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

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Abstract

Commensal leucothoid amphipods have been collected from the canals of their sponge hosts throughout the Ryukyu Archipelago, Japan. Eleven new species are described in the genus *Leucothoe* with valuable location data and host records. An identification key to sponge-dwelling Leucothoidae of the Ryukyu Archipelago is provided.

Keywords

Leucothoidae, Ryukyus, Okinawa, Japan, new species, commensal, *Leucothoe akaoni*, *Leucothoe bise*, *Leucothoe daisukei*, *Leucothoe hashi*, *Leucothoe lecroyae*, *Leucothoe nagatekubi*, *Leucothoe nurununu*, *Leucothoe ouraensis*, *Leucothoe togatta*, *Leucothoe toribe*, *Leucothoe zanpa*

Introduction

The Leucothoidae are a marine family of gammaridean amphipods that can be found inhabiting sessile invertebrate hosts worldwide. The family currently contains 146 species in five genera and can be divided into two clades (White 2011, White and Reimer 2012a). Leucothoids are typically found as endocommensal associates of spong-

es, ascidians, and bivalve mollusks, where they utilize the feeding current produced by their hosts to feed (White 2011, White and Reimer 2012a).

There are currently 14 Leucothoidae species reported from Japan, with only seven of these from the Ryukyu Archipelago (White and Reimer 2012a). A map of the study area is available in part 1 (White and Reimer 2012a).

Methods

Specimens were collected via snorkeling and SCUBA at 47 locations throughout the Ryukyu Archipelago: Ishigaki–jima Island (4 locations), 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) (see map in White and Reimer 2012a). Detailed station data are available in Supplementary Table 1 in White and Reimer (2012a).

Entire sponges were isolated in zip-lock plastic bags for subsequent dissection in the laboratory or amphipods were captured individually in situ using a modified squirt bottle (following Thomas and Klebba 2006, 2007). When possible, pieces of sponge were preserved in 99% EtOH. Sponges were tentatively identified by Nicole de Voogd (Naturalis, Leiden) via photos of sponges and sponge spicules and by referencing Allen and Steene (2002). Coral rubble samples were also taken, elutriated, and sieved on location using both saltwater and formalin washes. Samples were sorted immediately. Amphipods were preserved in 2% seawater buffered formalin for morphological analysis and 99% ethanol for molecular studies.

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 unless noted 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 and sponge pieces are 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.

Figures 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; **p** paratype; **+** enlarged.

Taxonomy

***Leucothoe* Leach, 1814**
http://species-id.net/wiki/Leucothoe\according_to_White_et_al_2012

Generic diagnosis. Eyes, if present, generally well developed with 10 or more ommatidia. 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 akaoni* sp. n.**
urn:lsid:zoobank.org:act:F254D541-1FB7-432B-A62E-665D65E787B6
http://species-id.net/wiki/Leucothoe_akaoni
Figures 1, 2

Type material. Holotype female, 9.6 mm RUMF-ZC-1732, Zanpa Cape, Okinawa–jima Island, Okinawa, reef wall (26°26'27"N ,127°43'03"E), in canals of large white ball sponge, Tetillidae of Sollas, 1886, 30 m, Daisuke Ueno, col., 26 February 2011 (KNWOkinawa34C). Paratype male, 8.3 mm, RUMF-ZC-1733, Zanpa Cape, Okinawa–jima Island, Okinawa, reef wall (26°26'27"N, 127°43'03"E), in canals of large white ball sponge, 30–33 m, K.N. White and N.S. White, col., 3 April 2011 (KNWOkinawa40D).

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

Additional material examined. 1 specimen, RUMF-ZC-1734, KNW17Aug10; 1 specimen, NSMT-Cr 21871, KNWOkinawa10A; 3 specimens, NSMT-Cr 21872, KNWOkinawa15G; 2 specimens, RUMF-ZC-1735, KNWOkinawa16I; 2 specimens, RUMF-ZC-1736, KNWOkinawa29D; 0.5 specimen, NSMT-Cr 21873, KNWOkinawa34C; 15 specimens, NSMT-Cr 21874, KNWYaku2F; 1 specimen, RUMF-ZC-1737, KNWOkinawa40D.

Diagnosis (female). Ventral cephalic keel anteroventral margin with anteriorly projecting cusp. Right mandible lacinia mobilis with 2 rows of dentition. Maxilliped inner plates with short serrate robust setae. Gnathopod 1 coxa anterior margin serrate; basis anterior margin with 12 medium-length setae, posterior margin with 14 short setae. Gnathopod 2 basis anterior margin with 33 medium-length setae, posterior margin with 7 setae, distal margin with 4 curved setae; ischium with several short posterior and distal setae and posterodistal serrations; carpus distally truncate.

Description (female). Head. Anterior margin rounded, anterodistal margin evenly rounded; ventral cephalic keel anterior margin excavate, anteroventral margin with anteriorly projecting cusp, ventral margin straight; eyes present with more than 10 ommatidia, oval. Antenna 1 0.3 × body length, flagellum 10–articulate, peduncle article 1

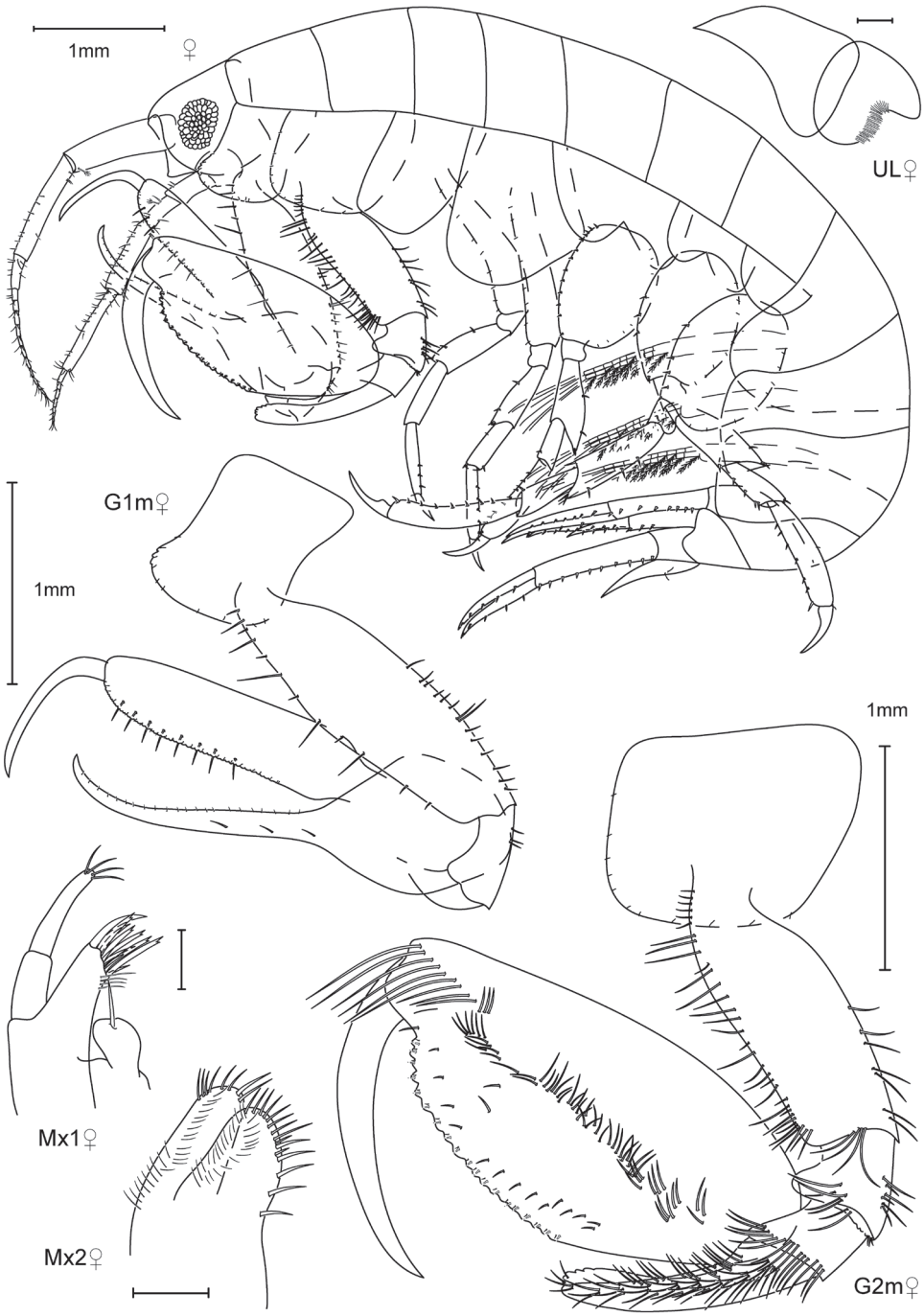

Figure 1. *Leucothoe akaoni* sp. n., holotype female, 9.6 mm, RUMF-ZC-1732.

