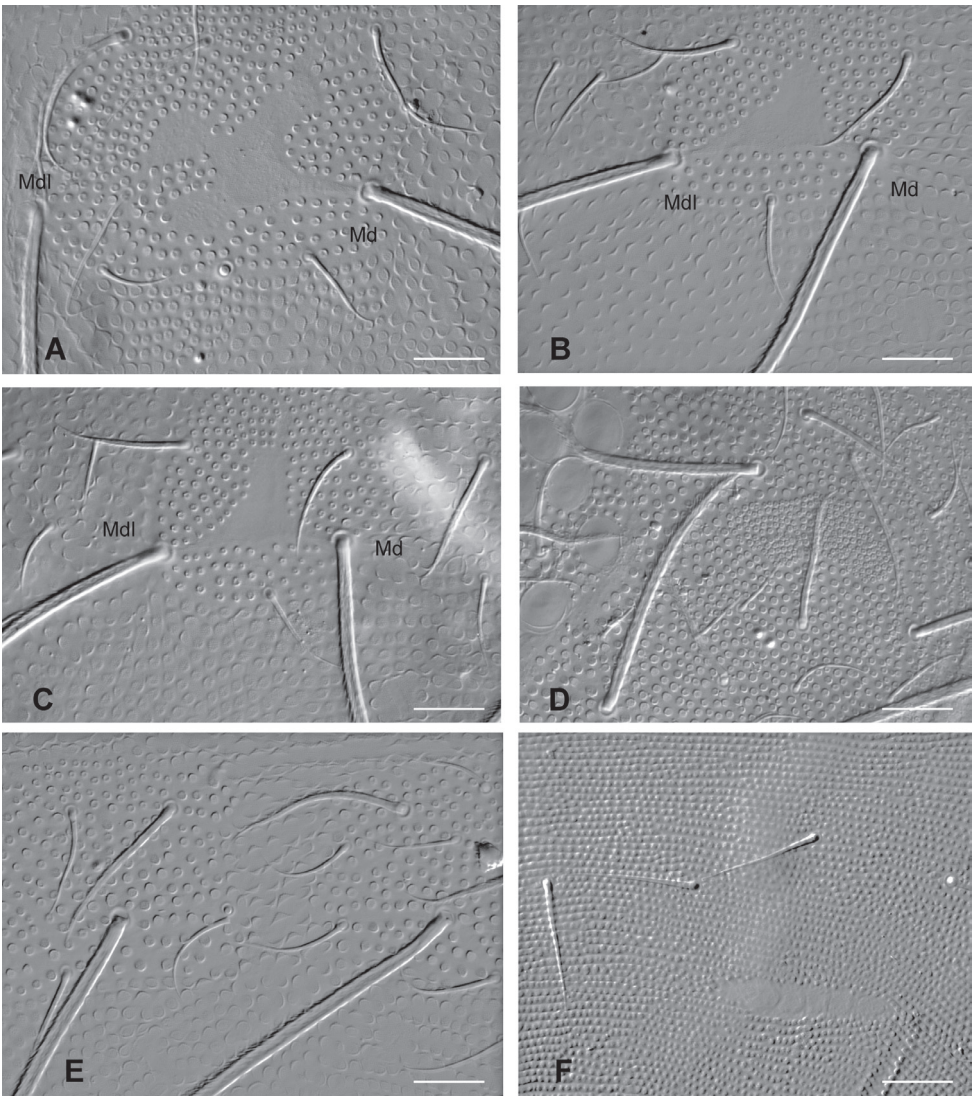

Figure 3. *Triacanthella madiba* sp. n., details of granulation types on dorsal side of the body. **A** amiboid primary granule area on Th. III **B** triangular primary granule area on Abd. III **C** triangular primary granule area on Abd. II, surrounded by smaller secondary granules **D** detail of the lateral plate of smaller secondary granules on head **E** axial area of Abd. V, with larger secondary granules between axial chaetae **F** linear arrangement of secondary granules on the manubrium. Scales: 30 μm.

Leg chaetotaxy slightly plurichaetotic. Trochanter with 7 chaetae. Tibiotarsi I, II, III with (proximal + distal): 8 + 11, 8 + 11, 7 + 11 acuminate chaetae. No clavate tenent hair. Claw with two inner teeth at about 40% and 65% of claw basis, and 1 + 1 latero-distal teeth, appressed on the integument and difficult to see at about 85% of claw basis (Fig. 6D). Empodial appendage short and pointed, internal to empodial apical tubercle according to Fig. 6D, 1+1 small praetarsal microchaetae. Ventral tube with

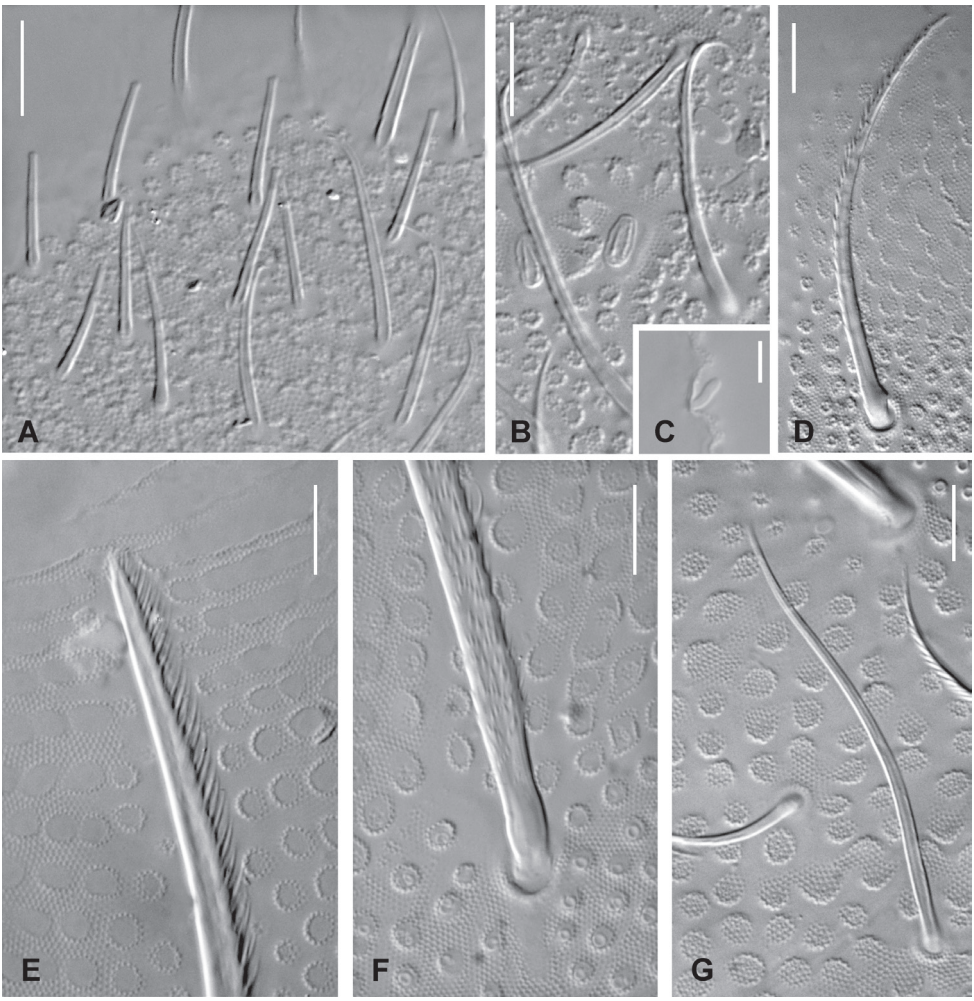

Figure 4. *Triacanthella madiba* sp. n., types of chaetae. **A** truncated chaetae of the ventral side of Ant. IV **B** microchaetae S3 and S4 of AIIIO **C** S-microchaeta of Ant. IV **D** ciliated chaeta of Ant. III **E** distal part of a macrochaeta on Abd. I **F** basal part of a macrochaeta on Abd. III **G** S-chaeta on Abd. I. Scales: 10 μm (**A, B, D, E, F, G**); 5 μm (**C**).

9–11 + 9–11 latero-distal chaetae, and 1–2 chaetae on each side of the sternite of Abd. I. Tenaculum with 3 + 3 teeth. Dens without ventro-apical lobe, bearing 10–15 chaetae dorsally with fine granulation (secondary granules smaller than chaetal sockets); the basal macrochaeta of the dens is about 2.3 the length of the nearest mesochaeta; well developed mucro with a large lamella and a very distinct dorso-basal heel (Figs 6E–F).

Discussion. *Triacanthella madiba* sp. n. shares numerous characters with *T. vogeli* Weiner & Najt, 1997, described from southern Chile. It differs mainly by the ocelli G and H being equal in size to the other ocelli and the absence of rosette-shape tubercles on Abd. VI. It is also morphologically close to *T. andina* Cassagnau & Rapoport,

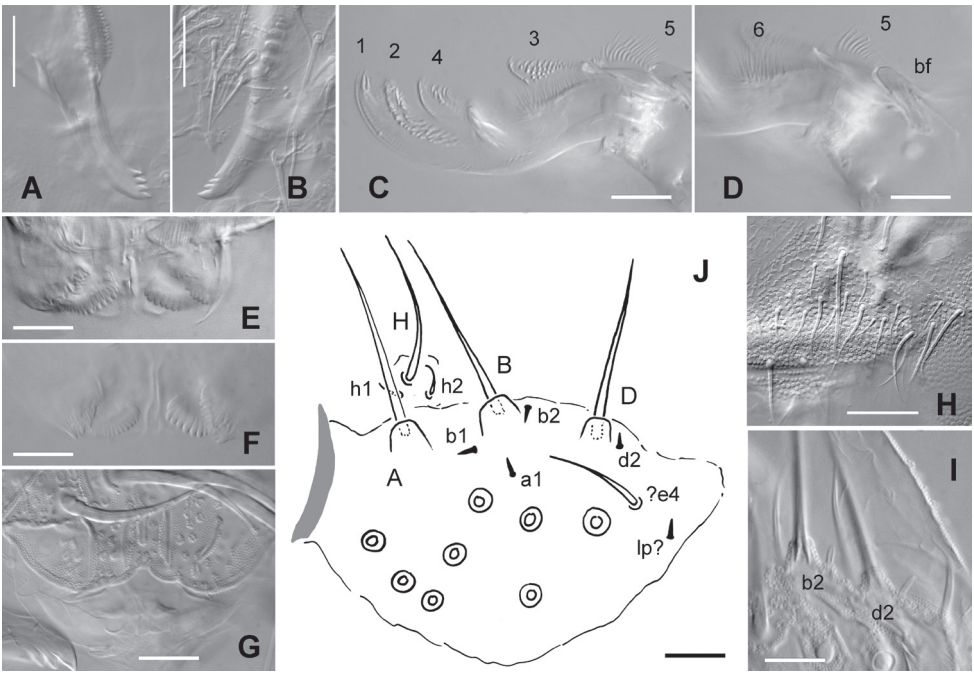

Figure 5. *Triacanthella madiba* sp. n., mouthparts. **A** mandible, right **B** mandible, left **C** maxilla head **D** proximal part of maxilla head, with basal flap bf **E, F** ventro-distal part of labrum with combs **G** dorso-distal part of labrum **H** clypeus **I** guards b2 and d2 of labial palp **J** labial palp (lp: lateral process). Scales: 10 µm.

1962 from Argentina, but macrochaetae are less numerous on Abd. I-III "(333 versus 444). In addition, the lamellae of the maxilla are shorter and the papillae bearing the anal spines are not as strong in *T. madiba* sp. n., as in *T. andina*. Overall, these three species are extremely similar morphologically in spite of being very remote geographically. *Triacanthella madiba* sp. n. differs from Australian and New-Zealand species by characters pointed out in the key. An additional important character is the chaetotaxy of the distal part of the labial palp, which is similar to that described by Fjellberg for an unidentified species of Australia (Fjellberg 1999), being strongly reduced compared to that of *T. biroi*, Stach 1924 from Europe (Fjellberg 1999).

Distribution and ecology. *Triacanthella madiba* sp. n. is recorded in bat guano in a cave of Table Mountain National Park. This is the first record of the genus *Triacanthella* in a guano habitat and the first record of the genus for Africa. None of the *Triacanthella* species recorded so far are found in tropical regions. They are all restricted to temperate zones, where they occur in a large range of habitats in Europe (from xeric Mediterranean to permanently cold), while they are limited to humid and cool litter or surface soil layers in the southern hemisphere (Australia, New Zealand, Chile and Argentina, Weiner and Najt 1997). Its presence underground in a cool, nutrient rich and permanently humid habitat, and its absence in the remnant forest patches of Table Mountain that we sampled extensively is surprising.

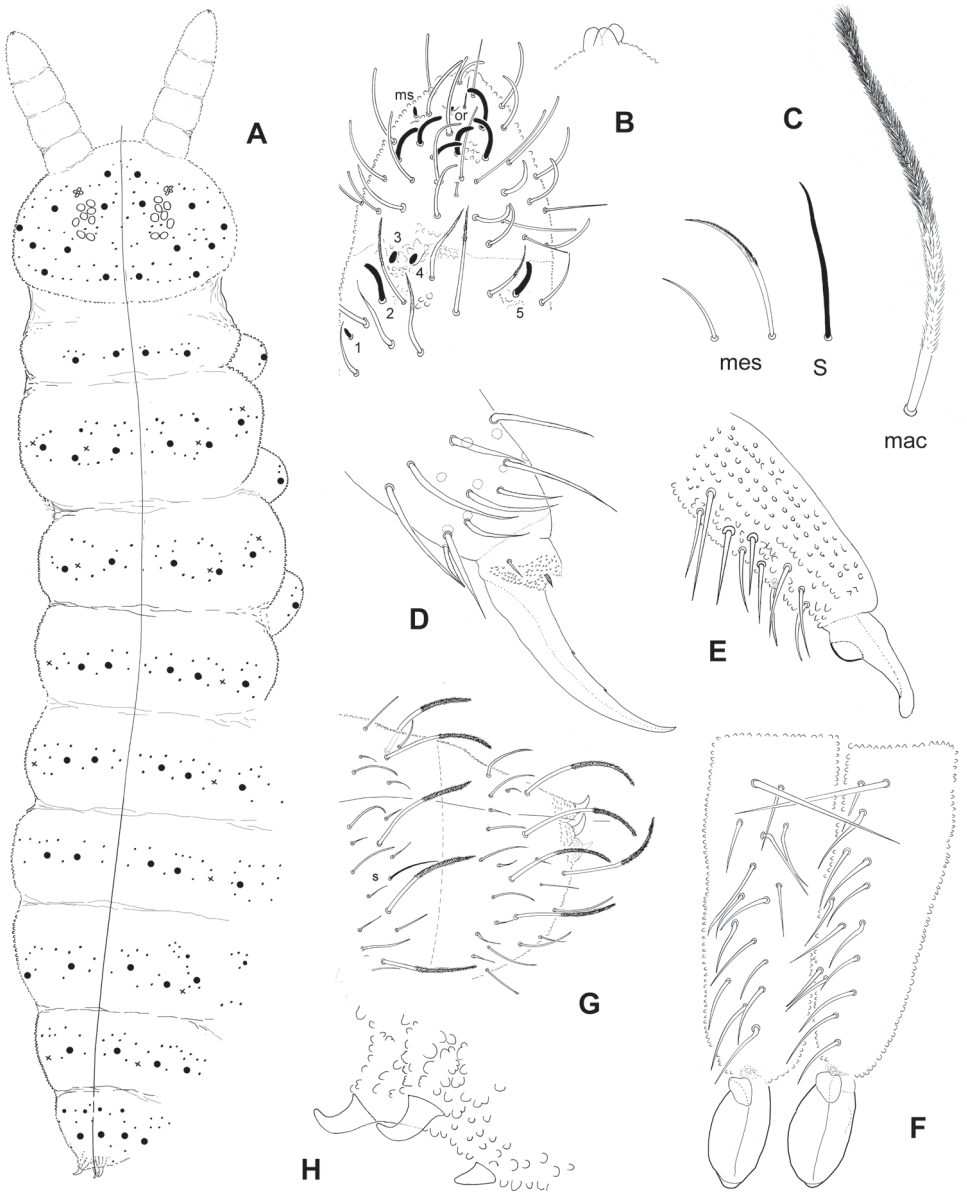

Figure 6. *Triacanthella madiba* sp. n. **A** habitus and chaetae distribution of the dorsal side (x: S-chaetae) **B** Ant. III distal and Ant. IV in dorsal view and detail of the apical bulb **C** morphology of dorsal chaetae: macrochaeta (mac), mesochaeta (mes), S-chaeta (S) **D** tibiotarsus and claw of leg III **E** mucrodens, lateral view **F** Mucrodens, dorsal view **G** Abd. V–VI tergites **H** anal spines.

The only subterranean records of the genus *Triacanthella*, include the record of *T. copelandi* in a cave in Tennessee (USA), without anymore detail, and a single specimen collected in a small shallow cave of oriental Pyrenees in France, that was described as *T. proxima* Delamare 1951, and later synonymised with *T. perfecta.* In

the area around this last cave, *T. perfecta* is actually common in beech forest litter (unpublished observations), and its presence underground as a single specimen is obviously accidental. Conversely, *T. madiba* sp. n. occurs abundantly in the guano microhabitat of Wynberg cave and was not found outside in Table Mountain. The species can therefore be considered troglophilic in this area. Actually, *T. madiba* sp. n. may have been already recorded as *Schaefferia* (*Typhlogastrura*) sp. in Sharratt et al. (2000), collected from guano material during a cave fauna survey in Table Mountain.

Although the labial palp of *T. madiba* sp. n. is similar to the unidentified Australian species (Fjellberg 1999), it also shares some characters with certain South American species, making its placement in the phylogeny based on morphological characters problematic. If the new species is more closely related to the Australian and New-Zealand species, it would follow a classical transantarctic gondwanian pattern (Brundin 1965, 1966; Sanmartín and Ronquist 2004). Alternatively, it could be that *T. madiba* sp. n. is more closely related to South American species based on the characters pointed out in the key provided. Thus, *T. madiba* sp. n. could be the result of dispersal from South America (e.g. Allwood et al. 2010), associated with a significant shift in its ecological requirements. On-going molecular and morphological studies on this basal genus will hopefully resolve their intriguing biogeographic pattern.

Name derivation. We dedicate this species to Madiba, former President of South Africa, Nelson Rolihlahla Mandela, who celebrated his 20 years of freedom on 11 February 2010.

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References

Arbea JI, Jordana R (1991) Colémbolos de Navarra (norte de la Península Ibérica). I. Orden Poduromorpha (Collembola). Publicacíones de Biología de la Universidad de Navarra, Serie Zoologica 22: 1–149.

Allwood J, Gleeson D, Mayer G, Daniels S, Beggs JR, Buckley TR (2010) Support for vicariant origins of the New Zealand Onychophora. Journal of Biogeography 37: 669–681. doi: 10.1111/j.1365-2699.2009.02233.x

Brundin L (1965) On the real nature of transantarctic relationships. Evolution 19: 496–505. doi: 10.2307/2406246

Brundin L (1966) Transantarctic relationships and their significance, as evidenced by chironomid midges, with a monograph of the subfamilies Podonominae and Aphroteniinae and the austral Heptagyiae. Kungliga Svenska Vetenskapsakademiens Handlingar 11: 1–472.

Cassagnau P, Deharveng L (1974) Les espèces européennes du genre *Triacanthella* (Collemboles). Nouvelle Revue d'Entomologie 4: 165-180.

Christiansen K, Bellinger P (1980) Part I. Poduridae and Hypogastruridae, The Collembola of North America North of Rio Grande, Grinnell College, Iowa, 386 pp.

de Izarra DC (1971) Sobre el genero *Triacanthella* Schäffer con descripcion de una nueva especie: *T. najtae* (Insecta, Collembola). Physis 30: 345–350.

D'Haese CA (2002) Were the first springtails semi-aquatic? A phylogenetic approach by means of 28S rDNA and optimization alignment. Proceedings of the Royal Society of London B 269: 1143–1151. doi: 10.1098/rspb.2002.1981

D'Haese CA (2003a) Homology and morphology in Poduromorpha (Hexapoda, Collembola). European Journal of Entomology 101: 385–407.

D'Haese CA (2003b) Morphological appraisal of Collembola phylogeny with special emphasis on Poduromorpha and a test of the aquatic origin hypothesis. Zoologica Scripta 32: 563–586. doi: 10.1046/j.1463-6409.2003.00134.x

Fjellberg (1984) Maxillary structures in Hypogastruridae (Collembola). Annales de la Société Royale de Zoologie de Belgique 114: 89–99.

Fjellberg A (1999) The labial palp in Collembola. Zoologischer Anzeiger 237: 309–330.