width less than 2 × article 2, accessory flagellum absent. Antenna 2 0.3 × body length, subequal in length with antenna 1, flagellum 8–articulate. Mandibular palp ratio of articles 1–3 1.0: 2.6: 1.7, article 2 with 8–9 long distal setae, article 3 with 2 distal setae, incisors strongly dentate; left mandible with 16 raker spines, lacinia mobilis large, strongly toothed; right mandible with 14 raker spines, lacinia mobilis small, with 2 rows of dentition. Upper lip asymmetrically lobate, anterior margin setose. Lower lip inner lobes fused, bare; outer lobes with small gape, anterior margins setose. Maxilla 1 palp 2–articulate with 4 distal setae; outer plate with 9 distal robust setae and 4 distal slender setae. Maxilla 2 inner plate with 8 slender distal setae, 6 robust marginal setae, and facial setae; outer plate with 2 robust and 6 slender distal setae, 9 slender marginal setae, and facial setae. Maxilliped inner plates distal margin with a v-shaped indentation, with short serrate robust setae; outer plate inner margin smooth, reaching 0.3 × palp article 1, with simple marginal setae, facial setae present; palp article 4 subequal in length with article 3, distally acute.

Pereon. Coxae 1–4 relative widths 1.0: 1.3: 1.0: 1.4. Gnathopod 1 coxa with tiny marginal setae, anterior margin serrate, anterodistal margin produced, rounded, distal margin straight, posterior margin excavate, facial setae absent; basis slightly inflated, anterior margin with 12 short setae, posterior margin with 14 short setae; ischium with posterior setae; carpus linear, distal length 12.9 × width, proximal margin dentate, distal margin with 3 setae; propodus straight, palm dentate with 8 distal setae; dactylus smooth, reaching 0.5 × propodus length. Gnathopod 2 coxa broader than long, subequal in size with coxa 3, smooth, with tiny marginal setae; anterior margin straight, anterodistally rounded, distal margin straight, posterior margin straight, facial setae absent; basis slightly posteriorly expanded, anterior margin with 33 medium setae, posterior margin with 7 setae, distal margin with 4 curved setae; ischium with several short posterior and distal setae and posterodistal serrations; carpus 0.3 × propodus length, curved, distally truncate, anterior margin dentate; propodus with 1 mediofacial setal row displaced to midline, reaching 0.8 × propodus length, with 1 row of submarginal setae, posterior margin smooth, palm convex dentate; dactylus curved, proximal margin smooth, bare, anterior margin distally subacute, reaching 0.6 × propodus length. Pereopod 3 coxa length 1.3 × width, anterodistal corner overriding distal face of coxa 2 and extending below it, smooth, bare, anterior margin straight, distal margin oblique, posterior margin tapered, facial setae absent. Pereopod 4 coxa smooth, bare, 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: 1.4, 1: 1.4, 1: 1.3, posterior margins smooth, setose.

Pleon. Epimera 1 and 3 bare, epimeron 2 with ventral setae; epimeron 3 posteroventral corner subquadrate. Uropods 1–3 relative lengths 1.0: 0.8: 1.1. Uropod 1 peduncle and outer ramus 0.9 × inner ramus length; inner ramus with 3 robust setae; outer ramus with 7 robust setae. Uropod 2 peduncle length 0.7 × inner ramus length, outer ramus length 0.6 × inner ramus length; inner ramus with 4 robust setae; outer

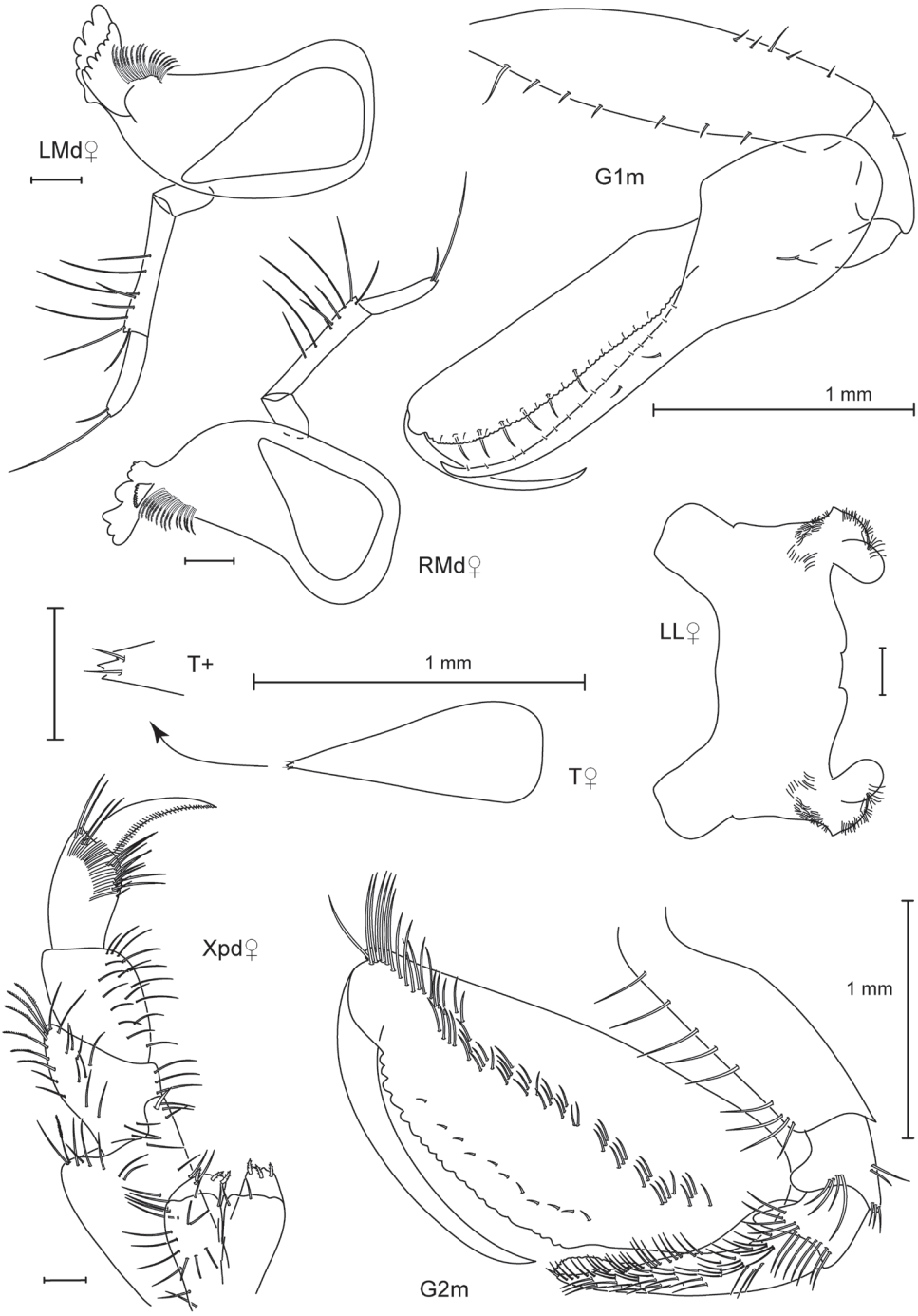

Figure 2. *Leucothoe akaoni* sp. n., holotype female, 9.6 mm, RUMF-ZC-1732; paratype male, 8.3 mm, RUMF-ZC-1733.

ramus with 7 robust setae. Uropod 3 peduncle 1.3 × inner ramus length, outer ramus length subequal in length with inner ramus; inner ramus with 4 robust setae; outer ramus with 5 robust setae. Telson 2.7 × longer than wide, apex strongly tridentate.

Male (sexually dimorphic characters). Gnathopod 1 basis anterior margin with 7 setae, posterior margin with 5 setae. Gnathopod 2 basis anterior margin with 9 long setae, posterior margin bare; ischium with posterodistal setae, smooth.

Etymology. After the Japanese words 'aka', meaning 'red', and 'oni', meaning 'barbarian' and referring to the red color and large size (pronounced ah-ka-oh-nee).