Greenslade P, Stevens MI, Torricelli G, D'Haese CA (2011) An ancient Antarctic endemic genus restored: morphological and molecular support for *Gomphiocephalus hodgsoni* (Collembola: Hypogastruridae). Systematic Entomology 36: 223–240. doi: 10.1111/j.1365-3113.2010.00553.x

Janion C, Bedos A, Bengtsson J, Deharveng L, Jansen van Vuuren B, Leinaas HP, Liu A, Malmström A, Porco D, Chown SL (2011) Springtails diversity in South Africa. South African Journal of Science 107(11/12): 1–7. doi: 10.4102/sajs.v107i11/12.582

Miller JS, Kamath A, Damashek J, Levin RA (2011) Out of America to Africa or Asia: Inference of dispersal histories using nuclear and plastid DNA and the S-RNase self-incompatibility locus. Molecular Biology and Evolution 28: 793–801. doi: 10.1093/molbev/msq253

Pryke JS, Samways MJ (2008) Conservation of invertebrate biodiversity on a mountain in a global biodiversity hotspot, Cape Floral Region. Biodiversity and Conservation 17: 3027–3043. doi: 10.1007/s10531-008-9414-4

Rebelo AG, Boucher C, Helme N, Mucina L, Rutherford MC (2006) Fynbos Biome. In: Mucina L, Rutherford MC (Eds) The Vegetation of South Africa, Lesotho and Swaziland. South African National Biodiversity Institute, Pretoria, 52–219.

Salmon JT (1941) The Collembolan Fauna of New Zealand, including a discussion of its distribution and affinities. Transactions of the Royal Society of New Zealand 70: 282–431.

Sharratt NJ, Picker MD, Samways MJ (2000) The invertebrate fauna of the sandstone caves of the Cape Peninsula (South Africa): patterns of endemism and conservation priorities. Biodiversity and Conservation 9: 107–143. doi: 10.1023/A:1008968518058

Weiner WM, Najt J (1997) Collembola Poduromorpha from the Magallanes Province (Chile). Bonner Zoologische Beiträge 47: 99–110.

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Description of a new species of *Platynus* Bonelli from the Appalachian Mountains of eastern North America (Coleoptera, Carabidae)

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Abstract

A new species of the genus *Platynus* Bonelli, *P. daviesi*, is described from specimens collected in the Appalachian Mountains. The species is structurally most similar to *P. parmarginatus* Hamilton but differs in having the coloration of the body dorsally darker on average, the elytra proportionally longer and wider, the vertex and disc of pronotum with well impressed microsculpture, the elytral interval 3 with four or five discal setae in most specimens, and the median lobe of aedeagus less curved overall. DNA barcoding was performed on several species of eastern North American *Platynus* species and *P. daviesi* was found to be genetically distinct from *P. parmarginatus*. A key to the 12 species of *Platynus* found east of the Mississippi River is provided.

Keywords

Platynus, Carabidae, new species, identification key, barcoding

Introduction

The genus *Platynus* Bonelli is a large, inadequately understood, and probably polyphyletic group belonging to the tribe Platynini. In Mexico alone, the genus contains an estimated 300 species (Liebherr and Will 1996: 301). The North American (north of Mexico) *Platynus* are much less diversified and relatively well known. Lindroth (1966,

as the *decentis* and *hypolithos* groups included in the genus *Agonum*) treated all species then known except those restricted to the southwest and *P. prognathus* Van Dyke, an aberrant species known only from the holotype collected on Saint Simon Island, in southeastern Georgia. Liebherr and Will (1996) described three new species and presented a key to all 22 species found in North America north of Mexico.

While curating the Nearctic carabids of the Canadian National Collection of Insects, I found that two species were mixed under the name *Platynus parmarginatus* Hamilton. The purpose of this paper is to describe the unnamed species.

Material and methods

All the specimens reported in this study belong to the Canadian National Collection of Insects, Ottawa, Ontario (CNC), the Carnegie Museum of Natural History, Pittsburgh, Pennsylvania (CMNH), and the University of New Hampshire Collection, Durham, New Hampshire (NHDE). No attempt was made to locate further specimens in other collections.

The following measurements were taken on several specimens of the new species and *P. parmarginatus*: length of the head (LH) from the anterior edge of the clypeus at middle to an imaginary line between the posterior edges of the eyes; width of head (WH) across the eyes; length of pronotum (LP) along the midline; maximum width of pronotum (WP); length of elytra (LE) measured from the tip of the scutellum to the apex of the right elytron; and maximum width of elytra (WE). The standard body length [SBL = LH + LP + LE] was used to express the body length.

DNA extraction, PCR and COI sequencing followed standard protocols and primers at the Canadian Centre for DNA Barcoding (http://www.dnabarcoding.ca/pa/ge/research/protocols); all data are registered in the Barcode of Life Database (BOLD). The taxon ID-tree was produced by neighbour-joining analysis on Kimura 2-parameter distances, using the analytical tool in BOLD. Only sequences with lengths above 400 base pairs were used in the analysis. Genetic distances were estimated with MEGA 5.05 (http://www.megasoftware.net; accessed 20 October 2011).

Platynus daviesi Bousquet, sp. n.

urn:lsid:zoobank.org:act:95C15DCE-1DC3-413D-88B8-6DC5ECC9DD3C
http://species-id.net/wiki/Platynus_daviesi
Figs 1, 2, 4

Type material. Holotype (♂) labelled: "VIRG. Shenandoah N.P. Powell Gap 13.VI.1982, 2300' Bousquet & Davies / Holotype Platynus daviesi Bousquet CNC no 23464." The specimen is deposited in the Canadian National Collection of Insects.

Paratypes (160♂♂, 127♀♀) from the following localities in the United States of America: ALABAMA. Natural Bridge Cave, Winston Co., 17.VI.61, H.R. Steeves [under

rock, light zone] (1♂, CMNH). Monte Sano State Park, Hunstville, Madison Co., 6–8. IV.1991, R. Davidson, R. Acciavatti & M. Klingler (2♂♂, 5♀♀, CMNH). Connecticut. Burnham Brook, East Haddam, Middlesex Co., 16.VI.1980, 24.VII.1980, A.J. Main & W.L. Krinsky [malaise trap over brook] (2♀♀, CMNH). Kentucky. Foxtown, Jackson Co., 4.V.1984 (8♂♂, 11♀♀, CMNH). Carter Caves, Carter Co., 28.VII.1983, A. Larochelle (1♂, CMNH). Maryland. Garrett St. For., Garrett Co., 5.VI.96, J. Glaser (1♀, CMNH). New York. W. Shokan, Ulster Co., various dates, M.S. Adams [256 m, UV Light, Mesic forest hemlock] (9♂♂, 8♀♀, CMNH). Olivebridge, Ulster Co., various dates, M.S. Adams [118 m, UV Light] (7♂♂, 6♀♀, CMNH). "Plivebridge", Ulster Co., 13–14.VII.1995, M.S. Adams (1♂, CMNH). Ithaca, Tompkins Co., 15.VII.1980, J.E. Rawlins (1♀, CMNH). North Carolina. Blue Ridge Parkway near Craven Gap, 940 m, Buncombe Co., 5.VI.1986, A. Smetana (1♂, CNC). Blue Ridge Parkway, Wolf Mountain outlook, 1680 m, 26.V.1986, A. Smetana (1♂, CNC). Highlands, 3800', Macon Co., 8.VI.1957, W.J. Brown (1♀, CNC). Wayah Bald, 5500', Macon Co., 6.VII.1952, H.& A. Howden (1♀, CNC). Pennsylvania. Cook State Forest, 1.2 mi N Cooksburg, Jefferson Co., 6.VI.1997, D. Chandler (3♂♂, 2♀♀, NHDE). Pittsburgh, 1.VII.1922 (1♂, 1♀, CMNH). Powdermill Nature Res., nr Rector, Westmoreland Co., 13.IX.58 (1♂, CMNH); idem, 26.IV.–2.V.1982, 16–20.V.1982, 26.IX.–1.X.1981, 30.V.–9.VI.1983, R. Davidson (4♂♂, 1♀, CMNH). 3 km NE Lower Burrell, Westmoreland Co., 19.VII.1946 (1♂, CMNH). 4.9 km S Ludlow, Pigeon Run, McKean Co., 15.VI.1994, 18.VII.1994, 24.V.1995, 22.VI.1995, J. Deeds or M. Ricke [560 m, UV Light Trap] (1♂, 5♀♀, CMNH). 5.4 km ENE Donaldson, Tionesta Scenic Area, McKean Co., 15.VI.1994, 22.VI.1995, M. Ricke or J. Deeds [565 m, UV Light Trap] (1♂, 1♀, CMNH). 4.2 km SSE Donaldson, Rock Run, Warren Co., 13.VII.1994, 9.VII.1994, 19.VII.1994, 5.VIII.1994, 19.VIII.1994, 24.V. 1995, 22.VI.1995, J. Deeds or M. Ricke [540 m, UV Light Trap] (2♂♂, 5♀♀, CMNH). 4.6 km ESE Donaldson, Tionesta Scenic Area, Warren Co., 15.VI.1994, M. Ricke (1♀, CMNH). 2.2 km NW Truemans, Warren Co., 15.VI.1994, 5.VIII.1994, M. Ricke (3♂♂, CMNH). 6.4 km S Irvine, Hedgehog Run, Warren Co., 1.VIII.1995, J. Deeds (1♀, CMNH). 6 km E Cobham, Warren Co., 10.VI.1995, C. Bier, J. Deeds & T. Schumann (1♂, CMNH). 7.7 km SSW Cherry Grove, Warren Co., 25.VII.1995, J. Deeds (1♂, CMNH). Black's Run, Oakmont, Allegheny Co., 19.IV.1982, R. Davidson (1♀, CMNH). 1.6 km WSW Truemans, near mouth of Minister Creek, Forest Co., 15.VI.1994, M. Ricke [380 m, UV Light Trap] (1♂, CMNH). 8.7 km N Kellettville, Forest Co., 14.VIII.1995, J. Deeds (1♂, CMNH). 3.9 km WSW Pigeon, Penoke Run, Forest Co., 8.VIII.1996, J. Isaac [marsh with alders, UV light trap] (1♀, CMNH). 1.3 km SW Nansen, East Branch Spring Creek, 21.VIII.1996, J. Isaac [riparian, hemlocks] (1♂, CMNH). 5 km SSW West Finley, Enlow Fork Wheeling Creek, Washington Co., 16.V.1986, J.E. Rawlins (1♂, 1♀, CMNH). Lycoming Creek, 0.9 km NW Bodines, Lycoming Co., 14.VI.2001, B.J. Ray & S.E. Hamsher (1♀, CMNH). 3.5 km NE Shanksville, Somerset Co., 13.V.1995, W.A. Zanol (1♀, CMNH). Hawk Mountain Sanctuary, 2.3 km W Eckville, Berks Co., 8.VII.1997, M. Monroe & M. Medina (1♂, CMNH). Hawk Mountain Sanctuary, 1.1 km WNW Eckville, 15.V.1998, 28.V.1998, 26.VI.1998, 13.VIII.1998, 14.IX.1998, var-

ious collectors (5♂♂, 3♀♀, CMNH). Gravel Lick, Clarion Co., 3.V.1994, W.A. Zanol (1♀, CMNH). Tennessee. Chimney Tops, Great Smoky Mountains National Park, 8 km S Gatlinburg, 8.VI.1982, Bousquet & Davies (1♂, 2♀♀, CNC). Smoky Mtn. Nat. Pk., Elkmont, 12.VII.1974, R.D. Ward (1♀, CMNH). Foster Falls, 10 km SE Tracy City, Marion Co., 31.V.1991, R. Davidson, W. Zanol & R. Acciavatti (3♂♂, 5♀♀, CMNH). Virginia. Powell Gap, Shenandoah Nat. Park, 2300', 13.VI.1982, Bousquet & Davies (5♂♂, 2♀♀, CNC). Simmons Gap, Shenandoah Nat. Park, 2250', 14.VI.1982, Bousquet & Davies (1♂, 1♀, CNC). McCormick Gap, Shenandoah Nat. Park, 2430', 14.VI.1982, Bousquet & Davies (3♀♀, CNC). Skyline Drive, Shenandoah Nat. Park, 3140', 18.VII.1976, R.D. Ward (1♀, CMNH). Compton Gap, Shenandoah Nat. Park, 17.VI.1981, R. Davidson (1♀, CMNH). Mountain Lake Biological Station, 3820', 12 km E Pembroke [Giles Co.], 11.VI.1982, Bousquet & Davies (2♂♂, CNC). "Matthews Arm", Rappahannock Co., 19.VII.1980, A. Larochelle (1♀, CNC). Elkton, Rockingham Co., 21.VII.1980, A. Larochelle (1♀, CNC). Hightown, Highland Co., 4.VII.1980, A. Larochelle (1♂, CMNH). Loft Mtn., Greene Co., 3.VII.1980, A. Larochelle (1♀, CMNH). "Troutdale", Grayson Co., 7.VII.1980, A. Larochelle (1♂, CMNH). 3 mi W Dungannon, Scott Co., 15.VI.–15.VII.1994, E. van den Berghe (3♂♂, 1♀, CMNH). Cumberland Gap Nat. Park, Lee Co., 5.VII.1984, E. Censky (7♂♂, 4♀♀, CMNH). West Virginia. Harpers Ferry, Jefferson Co., 18.VI.1974, P. Van Buskirk (3♂♂, CNC). Hungry Beech Preserve, 1 km E Kettle, Roane Co., 5–8.VI.1995, Harrity, Davidson & Onore [deciduous forest] (9♂♂, 7♀♀, CMNH). Ice Mountain Preserve, 0.5 km E North River Mills, Hampshire Co., 14–17.VI.1995, 19–22.VII.1995, 20–22.IX.1995, various collectors [deciduous forest, light trap] (27♂♂, 17♀♀, CMNH). Slaty Mountain Preserve, 4 km NW Sweet Springs, Monroe Co., 2–5.VI.1995, 25–28.VII.1995, various collectors [shale barrens, light trap] (8♂♂, 6♀♀, CMNH). Fayette Station, Fayette Co., 1–2.VII.1990, 2–12.VII.1990, Acciavatti & Davidson (2♂♂, 1♀, CMNH). Burner Mt., 3 km N Bartow, Pocahontas Co., 6.VIII.1986, R.E. Acciavatti [ex tree trunk] (1♂, CMNH). North Fork Mountain, 6.3 or 6.5 km SSE Hopeville, Grant Co., 25.IV.1994, 31.V.1994, 7.VI.1994, D. Mitchell & L. Mennell (3♂♂, 3♀♀, CMNH). 3.7 km WNW Hopeville, Grant Co., 31.V.1994, 7.VI.1994, D. Mitchell & L. Mennell [oak/maple forest] (8♂♂, 1♀, CMNH). 9.8 km N Upper Tract, Pendleton Co., 25.V.1994, 7.VI.1994, 9.VI.1994, D. Mitchell & L. Mennell (7♂♂, 2♀♀, CMNH). U.S. 50 at Cheat R., Preston Co., 12.V.1983, R.E. Acciavatti (1♀, CMNH). 3.2 km NNE Bowden, Randolph Co., 11–19.V.1995, 19–21.VI.1995, 22–29.VI.1995, 1–6.VII.1995, 2.VIII.1995, 22–31.VIII.1995, L. Mennell (5♂♂, 2♀♀, CMNH). 3.7 km NNW Bowden, Randolph Co., 2.VIII.1995, 14.VIII.1995, L. Mennell (1♂, 1♀, CMNH). Near Alderson [Greenbrier Co.], 30.VI–1.VII.1936, G.M. Kutchka (1♂, CMNH). Falls of Mills Creek, 11 mi W Mill Point, Greenbrier Co., 2–8.V.1982, R. Davidson (1♂, CMNH).

Description. Habitus (Fig. 1). *Coloration*. Body dorsally without metallic lustre, brownish red to reddish brown or reddish piceous, with lateral margins of pronotum and elytra paler, yellowish. Antennomeres brownish red to reddish brown, though antennomeres 2 and/or 3 often slightly darker than remaining ones, femora and tibiae also brownish red to reddish brown, though tibiae often slightly paler than femora;

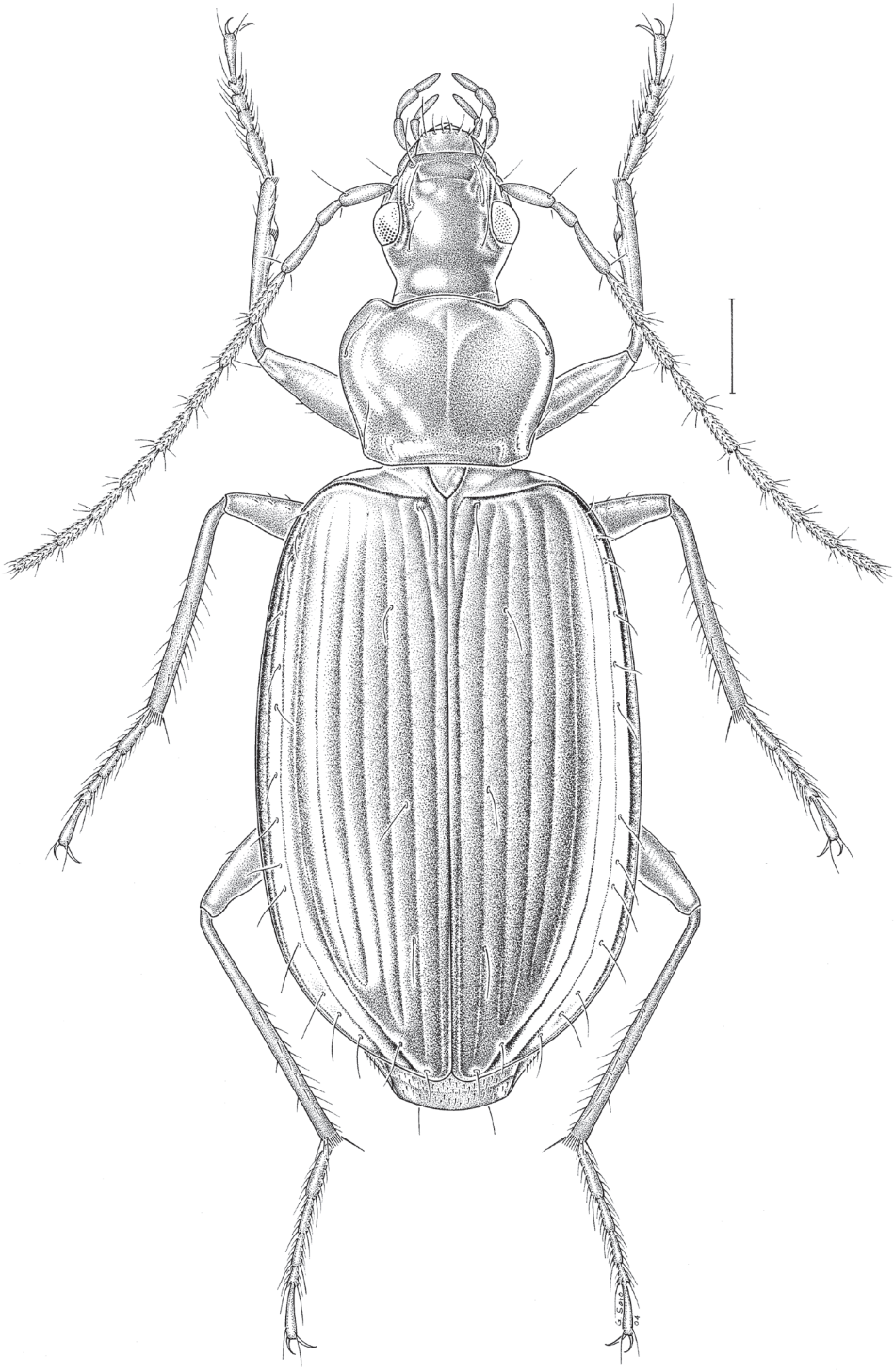


Figure 1. *Platynus daviesi*, habitus (dorsal view). Scale bar = 1 mm.