Ecology. In canals of sponges, spiculose green ball sponge, ?*Axinyssa* of Lendenfeld 1897 (Figure 24E); spiculose beige sponge, Niphatidae of Van Soest 1980 (probably *Niphates* of Duchassaing and Michelotti 1864), RUMF-ZP-6, KNWOkinawa10A (Figure 25I); large white ball sponge, Tetillidae, RUMF-ZP-11, KNWOkinawa40E (Figure 24I); and among coral rubble.

Relationships. *Leucothoe akaoni* sp. n. is similar to *Leucothoe denticulata* Costa, 1851 and *Leucothoe wuriti* Thomas & Klebba, 2007 in having a rounded head, ventral cephalic keel with projection, gnathopod 1 dactylus reaching greater than 0.2 × propodus length, and a truncate gnathopod 2 carpus. *Leucothoe akaoni* sp. n. differs from these species in lacking facial setae on coxa 1, having a setose posterior margin on the gnathopod 1 basis, gnathopod 2 basis anterior margin with more than 9 setae, slightly less broadly expanded bases on pereopods 5–7.

Remarks. *Leucothoe akaoni* sp. n. is deep red in color, darkest on the head, fading to deep orange posteriorly (Figure 23A). This species has been collected only on Yakushima Island, Kagoshima and from the northwestern coast of Okinawa–jima Island, Okinawa.

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

***Leucothoe bise* sp. n.**

urn:lsid:zoobank.org:act:316E130F-9811-4DAE-9666-4625146E5339
http://species-id.net/wiki/Leucothoe_bise
Figures 3, 4

Type material. Holotype male, 2.1 mm RUMF-ZC-1738, Bise, Okinawa–jima Island, Okinawa, reef wall (26°42'46"N, 127°52'44"E), among coral rubble, 7–15 m, K.N. White and N.S. White, col., 9 February 2011 (KNWOkinawa30D). Paratype female, 3.6 mm RUMF-ZC-1739, same station data as holotype. Paratype male, 3.3 mm RUMF-ZC-1846, Yona, Kunigami, Okinawa–jima Island, Okinawa, reef wall (26°45'56"N, 128°46'39"E), among coral rubble, 9 m, K.N. White and N.S. White, col., 23 October 2010 (KNWOkinawa15E).

Type locality. Bise, Okinawa–jima Island, Okinawa, Japan (26°42'46"N, 127°52'44"E).

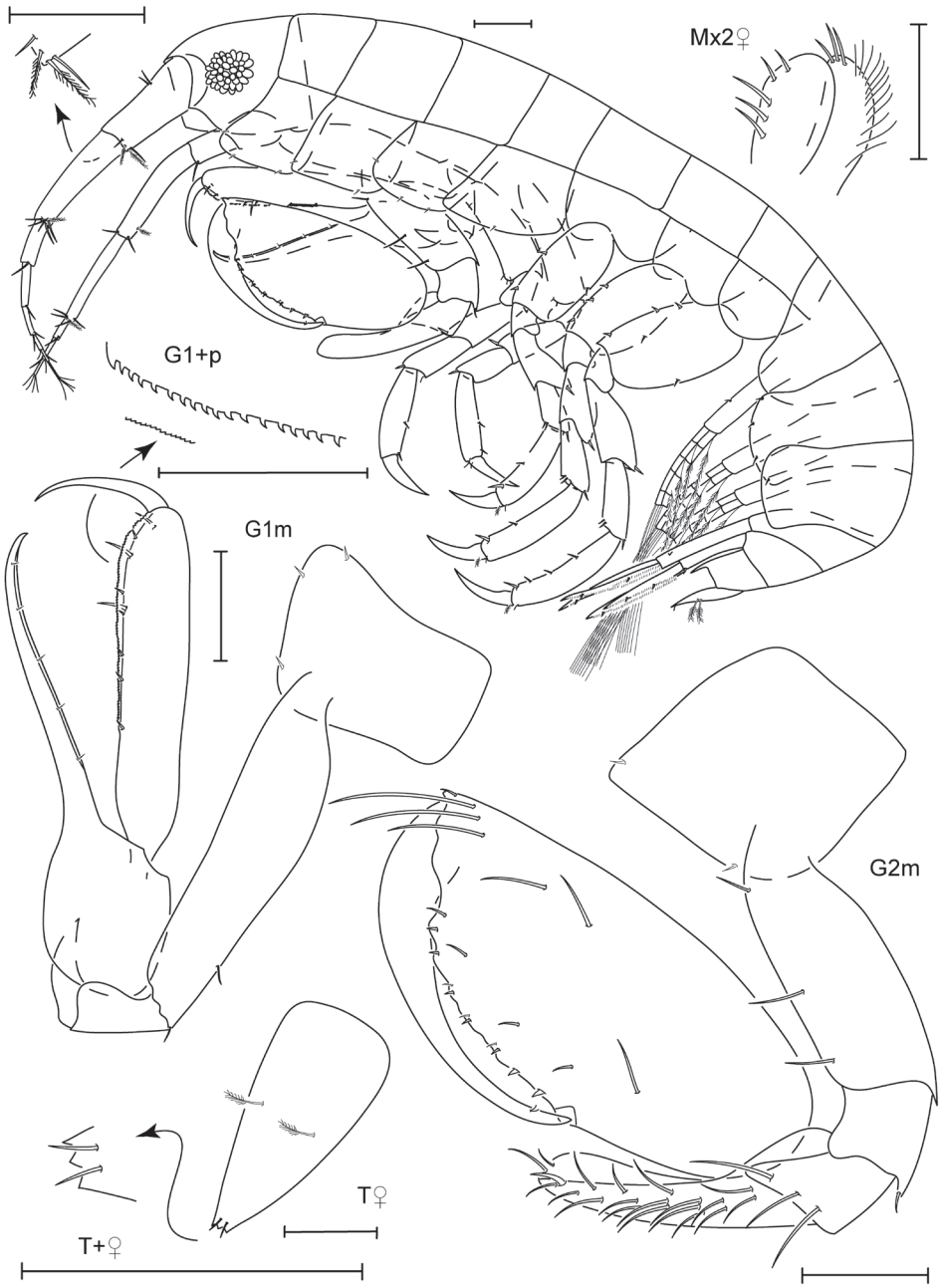

Figure 3. Leucothoe bise sp. n., holotype male, 2.1 mm, RUMF-ZC-1738; paratype female, 3.6 mm, RUMF-ZC-1739; paratype male, 3.3 mm RUMF-ZC-1846.

Additional material examined. 1 specimen, NSMT-Cr 21875, KNWOkinawa23F; 1 specimen, NSMT-Cr 21876, KNWOkinawa27E; 1 specimen, RUMF-ZC-1740, KNWOkinawa29B; 1 specimen, RUMF-ZC-1741, KNWOkinawa29M;

6 specimens, RUMF-ZC-1742, KNWOkinawa30D; 1 specimen, NSMT-Cr 21877, KNWOkinawa31G; 5 specimens, NSMT-Cr 21878, KNWOkinawa39I; 6 specimens, NSMT-Cr 21879, KNWOkinawa43C; 1 specimen, NSMT-Cr 21880, KNWOkinawa50C; 1 specimen, RUMF-ZC-1743, KNWOkinawa55A; 5 specimens, RUMF-ZC-1795, KNWYaku3G; 1 specimen, RUMF-ZC-1847, KNWOkinawa15E; 1 specimen, RUMF-ZC-1848, KNWOkinawa15E; 4 specimens, NSMT-Cr 21991, KNWOkinawa15E; 1 specimen, RUMF-ZC-1849, KNWOkinawa21C; 2 specimens, NSMT-Cr 21992, KNWOkinawa13E.

Diagnosis (male). Head anterodistal margin quadrate with cusp. Antenna 1 with many setulate-serrate setae. Maxilla 1 palp 1–articulate, margins constricted. Gnathopod 1 basis proximally widened; propodus palm serrate, saw-like. Gnathopod 2 carpus distally rounded; propodus with 2 mediofacial setal rows, primary mediofacial setal row very short. Pereopods 5–7 bases very narrowly expanded. Female gnathopod 1 basis posterior margin with 7 setae; gnathopod 2 carpus distally truncate.