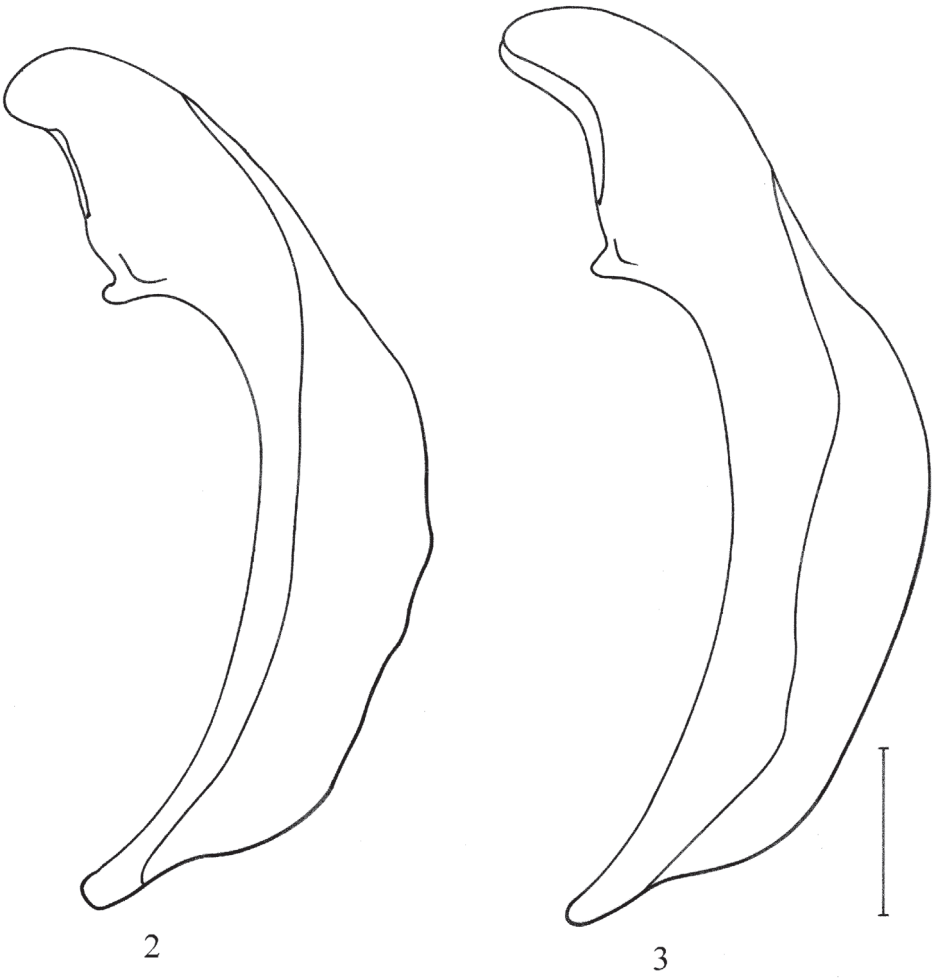
tarsomeres paler, yellowish. Frons with two distinct rufous median spots in many specimens. *Microsculpture*. Vertex, less so at centre, with well impressed isodiametric meshes; clypeus with transverse meshes laterally and over anterior half; labrum with well impressed, more or less isodiametric meshes. Pronotum with well impressed moderately transverse meshes on disc, with isodiametric meshes at base between impressions; lateral margins with more or less distinct transverse meshes. Elytra with well impressed, very transverse meshes. *Head*. Eyes moderately protruding. Antennae elongate, antennomere 9 more than four times as long as wide. Mandible not particularly elongate, with retinacular tooth covered by labrum in dorsal view. Anterior edge of mentum tooth not or very slightly emarginate. Submentum with two lateral setae on each side. *Pronotum*. Disc flat. Lateral edge with very shallow sinuation on posterior half. Anterior angle protruding anteriad; posterior angle obtusely rounded. Laterobasal impression deep, rounded, punctate, though in some specimens sparsely so, without convexity. Lateral margin widely reflexed over entire length, punctate toward base, though usually sparsely so; lateral bead indistinct; basal bead indistinct laterally, more or less distinct between impressions. Midlateral and laterobasal setae present; basal seta close to, or even touching, lateral edge. Anterotransverse impression very shallow. *Elytra*. Humerus rounded. Striae moderately finely impressed up to apex, shallowly and sparsely punctate to impunctate; stria 7 usually as impressed as stria 6. Intervals flat; interval 3 with three discal setae on both sides in most specimens (232/285 = 81.5%), rarely with two (3/285 = 1%) on one side or four (39/285 = 13.5%) on one side or four setae (11/285 = 4%) on both sides; anterior seta adjoining stria 3, median and posterior setae close to or adjoining stria 2. Surface around striae 5 and 6 not or only slightly impressed in apical fourth. *Pterothorax*. Metasternum long, its length behind mesocoxa about two times that of longitudinal diameter of mesocoxa. Metepisternum and metasternum impunctate. *Abdomen*. Last visible sternum with two (♂) or four (♀) subapical setae along edge. *Legs*. Mesofemur with three or four ventral setae along posterior edge. Metafemur with zero to two very small dorsoapical setae. Tarsomeres without dorsal keel; metatarsomeres 1 and 2 or 1–3 with shallow lateral furrows but without evident medial furrow; tarsomere 4 symmetric to very slightly asymmetric; tarsomere 5 without setae underneath, though with two to six very small hairs in many specimens. *Genitalia*. Median lobe of aedeagus moderately curved in lateral aspect (Fig. 2); endophallus without sclerified structures.

SBL: 8.7–9.9 mm (mean = 9.2 mm; n = 24).

Etymology. This species is named for my colleague Anthony Davies, a dedicated research assistant working at Agriculture and Agri-Food Canada, who collected, along with the author, several specimens of the type series.

Geographical distribution. As far as known, this species lives mainly along the Appalachian Mountains, ranging from Connecticut and southern Pennsylvania to northwestern Alabama (Fig. 4).

In addition to records listed in the "Type Material" section, specimens were seen with the following locality labels: "Pen" (1♀, CMNH). "Pa" (1♀, CMNH). "Ohio Pyle," VII.1905 (1♀, CMNH).



Figures 2–3. Median lobe of aedeagus (left lateral view) **2** *Platynus daviesi* **3** *P. parmarginatus*. Scale bar = 0.3 mm.

Habitat. Based on information attached to specimen labels, this species is probably an inhabitant of deciduous forests.

Dispersal Power. The wings are fully developed and no doubt functional. Several specimens were collected at ultraviolet light.

Comments. The new species is most similar to *Platynus parmarginatus* Hamilton and *P. tenuicollis* (LeConte). Adults of *P. parmarginatus* differ from those of *P. daviesi* by the following character states: size smaller (SBL: 7.2–8.9 mm; mean= 8.2 mm; n=20) on average; coloration paler on average, more reddish; elytra proportionally shorter and, on average, proportionally narrower (see Table 1); vertex without evident microsculpture meshes; disc of pronotum without or with shallowly impressed,

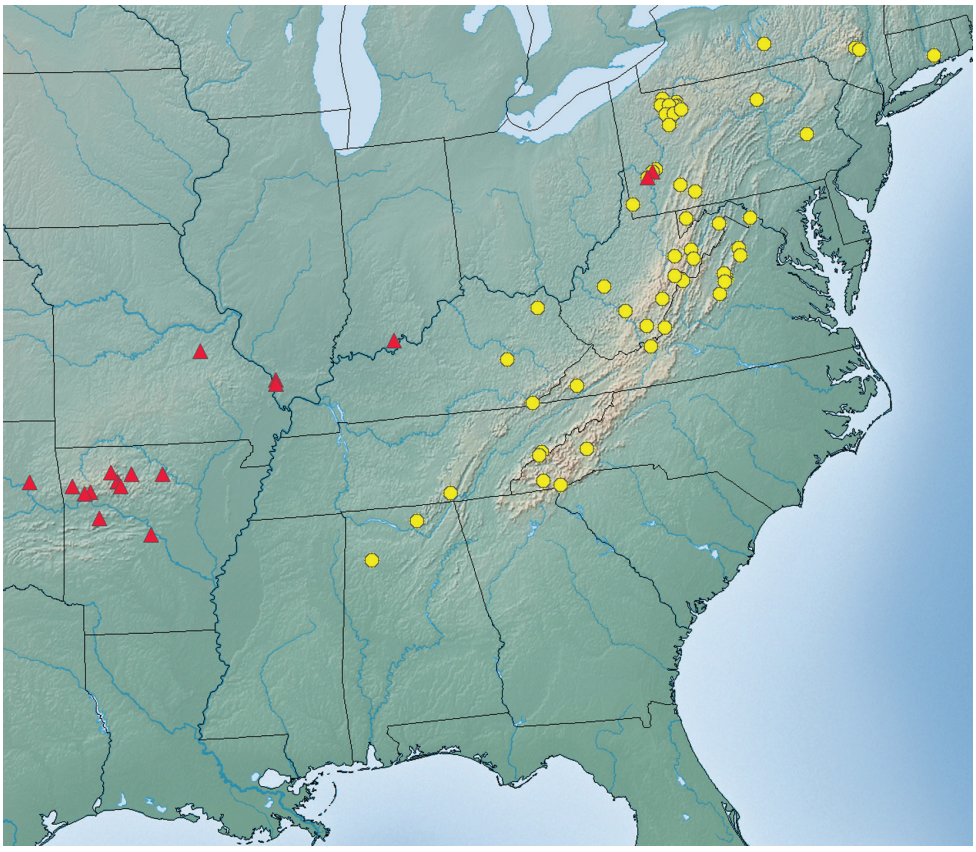


Figure 4. Collection localities for *Platynus daviesi* and *P. parmarginatus*. Yellow cercles = *P. daviesi*; red triangles = *P. parmarginatus*.

Table 1. Body proportions for *Platynus daviesi* and *P. parmarginatus*

Species	number	WH/WP (mean)	WP/LP (mean)	LE/LP (mean)	LE/WE (mean)
daviesi	24	0.65–0.72 (0.69)	1.19–1.31 (1.25)	3.41–3.73 (3.56)	1.54–1.62 (1.58)
parmarginatus	20	0.65–0.75 (0.70)	1.17–1.34 (1.26)	2.94–3.35 (3.19)	1.45–1.56 (1.50)

more or less distinct microsculpture microlines; elytral interval 3 with four or five discal setae on both sides in most specimens (77/88 = 88%), rarely with three on one (9/88 = 10%) or both sides (2/88 = 2%); median lobe of aedeagus more curved overall (Fig. 3). *Platynus parmarginatus* is found mainly west of the Appalachian Mountains (Fig. 4); I have seen specimens of that species from Pennsylvania (Allegheny County), Indiana (Perry County), Illinois (Union County), Missouri (Franklin County), Arkansas (Franklin, Newton, Pope, Stone, and Washington Counties), and Oklahoma (Cherokee County). Both species are sympatric in southwestern Pennsylvania.

While most specimens of *P. daviesi* are easy to distinguish from those of *P. parmarginatus*, those seen from southwestern Pennsylvania are structurally less distinct. The microsculpture on the vertex and disc of pronotum is less evident on average and the body proportions not so clearly segregated. Nevertheless, all specimens seen could be identified with confidence.

Regarding *Platynus parmarginatus*, Krinsky (1989) pointed out that the median lobes of the aedeagi of his Connecticut specimens did not resemble the median lobe illustrated by Lindroth (1966). In fact, the median lobe illustrated by Krinsky (1989: fig. 1) is that of *P. daviesi* while that, extracted from a syntype, illustrated by Lindroth (1966: fig. 323b) belongs to *P. parmarginatus*.

Adults of *Platynus tenuicollis* differ from those of *P. daviesi* in having the meso- and metatarsomeres 1–3 each with a well-defined dorsal keel and the laterobasal impressions of the pronotum impunctate. *Platynus tenuicollis* is morphologically variable, for example in the elytral microsculpture, and may consist of more than one species.

CO1 sequences were analyzed for 46 specimens of *Platynus* representing 11 species (Fig. 5). All barcoded specimens clustered congruently with their respective, morphologically defined species. Mean interspecific divergences ranged from 2.59–15.12% (Table 2). The intraspecific variation ranged from 0.00–1.32% (Table 2), except in *P. angustatus* which tabulated at 2.91% suggesting that possibly more than one species are assigned under this name. Indeed, Lindroth (1966: 646) pointed out that the apex of the median lobe in this species varies considerably in length, which is unusual in North American *Platynus* species. Specimens of *P. daviesi* were 2.69% divergent from *P. parmarginatus*, which is close to the divergence observed between *P. trifoveolatus* and *P. parmarginatus* (2.98%), two species that have long been separated on the basis of morphological differences. It is interesting to note that *P. trifoveolatus*, a morphologically quite isolated species within the eastern North American *Platynus* (see Lindroth 1966: 641), is the species genetically closest to *P. daviesi* (2.59%) among the 11 species analyzed (Table 2).

In order to help with identifying specimens of the new species, a key to all known eastern *Platynus* species is given.

Key to species of *Platynus* found east of the Mississippi River

1	Tarsomere 5 with relatively long setae underneath **2**
–	Tarsomere 5 without setae underneath, though with minute hairs in some specimens **4**
2 [1]	Legs yellow to reddish yellow. Elytral intervals 3, 5 and 7 each with double rows of setae aligned along striae..... ***P.* (*Batenus*) *hypolithos* (Say)**
–	At least femora, in most specimens entire legs, reddish brown to black. Elytral intervals 3, 5, and 7 without setae or each with single row of setae not aligned along striae..... **3**
3 [2]	Pronotum narrow, subquadrate (though appearing elongate), with rounded posterior angles; posterolateral setae well removed from angles. Frons with two rufous spots..... ***P.* (*Batenus*) *angustatus* Dejean**

–	Pronotum wide, transverse (though appearing subquadrate), with denticulate posterior angles; posterolateral setae relatively close to angles. Frons without rufous spots ..... ***P.* (*Platynus*) *indecentis* Liebherr & Will**
4 [1]	Meso- and metatarsomeres 1–3 each with dorsal keel..... ..... ***P.* (*Platynus*) *tenuicollis* (LeConte)**
–	Meso- and metatarsomeres 1–3 without dorsal keel **5**
5 [4]	Elytral microsculpture transverse to striate **6**
–	Elytral microsculpture isodiametric or irregularly isodiametric..... **8**
6 [5]	Metasternum short, length behind mesocoxa distinctly shorter than longitudinal diameter of mesocoxa; wings markedly reduced .... ***P.* (*Platynus*) *trifoveolatus* Beutenmüller**
–	Metasternum long, length behind mesocoxa longer than longitudinal diameter of mesocoxa; wings fully developed **7**
7 [6]	Vertex with isodiametric meshes. Pronotal disc with well-impressed microsculpture microlines. Antennomeres 1–3, femora, and tibiae ± reddish brown, tarsomeres paler. Elytral interval 3 with three discal setae at least on one side in most specimens (96% of specimens seen) ..... ***P.* (*Platynus*) *daviesi* sp. n.**
–	Vertex without meshes. Pronotal disc without or with shallowly impressed microlines. Antennomeres 1–3, femora, and tibiae yellowish to reddish, tarsomeres not paler. Elytral interval 3 with four or five discal setae on both side in most specimens (87.5% of specimens seen) .... ***P.* (*Platynus*) *parmarginatus* Hamilton**
8 [5]	Frons with two rufous spots..... **9**
–	Frons without rufous spots..... **10**
9 [8]	Pronotum without or with very small notch at each posterior angle. Metasternum shorter: length behind mesocoxa shorter than longitudinal diameter of mesocoxa. Antennomeres 1–3 black (except at extremities). Lateral depressions of pronotum not paler than disc ..... ***P.* (*Batenus*) *mannerheimii* (Dejean)**
–	Pronotum with distinct notch at each posterior angle. Metasternum longer: length behind mesocoxa longer than longitudinal diameter of mesocoxa. Antennomeres 1–3 reddish to reddish black. Lateral depressions of pronotum paler than disc..... ***P.* (*Batenus*) *cincticollis* (Say)**
10 [8]	Mandible markedly elongate, terebral blade narrowly but acutely curved apically, retinacular tooth distinct, not hidden by labrum in dorsal view [*fide* Liebherr (1990)] ..... ***P.* (*Batenus*) *prognathus* Van Dyke**
–	Mandible moderately elongate, terebral blade more widely and less acutely curved apically, retinacular tooth hidden by labrum in dorsal view **11**
11 [10]	Pronotum without evident microsculpture. Elytra proportionally shorter (LE/LP = 2.6–2.9; n=12), ± shiny, and ± oval; intervals convex..... ..... ***P.* (*Platynus*) *decentis* (Say)**
–	Pronotum with distinct microsculpture, particularly toward sides. Elytra proportionally longer (LE/LP = 3.4–3.8; n=12), dull, and ± parallel-sided; intervals flat or only slightly convex..... ***P.* (*Platynus*) *opaculus* LeConte**

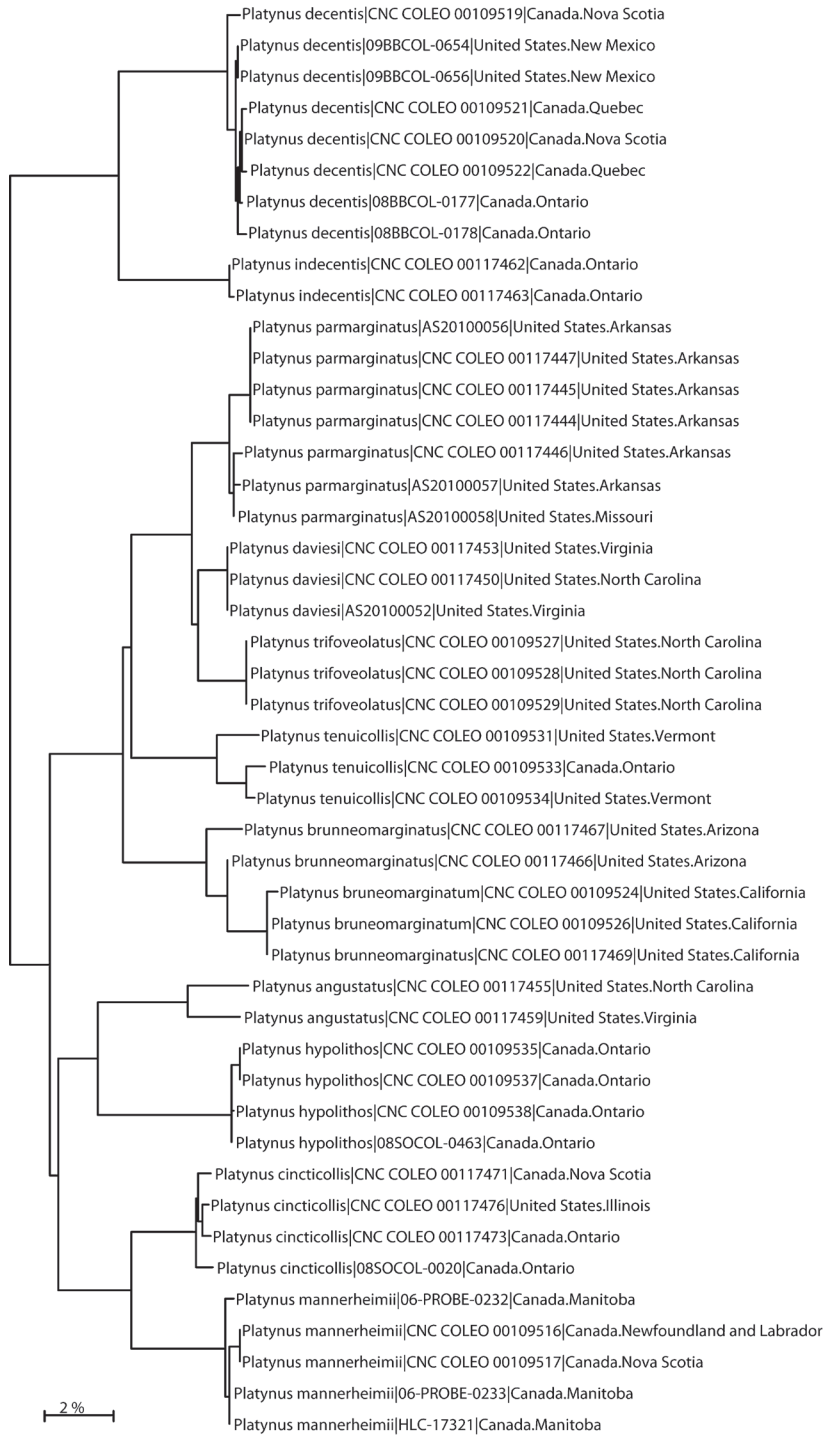


Figure 5. Neighbor-joining tree of genetic distances (Kimura-2-parameter model) of cytochrome c oxidase I (COI) in species of North American *Platynus*. Numbers in parentheses are specimen Sample IDs.

Table 2. Percent mitochondrial cytochrome c oxidase I (COI) sequence divergence among species of North American *Platynus* (mean ± standard deviation). Uncorrected average pairwise distances are shown. Cells below diagonal give the mean between-species distances in %. Diagonal (shaded) cells give the mean within-species distances in %. Number of sequences in square brackets after species names.