Description (male). Head. Anterior margin truncate, anterodistal margin quadrate with cusp; ventral cephalic keel anterior margin transverse, anteroventral margin quadrate, ventral margin straight; eyes with more than 10 ommatidia, round. Antenna 1 0.3 × body length, with setulate-serrate setae, flagellum 4–articulate, peduncle article 1 width less than 2 × article 2, accessory flagellum 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: 3.0: 1.8, article 2 with 5 medium distal setae, article 3 with 2 distal setae, incisors strongly dentate; left mandible lacinia mobilis with 12 raker spines, large, strongly toothed; right mandible with 10 raker spines, lacinia mobilis small, strongly 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 and with 4 distal setae; outer plate with 5 distal robust setae and 4 distal setae. Maxilla 2 inner plate with 5 robust distal setae; outer plate with 3 robust distal setae and 11 slender distal marginal setae. Maxilliped inner plates distal margin with a v-shaped indentation, with short robust setae; outer plate inner margin smooth, reaching 0.2 × palp article 1, with simple marginal setae, facial setae absent; palp 4–articulate, article 4 subequal in length with article 3, distally acute.

Pereon. Coxae 1–4 relative widths 1.0: 1.0: 0.9: 1.1. Gnathopod 1 coxa smooth, with tiny marginal setae, anterodistal margin produced, subtriangular, distal margin straight, posterior margin excavate, facial setae absent; basis proximally widened, anterior margin bare, posterior margin with 2 setae; ischium bare; carpus linear, distal length 18.8 × width, proximal margin smooth, distal margin bare; propodus straight, palm serrate, saw-like, with 3 robust and 5 short proximal setae; dactylus smooth, reaching 0.4 × propodus length. Gnathopod 2 coxa broader than long, subequal in size to coxa 3, smooth, with tiny marginal setae, anterior margin straight, anterodistally acute, distal and posterior margins straight, facial setae absent; basis linear, anterior margin with 3 setae, posterior margin bare; ischium bare; carpus 0.3 × propodus length, curved, distally rounded, anterior margin smooth; propodus

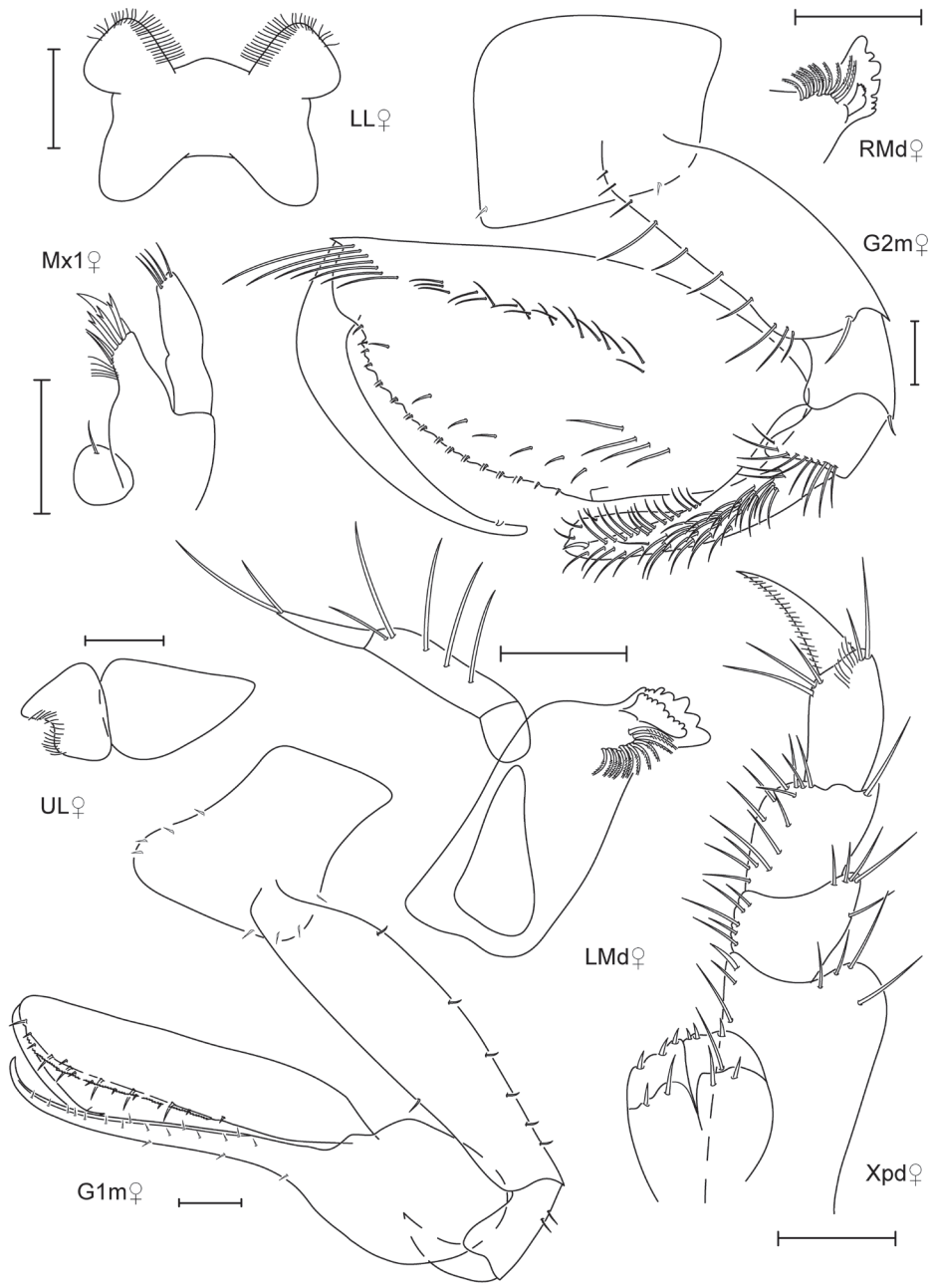

Figure 4. *Leucothoe bise* sp. n., paratype female, 3.6 mm, RUMF-ZC-1739.

with 2 mediofacial setal rows, primary mediofacial setal row above midline, reaching 0.4 × propodus length, secondary mediofacial setal row with 1 seta, with 1 row of submarginal setae, posterior margin smooth, palm convex, dentate; dactylus curved,

proximal margin smooth, with 2 setae, anterior margin distally subacute, reaching 0.6 × propodus length. Pereopod 3 coxa length 0.9 × width, anterodistal corner overriding distal face of coxa 2 and extending below it, smooth, with tiny marginal setae, anterior margin evenly rounded, distal margin slightly convex, posterior margin straight, facial setae absent. Pereopod 4 coxa smooth, with tiny marginal setae, anterior margin tapered, distal margin straight, posterior margin tapered, facial setae absent. Pereopods 5–7 coxae facial setae absent; bases width length ratios 1: 1.9, 1: 1.7, 1: 1.8, posterior margins smooth, setose.

Pleon. Epimera 1 and 3 bare, epimeron 2 with ventral setae; epimeron 3 posteroventral corner subquadrate, produced. Uropods 1–2 relative lengths 1.0: 0.9; inner and outer rami lined with short marginal setae. Uropod 1 peduncle 0.9 × inner ramus length, outer ramus subequal in length with inner ramus length; inner ramus with 2 robust setae, outer ramus with 1 robust seta. Uropod 2 peduncle 0.7 × inner ramus length, outer ramus 0.9 × inner ramus length; inner ramus with 1 robust seta, outer ramus with 2 robust setae. Uropod 3 missing. Telson 2.1 × longer than wide, with plumose facial setae, apex weakly tridentate.

Female (sexually dimorphic characters). Gnathopod 1 basis anterior margin with 1 seta, posterior margin with 7 setae; ischium with 2 posterior setae; carpus distal margin with 3 setae. Gnathopod 2 basis anterior margin with 10 medium setae, posteromedial margin with 1 seta; carpus distally truncate, reaching 0.5 × propodus length; propodus secondary mediofacial setal row with 4 setae, palm with more prominent tubercles.

Etymology. After the Japanese place name, 'Bise', and referring to the type locality. (Pronounced bee-say.)

Ecology. In canals of sponges, *Tedania* of Gray 1867 (Figure 25E); and among coral rubble.

Relationships. *Leucothoe bise* sp. n. is similar to *Leucothoe hortapugai* Winfield et al., 2009 and *Leucothoe kensleyi* Thomas & Klebba, 2006 in having a quadrate anterior head margin, anterodistal head margin quadrate with cusp, narrow pereopod 5–7 bases, and gnathopod 1 dactylus reaching less than 0.2 × propodus. It differs from these species in having a quadrate keel without a projection, maxilla 1 palp 1–articulate, margins constricted, bare gnathopod 1 basis anterior margin, gnathopod 2 carpus distally rounded and reaching less than 0.4 × propodus length, and a produced posteroventral margin on epimeron 3.

Remarks. Some sexually dimorphic characters may be due to the larger size of the female. Some specimens have larger serrations on the saw-like gnathopod 1 propodus palm, suggesting morphological variation in this character, perhaps depending on size. *Leucothoe bise* sp. n. is translucent orange in color (Figure 24B). This species has been collected on Iriomote–jima and throughout the western coast of Okinawa–jima Island, Okinawa.

Distribution. East China Sea: Okinawa–jima Island, Iriomote–jima Island (both Okinawa), Japan.

***Leucothoe daisukei* sp. n.**
urn:lsid:zoobank.org:act:93EDC549-9973-448C-A5E0-88ED1BD45443
http://species-id.net/wiki/Leucothoe_daisukei
Figures 5, 6

Type material. Holotype male, 4.4 mm RUMF-ZC-1744, Zanpa Cape, Okinawa–jima Island, Okinawa, reef wall (26°26'27"N, 127°43'03"E), in canals of large white ball sponge, Tetillidae, 30 m, Daisuke Ueno, col., 26 February 2011 (KNWOkinawa34F). Paratype female, 2.8 mm RUMF-ZC-1745, Zanpa Cape, Okinawa–jima Island, Okinawa, reef wall (26°26'27"N, 127°43'03"E), among coral rubble, 10–30 m, K.N. White and N.S. White, col., 26 February 2011 (KNWOkinawa34N).

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

Additional material examined. 2 specimens, KNWOkinawa34E; 2 specimens, KNWIshigaki2C; 1 specimen, RUMF-ZC-1746, KNWOkinawa40E; 1 specimen, NSMT-Cr 21881, KNWOkinawa34F.

Diagnosis (male). Body stout. Antennae robust, short. Ventral cephalic keel anterior margin excavate. Mandibular palp article 2 robust. Maxilla 1 palp 1–articulate. Maxilliped inner plates with short serrate robust setae. Pereopods 5 and 7 coxae with facial setae. Gnathopod 2 stout.

Description (male). Head. Anterior margin rounded, anterodistal margin subquadrate; ventral cephalic keel anterior margin excavate, anteroventral margin subquadrate, ventral margin oblique; eyes with more than 10 ommatidia, round. Antenna 1 0.3 × body length, flagellum 6–articulate, peduncle article 1 width less than 2 × article 2, accessory flagellum absent. Antenna 2 0.3 × body length, subequal in length with antenna 1, flagellum 6–articulate. Mandibular palp ratio of articles 1–3 1.0: 2.3: 1.8, article 2 robust, with 2–3 long distal setae, article 3 with 2 distal setae, incisors strongly dentate; left mandible with 11 raker spines, lacinia mobilis large, strongly toothed; right mandible with 11 raker spines, lacinia mobilis small, strongly dentate. Upper lip asymmetrically lobate, anterior margin setose. Lower lip inner lobes fused, setose; outer lobes with moderate gape, anterior margins setose. Maxilla 1 palp 1–articulate with 4 distal setae; outer plate with 4 distal robust setae and 10 distal setae. Maxilla 2 inner plate with 7 robust distal setae; outer plate with 3 robust distal setae and 16 slender distal marginal setae. Maxilliped inner plates distal margin with a v-shaped indentation, with short and long serrate robust setae; outer plate inner margin smooth, reaching 0.2 × palp article 1, with simple marginal setae, facial setae absent; palp article 2 with setulate-serrate marginal setae; article 4 subequal in length with article 3, distally acute.

Pereon. Coxae 1–4 relative widths 1.0: 1.2: 0.8: 1.3. Gnathopod 1 coxa smooth, with tiny marginal setae, anterodistal margin produced, rounded, distal margin straight, posterior margin excavate, facial setae absent; basis linear, anterior margin with 3 setae, posterior margin with 1 seta; ischium bare; carpus linear, distal length

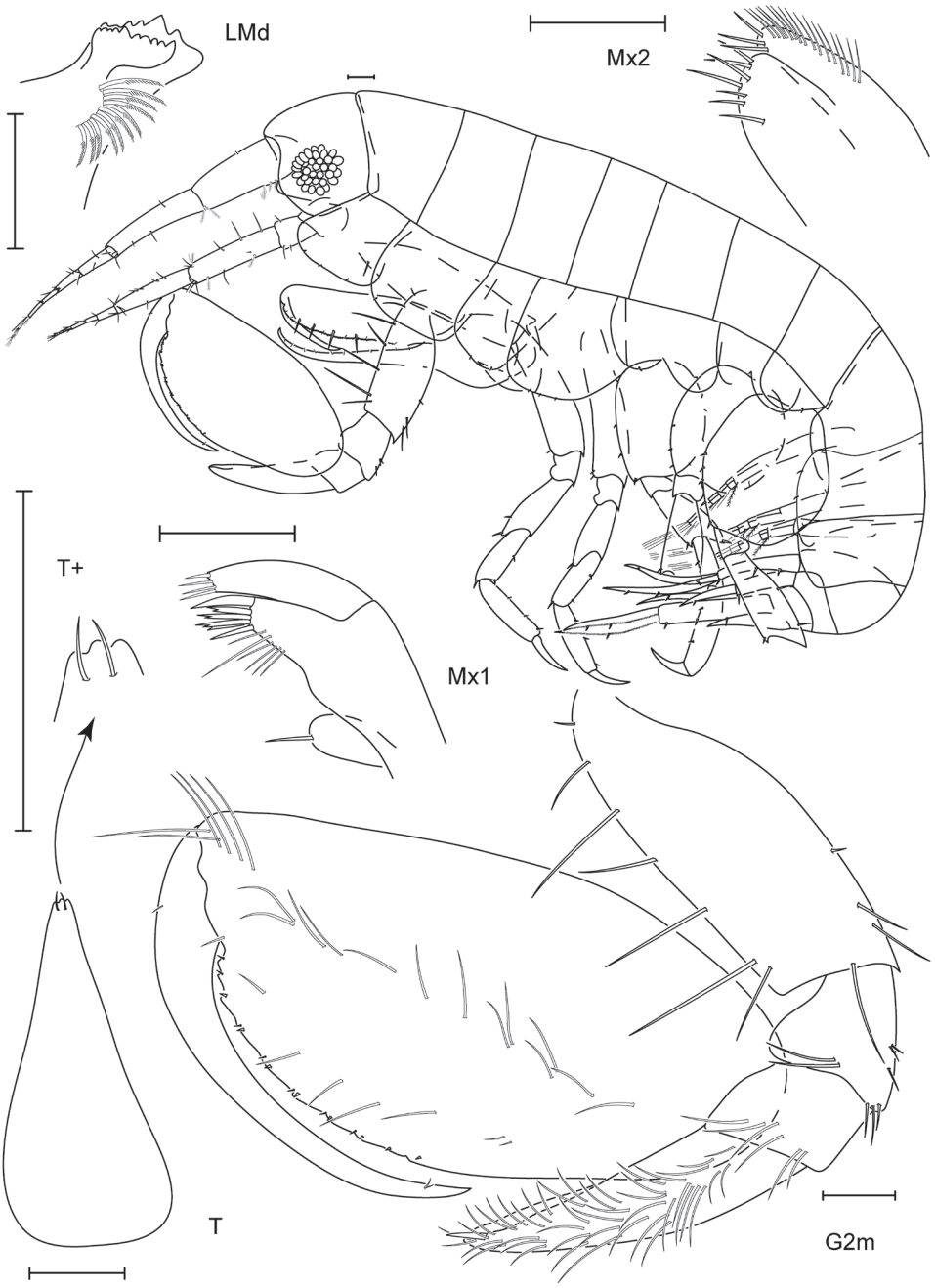

Figure 5. *Leucothoe daisukei* sp. n., holotype male, 4.4 mm, RUMF-ZC-1744.