SPECIES	angustatus	brunneomarginatus	cincticollis	daviesi	decentis	hypolithos	indecentis	mannerheimii	parmarginatus	tenuicollis	trifoveolatus
angustatus [2]	2.91±0.89										
brunneomarginatus [5]	9.59±1.69	1.32±0.40									
cincticollis [4]	8.96±1.57	9.54±1.63	0.95±0.39								
daviesi [3]	8.86±1.63	6.84±1.34	10.78±1.72	0.00±0.00							
decentis [8]	13.97±2.19	13.81±1.96	14.11±2.17	13.12±1.89	0.35±0.15						
hypolithos [4]	6.35±1.35	11.74±1.82	9.35±1.54	9.31±1.67	14.23±2.12	0.00±0.00					
indecentis [2]	13.91±2.15	14.47±2.04	13.01±2.06	14.66±2.10	6.46±1.33	13.99±2.15	0.28±0.28				
mannerheimii [5]	11.29±1.85	9.03±1.61	4.97±1.16	11.05±1.78	14.17±2.10	12.26±1.92	13.26±2.00	0.28±0.19			
parmarginatus [7]	8.98±1.62	7.28±1.43	10.93±1.76	2.69±0.84	14.74±1.99	9.45±1.69	15.12±2.09	10.67±1.76	0.41±0.24		
tenuicollis [3]	10.26±1.69	5.87±1.23	8.69±1.61	4.90±1.11	12.82±1.82	11.91±1.88	12.15±1.82	7.79±1.48	4.96±1.11	1.15±0.45	
trifoveolatus [3]	9.37±1.61	7.22±1.44	10.22±1.69	2.59±0.83	14.20±1.95	11.29±1.84	14.67±2.08	11.05±1.79	2.98±0.89	5.72±1.24	0.00±0.00

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References

Krinsky WL (1989) *Platynus parmarginatus* Hamilton (Coleoptera: Carabidae): re-evaluation of aedeagal morphology and comments on geographical distribution. The Coleopterists Bulletin 43: 25–26.

Liebherr JK (1990) Redescription of *Platynus prognathus* Van Dyke (Coleoptera: Carabidae: Platynini) and circumscription of Lindroth's *decentis* and *hypolithos* groups. Journal of the New York Entomological Society 97: 430–437.

Liebherr JK, Will KW (1996) New North American *Platynus* Bonelli (Coleoptera: Carabidae), a key to species north of Mexico, and notes on species from the southwestern United States. The Coleopterists Bulletin 50: 301–320.

Lindroth CH (1966) The ground-beetles (Carabidae, excl. Cicindelinae) of Canada and Alaska. Part 4. Opuscula Entomologica Supplementum 29: 409–648.

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RESEARCH ARTICLE

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Discovery of the genus *Meggoleus* Townes, 1971 (Hymenoptera, Ichneumonidae, Tersilochinae) in Peru, with the description of two new species

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Abstract

The genus *Meggoleus* Townes, 1971 (Ichneumonidae, Tersilochinae) currently comprises two species, one from Brazil and one from Gabon. The genus is recorded from Peru for the first time, with a range extension of the type species, *Meggoleus spirator* Townes, 1971, and the discovery of two new species – *Meggoleus fuscatus* **sp. n.** and *Meggoleus pampahermosensis* **sp. n**. A key to the world's species is provided.

Keywords

Ichneumonidae, taxonomy, new species, Peru, Neotropical region, South America

Introduction

Tersilochinae is a cosmopolitan ichneumonid subfamily that is most species-rich in the Holarctic region (Yu et al. 2005; Khalaim 2007). Only the Palaearctic fauna has been studied moderately well, the majority of non-Palaearctic species are still undescribed (Khalaim and Sheng 2009). The Neotropical fauna of Tersilochinae is poorly known

and includes only four genera, *Allophrys*, *Barycnemis, Meggoleus* and *Stethantyx*, and with 13 described species (Yu et al. 2005). This is the first record of Tersilochinae for Peru.

Meggoleus Townes, 1971 is a small, tropical genus known until now from only two species. *Meggoleus spirator* Townes, 1971, the type species, was described from Curitiba, Southern Brazil (Townes 1971), and *M. townesi* Khalaim, 2007 is known only from Gabon in equatorial Africa (Khalaim 2007). The genus was also recorded from Costa Rica but not assigned to species (Gauld 1991).

The majority of Tersilochinae are koinobiont endoparasitoids of beetle larvae, mainly Curculionidae, Chrysomelidae, and Nitidulidae (Khalaim 2011), but nothing is known of the biology of *Meggoleus*.

The aim of this paper is to describe two new species of *Meggoleus* from Peru and document a range extension for *M. spirator* to this country. A key to the world's species is also provided.

Materials and methods

This work is based on material of the San Marcos University Natural History Museum, Peru (MUSM). A paratype of *M. spirator* deposited in the American Entomological Institute, Gainesville, Florida (AEIC) was examined. Specimens of *M. townesi* were not examined since the original description was sufficient; this species has a distinct morphology with the epicnemial carina reaching the midline of the anterior margin of the mesopleuron and the first metasomal segment without glymmae (Khalaim 2007). I present below a key to females of the four species; males were not included because only the male of *M. townesi* is known.

Morphological terminology and the format for descriptions generally follow those of Gauld (1991) and Khalaim (2011). Photomicrographs were prepared using a Nikon D1x digital camera attached to an Infinity K-2 long-distance microscopic lens. Specimens studied herein are deposited in San Marcos Natural History Museum, Peru (MUSM) and the Division of Entomology, University of Kansas Natural History Museum (SEMC).

Systematics

Genus *Meggoleus* Townes, 1971
http://species-id.net/wiki/Meggoleus

Remarks. The genus is characterized by the labium prolonged into a tongue that is about 0.33 as long as the height of head; antenna with 15 flagellomeres; foveate groove on mesopleuron almost straight, inclined 45° from horizontal; propodeum moderately long with a narrow median longitudinal carina or basal keel between the base of the propodeum and transverse carina; fore wing vein 2*m-cu* postfurcal, pretarsal claws

long, not pectinate; thyridial depression much longer than wide. The Afrotropical species, *M. townesi*, differs from the Neotropical species in that the epicnemial carina reaches the anterior margin of the mesopleuron near its midlength (in Neotropical species the epicnemial carina reaches dorsally almost to the subtegular ridge) and the first tergite lacks a glymma in *M. townesi* but is present in all known Neotropical species. However, the most striking feature of *Meggoleus* is the exceptionally large (Townes 1971; Khalaim 2007) and rounded propodeal spiracle a character not known among other ichneumonids.

***Meggoleus fuscatus* Alvarado, sp. n.**
urn:lsid:zoobank.org:act:3CFA76C6-DD61-45AA-851D-A81A5E9D65F4
http://species-id.net/wiki/Meggoleus_fuscatus
Figs 3, 6

Holotype. ♀ (Fig. 3), PERU: JU [Junín], Chanchamayo, S.N. Pampa Hermosa, 10°59'52.7"S, 75°25'34.3"W, 1757 m. 23–31.v.2011, Malaise [trap]. M. Alvarado (MUSM).

Paratypes. 4♀♀, same data as holotype (MUSM); 2♀♀, same data as holotype, but Pan trap (SEMC); 1♀, same locality and collector as holotype, but 75°25'35.9"W/ 10°59'51.8"S, 1940 m, 23–31.v.2011, Pan trap. M. Alvarado (MUSM); 1♀, same locality and collector as holotype, but10°59'48.9"S, 75°25'35.3"W, 1593 m, 23–31.v.2011, Pan trap (MUSM).

Comparison. *Meggoleus fuscatus* can be distinguished from other Peruvian species by the long foveate groove almost reaching the epicnemial carina anteriorly (Fig. 6) and darker body coloration (Figs 3, 6).

Description. ♀: Body length 3.9 mm (without ovipositor); fore wing length 3.6 mm. Lateral ocellus separated from eye by ca. 2.5–2.7× ocellar diameter. Flagellum of antenna filiform, short, with 15 flagellomeres; flagellomeres elongate, first flagellomere 3–4x as long as centrally broad; penultimate flagellomere 1.6–1.7× as long as centrally broad; all flagellomeres covered by short hairs, in addition to apical long bristles. Malar space as long as basal mandibular width. Clypeus broad, usually smooth on lower part, granulate and punctate on upper part. Mandible punctate basally, upper tooth much longer than lower tooth. Face, frons, vertex and occiput finely granulate and usually finely punctate (punctures sometimes indistinct because of granulation). Temple finely and sparsely punctate, smooth between punctures; temporal orbits smooth without setae. Mesoscutum entirely granulate, indistinctly punctate; notaulus weak; mesopleuron almost smooth and punctate; epicnemial carina reaching to subalar prominence; foveate groove elongate, almost reaching to epicnemial carina, oblique, with some transverse wrinkles; metapleuron finely punctate. Propodeum with basal keel distinct, 0.75–1.0× as long as apical area; spiracle round and large, separated from pleural carina; apical area elongate, acute anteriorly, with apical longitudinal carinae reaching transverse carina anteriorly, alutaceous and coarsely punctate; dorsolateral areas usually

Figures 1–3. Lateral habitus of Neotropical *Meggoleus* species. **1** *Meggoleus pampahermosensis* sp. n., holotype female **2** *M. spirator* Townes, paratype female **3** *M. fuscatus* sp. n., holotype female.

smooth with fine, sparse punctures. Fore wing with vein 2*m-cu* unpigmented anteriorly. Tibial spurs weakly curved; pretarsal claws long, not pectinate. Metasoma with tergite I moderately slender, 3.9–4.3× as long as posteriorly broad, in dorsal view polished with a row of setae in lateral part of tergite, over lateromedian longitudinal carina, extending from base of segment to dorsad spiracle, and with some sparse setae on posterior area; tergite 2 smooth, 2.1–2.3× as long as basal broad; thyridial depression distinctly elongate, about 1.5 times as long as wide; tergites 3–6 similarly sculptured; spiracle of tergite 1 large, separation between spiracles at most 1.9–2.0× spiracle diameter (maximum diameter measured between external margins of carina round spiracle); ovipositor short, upcurved, with shallow dorsal depression near apex, without teeth.

Head black except palpi, clypeus, and mandible yellowish, and malar space, scape, and pedicel reddish. Mesosoma predominantly black, sometimes partly with reddish tinge, particularly on pronotum and mesopleuron; legs yellowish except dorsum of metafemur, mesotibia, metatibia, and meso- and metatarsomeres brown. Wing membranes hyaline and weakly infuscate; pterostigma dark brown. Metasoma with segment 1 and dorsum of tergites 2–4 dark brown; remainder of metasoma yellowish.

Etymology. The specific epithet is the Latin term *fuscatus*, meaning "darkened", in reference to the darker body coloration of the species, compared to the other Neotropical species.