12.8 × width, proximal margin dentate, distal margin with 2 short setae; propodus straight, palm dentate with 4 long and 8 short distal setae; dactylus smooth, reaching 0.5 × propodus length. Gnathopod 2 coxa broader than long, subequal in size

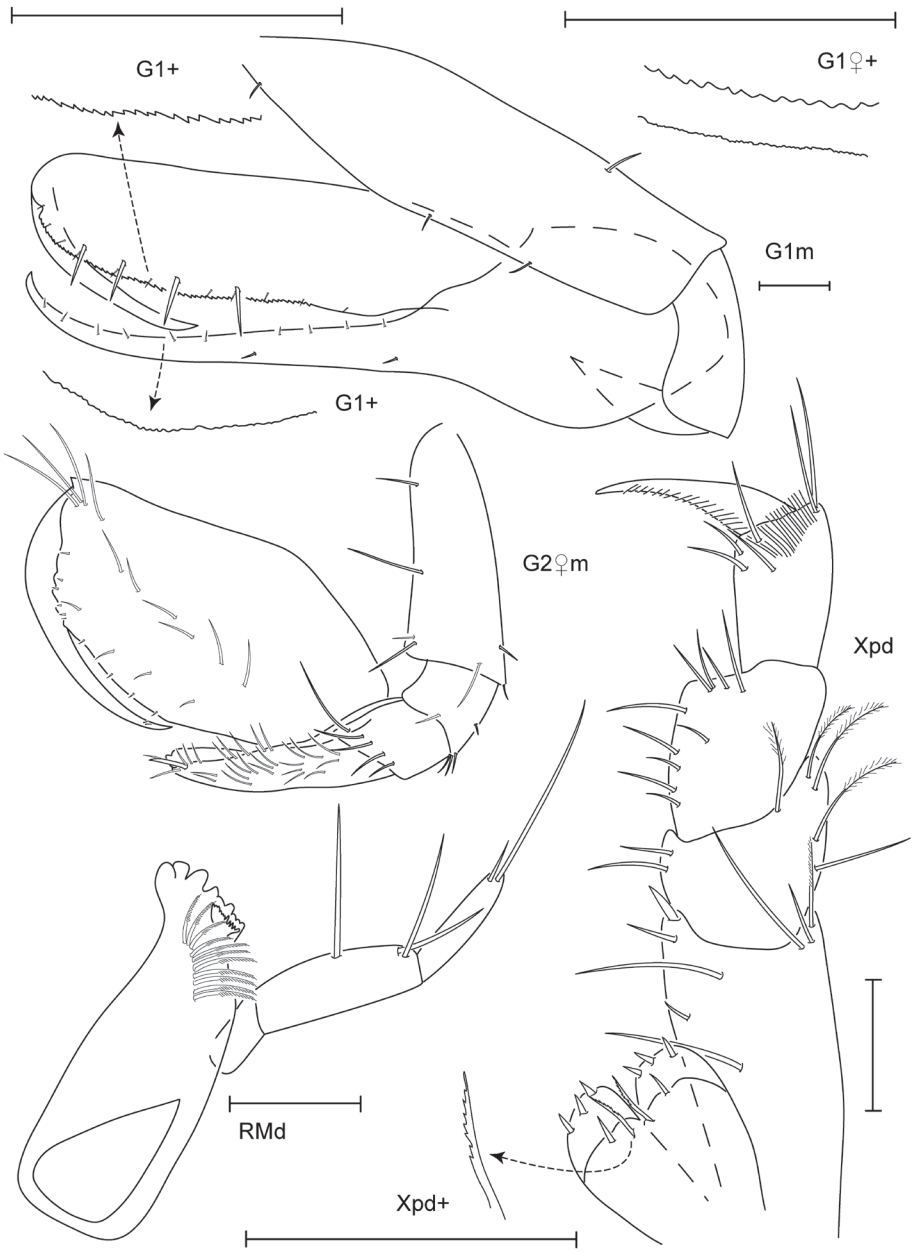

Figure 6. *Leucothoe daisukei* sp. n., holotype male, 4.4 mm, RUMF-ZC-1744; paratype female, 2.8 mm, RUMF-ZC-1745.

with coxa 3, smooth, with tiny marginal setae, anterior margin rounded, anterodistally rounded, distal margin straight, posterior margin straight, facial setae absent; basis distally expanded, anterior margin with 7 long setae, posterior margin with

3 setae, posteromedial margin with 1 long seta; ischium with distal, posterior, and posterodistal setae; carpus 0.4 × propodus length, curved, distally tapered, anterior margin smooth; propodus with 1 mediofacial setal row displaced to midline, reaching 0.8 × propodus length, with 1 row of submarginal setae, posterior margin smooth, palm convex, dentate; dactylus curved, proximal margin smooth with 2 setae, anterior margin distally acute, reaching 0.8 × propodus length. Pereopod 3 coxa length 1.4 × width, anterodistal corner overriding distal face of coxa 2 and extending below it, smooth, with tiny marginal setae, anterior margin straight, distal margin slightly convex, posterior margin straight, facial setae absent. Pereopod 4 coxa smooth, bare, anterior margin straight, distal margin evenly rounded, posterior margin tapered, facial setae absent. Pereopods 5 and 7 coxae facial setae present, pereopod 6 coxa facial setae absent. Pereopods 5–7 bases width length ratios 1: 1.3, 1: 1.1, 1: 1.1, posterior margins smooth, setose.

Pleon. Epimera 1 and 3 bare, epimeron 2 with ventral setae; epimeron 3 posteroventral corner subquadrate. Uropods 1–3 relative lengths 1.0: 0.8: 1.1. Uropod 1 peduncle and inner ramus 0.8 × inner ramus length; inner ramus with 2 robust setae, outer ramus with 1 robust seta. Uropod 2 peduncle 0.6 × inner ramus length, outer ramus 0.9 × inner ramus length; inner and outer rami each with 1 robust seta. Uropod 3 peduncle 1.1 × inner ramus length, outer ramus length 0.9 × inner ramus length; inner and outer rami lined with short marginal setae, inner ramus with 1 robust seta, outer ramus with 2 robust setae. Telson 2.1 × longer than wide, apex weakly tridentate.

Female (sexually dimorphic characters). Gnathopod 1 basis anterior margin with 1 seta, posterior margin with 2 setae; carpus distal margin with 1 short seta; propodus palm with 2 long and 7 short distal setae; dactylus with 2 proximal setae. Gnathopod 2 basis anterior margin with 4 long setae, posterior margin with 2 setae, posteromedial margin with 1 medium seta; carpus anterior margin dentate.

Etymology. Named for Dr. Daisuke Ueno, who collected the type specimens of this species. Dr. Ueno has shared valuable specimens and collection locations on Okinawa–jima Island.

Ecology. In canals of large white ball sponge, Tetillidae, RUMF-ZP-11, KNWOkinawa40E (Figure 24I); and among coral rubble.

Relationships. *Leucothoe daisukei* sp. n. is similar to *Leucothoe madrasana* Sivaprakasam, 1969 in having a subquadrate anterodistal head margin and gnathopod 1 dactylus reaching greater than 0.2 × propodus length. *Leucothoe daisukei* sp. n. differs from this species in having a rounded anterior head margin, 1–articulate maxilla 1 palp, a smooth gnathopod 1 carpus proximal margin, and a tapered gnathopod 2 carpus distal margin.

Remarks. *Leucothoe daisukei* sp. n. is peach in color, darkest along pereonite edges (Figure 23F). This species has been collected only on Ishigaki–jima Island and from 30 meters on the west coast of Okinawa–jima Island, Okinawa.

Distribution. East China Sea: Okinawa–jima Island, Ishigaki–jima Island (both Okinawa), Japan.

***Leucothoe hashi* sp. n.**
urn:lsid:zoobank.org:act:40C1B3A0-33C9-419C-A5D8-267DA462931C
http://species-id.net/wiki/Leucothoe_hashi
Figures 7, 8

Type material. Holotype male, 2.5 mm RUMF-ZC-1747, Mizugama, Okinawa–jima Island, Okinawa, reef wall (26°21'35"N, 127°44'22"E), in canals of yellow-beige sponge, *Callyspongia* of Duchassaing and Michelotti 1864, 8–10 m, K.N. White, col., 10 April 2011 (KNWOkinawa42A). Paratype female, 2.5 mm RUMF-ZC-1748, same station data as holotype. Paratype male, 1.9 mm RUMF-ZC-1749, Kaichu Doro, Okinawa–jima Island, Okinawa, seagrass bed (26°19'56"N, 127°55'23"E), in canals of green, hard branching sponge, ?*Clathria* (*Thalysias*) *reinwardti* Vosmaer, 1880, 1 m, K.N. White, col., 21 August 2010 (KNW_21Aug10).

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

Additional material examined. 1 specimen, RUMF-ZC-1750, KNW21Aug10; 2 specimens, RUMF-ZC-1751, KNWOkinawa11B; 1 specimen, RUMF-ZC-1752, KNWOkinawa12H; 1 specimen, NSMT-Cr 21882, KNWOkinawa12H; 1 specimen, RUMF-ZC-1753, KNWOkinawa16D; 1 specimen, RUMF-ZC-1754, KNWOkinawa21B; 1 specimen, NSMT-Cr 21883, KNWOkinawa21E; 1 specimen, RUMF-ZC-1755, KNWOkinawa22B; 1 specimen, NSMT-Cr 21884, KNWOkinawa25C; 1 specimen, NSMT-Cr 21885, KNWOkinawa29C; 2 specimens, NSMT-Cr 21886, KNWOkinawa31B; 4 specimens, RUMF-ZC-1756, KNWOkinawa31F; 3 specimens, RUMF-ZC-1757, KNWOkinawa33E; 1 specimen, NSMT-Cr 21887, KNWOkinawa33E; 3 specimens, NSMT-Cr 21888, KNWOkinawa34G; 4 specimens, RUMF-ZC-1758, KNWOkinawa42A; 2 specimens, NSMT-Cr 21889, KNWOkinawa43A; 3 specimens, NSMT-Cr 21890, KNWOkinawa44A; 2 specimens, RUMF-ZC-1759, KNWIriomote2H; 1 specimen, NSMT-Cr 21891, KNWOkinawa51C; 1 specimen, RUMF-ZC-1760, KNWOkinawa53A; 2 specimens, NSMT-Cr 21892, KNWOkinawa53D; 1 specimen, RUMF-ZC-1761, KNWYaku5O; 2 specimens, RUMF-ZC-1762, KNWTokuno4C; 2 specimens, RUMF-ZC-1796, KNWYaku3J; 1 specimen, RUMF-ZC-1797, KNWYaku5I; 2 specimens, RUMF-ZC-1798, KNWOkinawa43D.

Diagnosis (male). Antenna 1 accessory flagellum 1–articulate. Mandibular palp article 3 shorter than article 1. Maxilla 1 palp 1–articulate. Maxilliped outer plate tuberculate. Gnathopod 1 carpus and propodus very slender, chopstick-like; carpus proximal margin with denticles; propodus palm serrate with triangular teeth. Gnathopod 2 propodus with 2 mediofacial setal rows. Pereopods 5–7 bases narrowly expanded.

Description (male). Head. Anterior margin rounded, anterodistal margin evenly rounded; ventral cephalic keel anterior margin slightly excavate, anteroventral margin subquadrate, ventral margin straight; eyes with more than 10 ommatidia, round. Antenna 1 0.3 × body length, flagellum 5–articulate, peduncle article 1 width less than 2 × article 2, accessory flagellum 1–articulate. Antenna 2 0.2 × body length, slightly

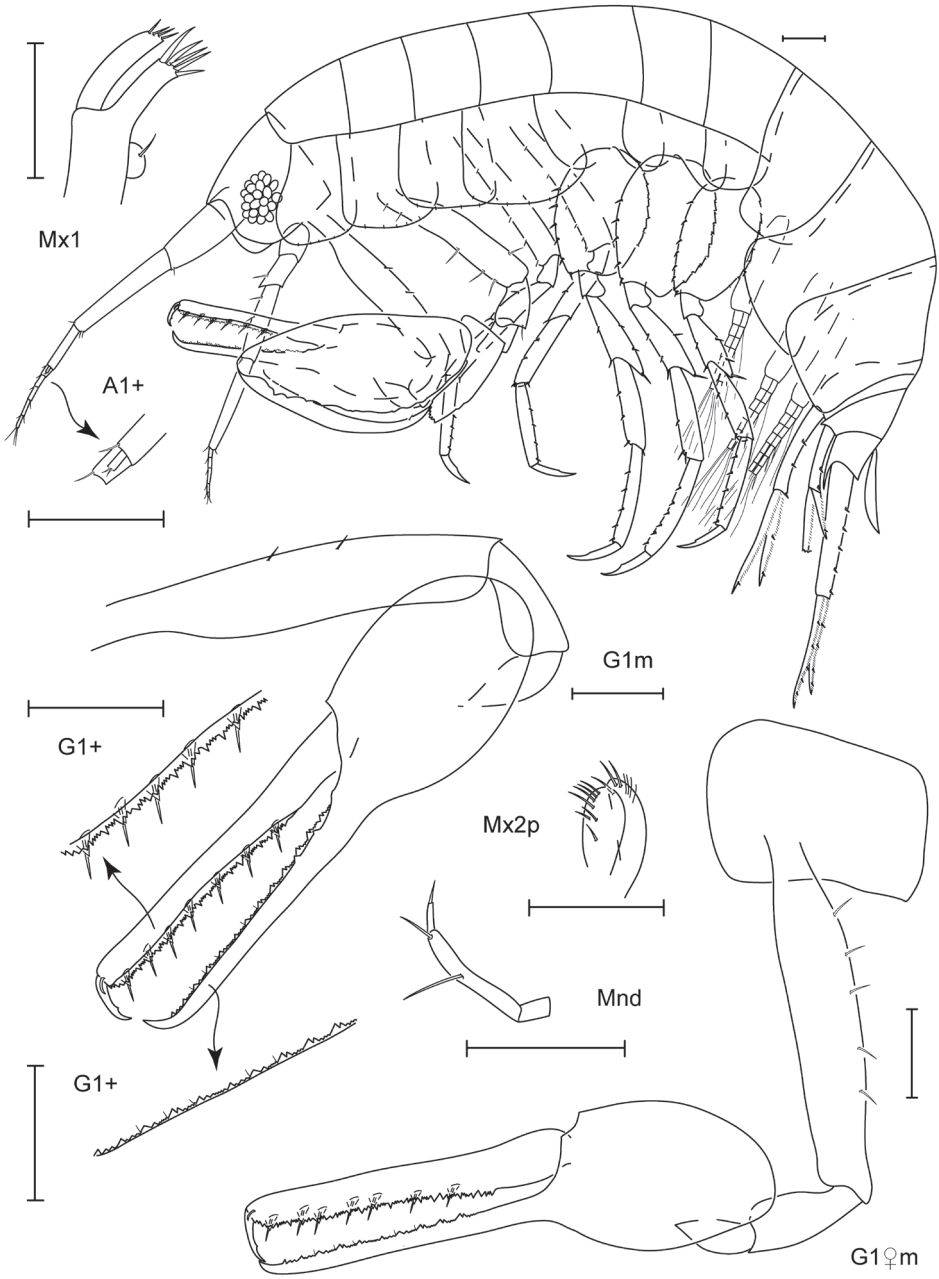

Figure 7. *Leucothoe hashi* sp. n., holotype male, 2.5 mm, RUMF-ZC-1747; paratype female, 2.5 mm, RUMF-ZC-1748.

shorter than antenna 1, flagellum 5–articulate. Mandibular palp ratio of articles 1–3 1.0: 2.0: 0.4, article 2 with 2 medium distal setae, article 3 with 1 distal seta, incisors weakly dentate; left mandible with 6 raker spines, lacinia mobilis large, strongly

toothed; right mandible with 6 raker spines, lacinia mobilis small, strongly 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 with 4 distal setae; outer plate with 5 distal robust setae. Maxilla 2 inner plate with 5 robust distal setae and 2 robust facial setae; outer plate with 3 robust distal setae and 4 slender distal marginal setae. Maxilliped inner plates distal margin with a v-shaped indentation, with short robust setae; outer plate inner margin tuberculate, reaching 0.1 × palp article 1, with simple marginal setae, facial setae absent; palp article 4 subequal in length with article 3, distally acute.

Pereon. Coxae 1–4 relative widths 1.0: 1.2: 1.2: 1.3. Gnathopod 1 coxa smooth, with tiny marginal setae, anterodistal margin produced, rounded, distal margin straight, posterior margin slightly excavate, facial setae absent; basis distally expanded, anterior margin bare, posterior margin with 2 short setae; ischium bare; carpus linear, distal length 15.8 × width, proximal margin with denticles, distal margin bare; propodus straight, palm serrate with 7 distal triangular teeth and 7 distal setae; dactylus with small proximal notch, reaching 0.2 × propodus length. Gnathopod 2 coxa as long as broad, subequal in size with coxa 3, smooth, with tiny marginal setae, anterior margin expanded, anterodistally rounded, distal and posterior margins straight, facial setae absent; basis distally expanded, anterior margin with 5 medium setae, posterior margin with 1 seta; ischium with 1 posterodistal seta; carpus 0.3 × propodus length, curved, distally truncate, anterior margin dentate; propodus with 2 mediofacial setal rows, primary mediofacial setal row above midline, reaching 0.8 × propodus length, secondary mediofacial setal row with 2 setae, with 1 row of submarginal setae, posterior margin smooth, palm convex with 4 small denticles; dactylus curved, proximal margin smooth with 1 seta, anterior margin distally subacute, reaching 0.8 × propodus length. Pereopod 3 coxa length 1.0 × width, anterodistal corner overriding distal face of coxa 2 and extending below it, 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: 1.5, 1: 1.5, 1: 1.7, 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: 0.8: 1.2; inner and outer rami lined with short marginal setae. Uropod 1 peduncle and outer ramus 0.8 × inner ramus length; inner ramus with 6 robust setae and outer ramus with 5 robust setae. Uropod 2 peduncle 0.7 × inner ramus length, outer ramus 0.6 × inner ramus length; inner ramus with 3 robust setae and outer ramus with 4 robust setae. Uropod 3 peduncle 1.2 × inner ramus length, outer ramus 0.9 × inner ramus length; inner ramus with 4 robust setae and outer ramus with 7 robust setae. Telson 2.0 × longer than wide, apex weakly tridentate, almost bidentate.