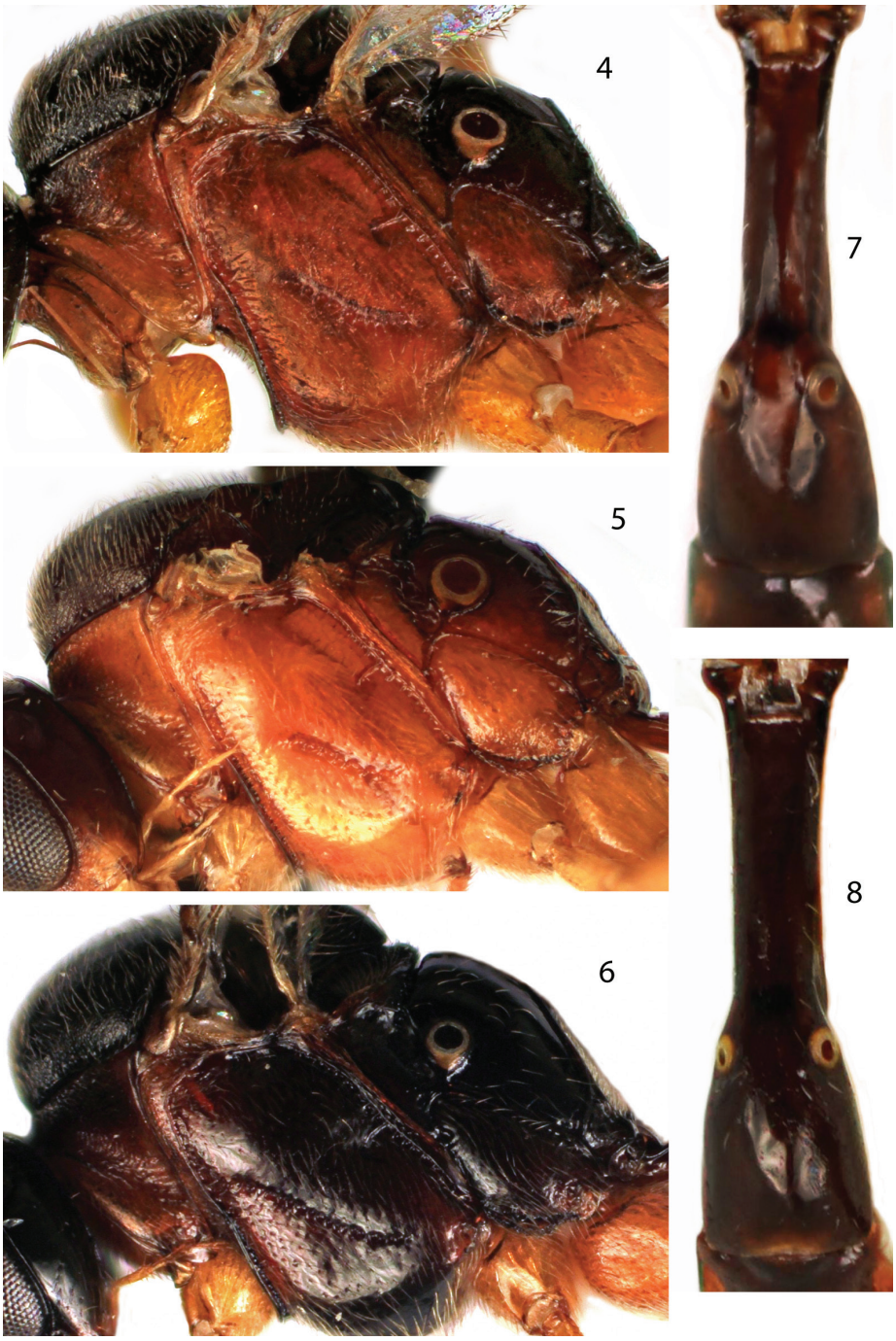
***Meggoleus pampahermosensis* Alvarado, sp. n.**
urn:lsid:zoobank.org:act:DA3BD80D-41E8-4710-85E6-82846B6DAEAB
http://species-id.net/wiki/Meggoleus_pampahermosensis
Figs 1, 4, 8

Holotype. ♀, PERU: JU [Junín], Chanchamayo, SN Pampa Hermosa, 10°59'48.9"S, 75°25'35.3"W, 1593 m, 23–31.v.2011, FIT [Flight Interception Trap], M. Alvarado (MUSM).

Paratypes. 3♀♀, same data as holotype (MUSM); 1♀, same data as holotype, but Pan trap (SEMC); 1♀, same data as holotype, but light trap (SEMC); 1♀, same locality and collector as holotype, 10°59'52.7"S, 75°25'34.3"W, 1757 m, 23–31.v.2011, Pan trap (MUSM).

Comparison. *Meggoleus pampahermosensis* most closely resembles *M. spirator* in that the foveate groove is short, and in general body coloration (Figs 1, 4). However, the new species differs in having the first metasomal segment with the spiracles smaller, more widely spaced, and in a more lateral position (Fig. 8).

Description. ♀: Body length 3.6 mm (without ovipositor); fore wing length 3.2 mm. Lateral ocellus separated from eye by ca. 1.6–1.8× ocellar diameter. Fagellum of antenna filiform, short, with 15 flagellomeres; flagellomeres elongate, first flagellomere 2.3–2.7× as long as centrally broad; penultimate flagellomere 1.3–1.4× as long as centrally broad; all flagellomeres covered by short hairs, in addition to apical long bristles. Malar space 0.7–0.8× as long as basal mandibular width. Clypeus broad, usually smooth on lower part, granulate and punctate on upper part. Mandible punctate basally, upper tooth much longer than lower tooth. Face, frons, vertex and occiput finely granulate and usually finely punctate (punctures sometimes indistinct because of granulation). Temple finely and sparsely punctate, smooth between puntures; temporal orbits smooth without setae. Mesoscutum entirely granulate, indistinctly punctate; notaulus weak; mesopleuron almost smooth and punctate; epicnemial carina reaching to subalar prominence; foveate groove short, oblique, scrobiculate; metapleuron finely punctate. Propodeum with basal keel distinct, 0.7–0.8× as long as apical area; spiracle round and large, separated from pleural carina; apical area elongate, acute anteriorly, with apical longitudinal carinae reaching transverse carina anteriorly, alutaceous and coarsely punctate; dorsolateral areas usually smooth with fine, sparse punctures. Fore wing with vein 2*m-cu* unpigmented anteriorly. Tibial spurs weakly curved; pretarsal claws long, not pectinate. Metasoma with tergite 1 moderately slender, 3.1–3.2× as long as posteriorly broad, in dorsal view polished with a row of setae in lateral part of tergite, over lateromedian longitudinal carina, extending from base of segment to dorsad spiracle, and with some sparse setae on posterior area; tergite 2 smooth, 1.6–1.8× as long as basal broad; thyridial depression distinctly elongate, about 1.5× as long as wide; tergites 3–6 similarly sculptured; spiracle of tergite 1 large, separation between spiracles at most 1.8–1.9× spiracle diameter (maximum diameter measured between external margins of carina around spiracle); ovipositor short, upcurved, with shallow dorsal depression near apex, without teeth.



Figures 4–8. Details of Neotropical *Meggoleus* species. **4** Lateral view of mesosoma of *Meggoleus pampahermosensis* sp. n., holotype female **5** Lateral view of mesosoma of *M. spirator* Townes, paratype female **6** Lateral view of mesosoma of *M. fuscatus* sp. n., holotype female **7** Dorsal view of first metasomal tergite of *M. spirator*, female **8** Dorsal view of first metasomal tergite of *M. pampahermosensis*, holotype female.

Head black except for palpi, clypeus, mandible, malar space, scape, and pedicel reddish. Mesosoma black except for pronotum, pleura, and sterna reddish; legs generally yellowish except base of pro- and mesotibiae, apex of metafemur, metatibia (with darker spots at base and apex), and metatarsus brown. Wing membranes generally hyaline and weakly infuscate; pterostigma dark brown. Metasoma with segment 1, dorsum of tergite 2, and basal parts of tergites 2–5 brown; remainder of metasoma yellowish.

Etymology. The specific epithet is based on the type locality of Pampa Hermosa.

***Meggoleus spirator* Townes, 1971**
http://species-id.net/wiki/Meggoleus_spirator
Figs 2, 5, 7

Material examined. BRAZIL: 1♀ (Paratype), Campina Grande nr. [near] Curitiba, Feb. 12, 1966, H. & M. Townes (AEIC). PERU: 1♀, MD [Madre de Dios], Reserva Comunal Amarakaeri, Qda Pinquiri, 70°51'33.96"W, 12°55'29.98"S, 421 m, 03–04. vi.2011, Malaise. [trap]B. Medina y L. Huerto (MUSM).

Key to species of *Meggoleus* (females only)

1 Epicnemial carina reaching anterior margin of mesopleuron near its midlength; first tergite without glymma (Afrotropical region) ..... ***M. townesi* Khalaim**

– Epicnemial carina reaching subalar prominence; first tergite with glymma (Neotropical region) **2**

2 Foveate groove on mesopleuron long, almost reaching to epicnemial carina (Fig. 6); metasoma brownish black to black, except pronotum reddish (Fig. 6) ..... ***M. fuscatus* sp. n.**

– Foveate groove short (Figs 4, 5); metasoma laterally and ventrally reddish (Figs 4, 5) **3**

3 Spiracle of tergite 1 large; separation between spiracles at most 1.1–1.2x spiracle diameter (maximum diameter measured between external margins of carina round spiracle), spiracles mostly located on dorsal part of tergite (Fig. 7) ..... ***M. spirator* Townes**

– Spiracle of tergite 1 moderate sized; separation between spiracles 1.8–1.9× spiracle diameter, spiracles mostly located on lateral part of tergite (Fig. 8) ... . ***M. pampahermosensis* sp. n.**

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References

Gauld ID (1991) The Ichneumonidae of Costa Rica 1, Introduction, keys to subfamilies, and keys to the species of the lower pimpliform subfamilies: Rhyssinae, Pimplinae, Poemeniinae, Acaenitinae and Cylloceriinae. Memoirs of the American Entomological Institute 47: 1–589.

Khalaim AI (2007) First records of *Meggoleus*, *Heterocola* and *Phradis* (Hymenoptera: Ichneumonidae: Tersilochinae) from the Afrotropical region, with description of four new species. African Invertebrates 48(2): 101–110.

Khalaim AI (2011) Tersilochinae of South, Southeast and East Asia, excluding Mongolia and Japan (Hymenoptera: Ichneumonidae). Zoosystematica Rossica 20(1): 96–148.

Khalaim AI, Sheng M-L (2009) Review of the Tersilochinae (Hymenoptera: Ichneumonidae) of China, with description of four new species. Zookeys 14: 67–81. doi: 10.3897/zookeys.14.141

Townes HK (1971) The genera of Ichneumonidae, Part 4. Memoirs of the American Entomological Institute 17: 1–372.

Yu DS, Achterberg Kv, Horstmann K (2005) World Ichneumonoidea 2004. In: Yu DS (Ed) Taxapad 2005 Data Base. [http://www.taxapad.com]