Female (sexually dimorphic characters). Gnathopod 1 basis posterior margin with 5 short setae. Gnathopod 2 basis posterior margin with 4 medium setae; ischium

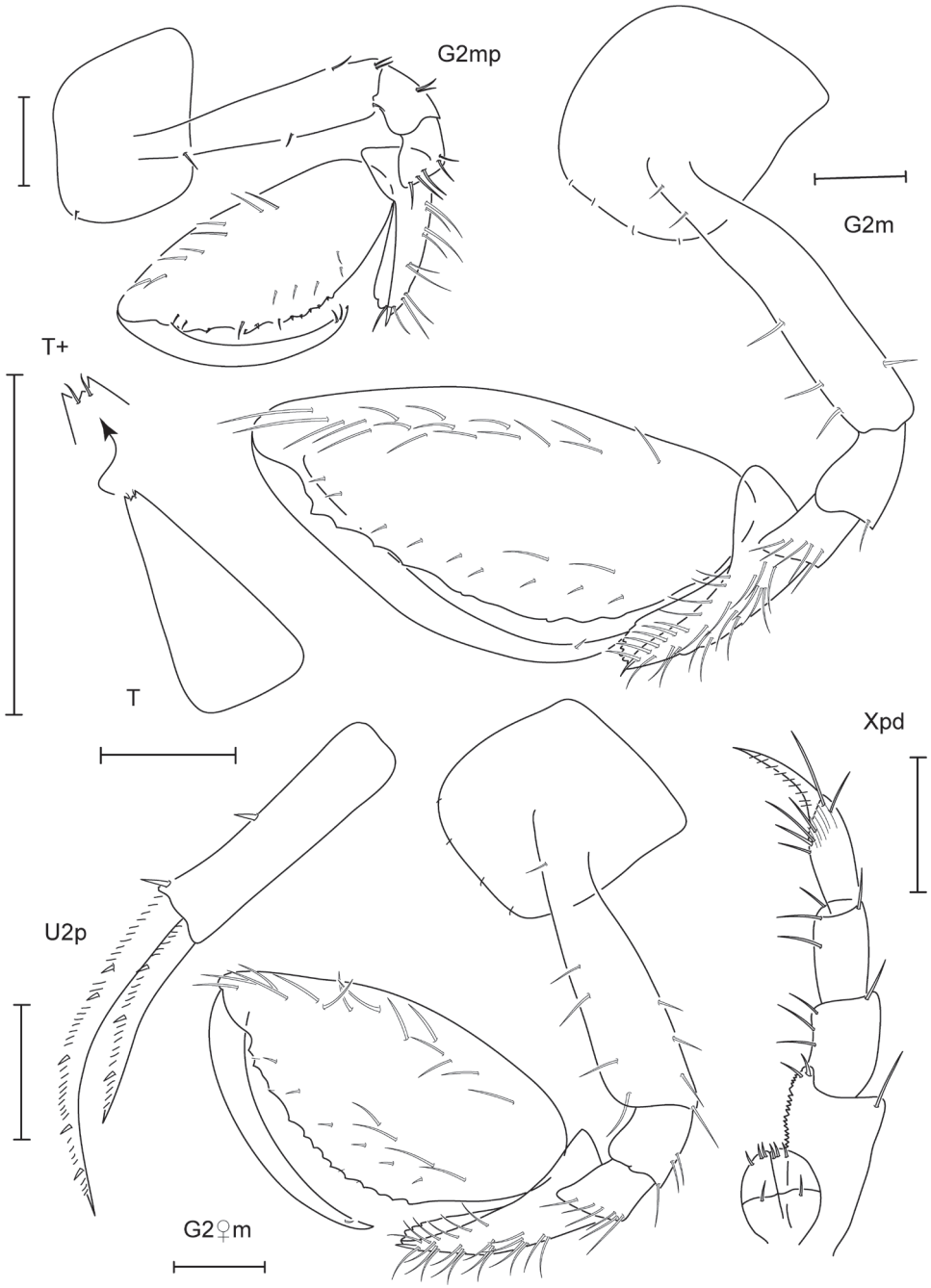

Figure 8. *Leucothoe hashi* sp. n., holotype male, 2.5 mm, RUMF-ZC-1747; paratype female, 2.5 mm, RUMF-ZC-1748; paratype male, 1.9 mm, RUMF-ZC-1749.

with 2 posterior and1 posterodistal seta; carpus distally tapered; propodus secondary mediofacial setal row with 4 setae.

Etymology. After the Japanese word 'hashi', meaning 'chopsticks' and referring to the extremely slender carpus and propodus of gnathopod 1. (Pronounced hah-shee.)

Ecology. In canals of sponges, *Callyspongia* sp., RUMF-ZP-2, KNWOkinawa42C (Figure 24F), ?*Clathria* (*Thalysias*) *reinwardti*, RUMF-ZP-4, 21Aug10 (Figure 25F), *Tedania* sp. (Figure 25E), *Haliclona* of Grant 1836, RUMF-ZP-3, KNWOkinawa44A (Figure 24G); and among coral rubble.

Relationships. *Leucothoe hashi* sp. n. is similar to *Leucothoe cheiriserra* Serejo, 1998, *Leucothoe gavialis* Myers, 1985, *Leucothoe hipposideros* White & Thomas, 2009, *Leucothoe squalidens* Ledoyer, 1984, and *Leucothoe lecroyae* sp. n. in having triangular teeth on the palm of gnathopod 1 propodus. It also shares a rounded anterodistal head margin and distally truncate gnathopod 2 carpus with *L. hipposideros* and *L. squalidens*, but differs in having narrow pereopod 5–7 bases, a 1–articulate maxilla 1 palp, tuberculate maxilliped inner plate, and a 1–articulate accessory flagellum on antenna 1.

Remarks. *Leucothoe hashi* sp. n. is translucent pink in color, darkest along pereonite edges (Figure 24A). This species has been collected from only 5 islands throughout the Ryukyu Archipelago. There appears to be some minor variation among specimens in the following characters: gnathopod 1 carpus dentition, propodus palm serration; gnathopod 2 shape and setal patterns.

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

Leucothoe lecroyae sp. n.

urn:lsid:zoobank.org:act:5089CA73-CBB4-4A13-A3A2-9F1CE93749FB
http://species-id.net/wiki/Leucothoe_lecroyae
Figures 9, 10

Type material. Holotype male, 3.5 mm RUMF-ZC-1763, Kuse, Kakeroma–jima Island reef wall (28°06'05"N, 129°21'12"E), in canals of brown sponge, *Rhabdastrella* of Thiele 1903, 10 m, K.N. White, col., 19 March 2011 (KNWAmami2C). Paratype female, 3.3 mm RUMF-ZC-1764, same station data as holotype.

Type locality. Kuse, Kakeroma–jima Island, Amami–oshima Island region, Kagoshima, Japan (28°06'05"N, 129°21'12"E).

Additional material examined. 7 specimens, NSMT-Cr 21894, KNWYaku3D; 7 specimens, RUMF-ZC-1765, KNWYaku3D; 1 specimen, RUMF-ZC-1766, KNWYaku5P; 3 specimens, NSMT-Cr 21895 KNWOkinawa44A; 1 specimen, RUMF-ZC-1767, KNWOkinawa44F; 5 specimens, NSMT-Cr 21893, KNWAmami2D; 1 male specimen, RUMF-ZC-1799, KNWAmami2C.

Diagnosis (male). Ventral cephalic keel anterior margin transverse, anteroventral margin quadrate. Eyes oval. Antennae 1 accessory flagellum 1–articulate. Right

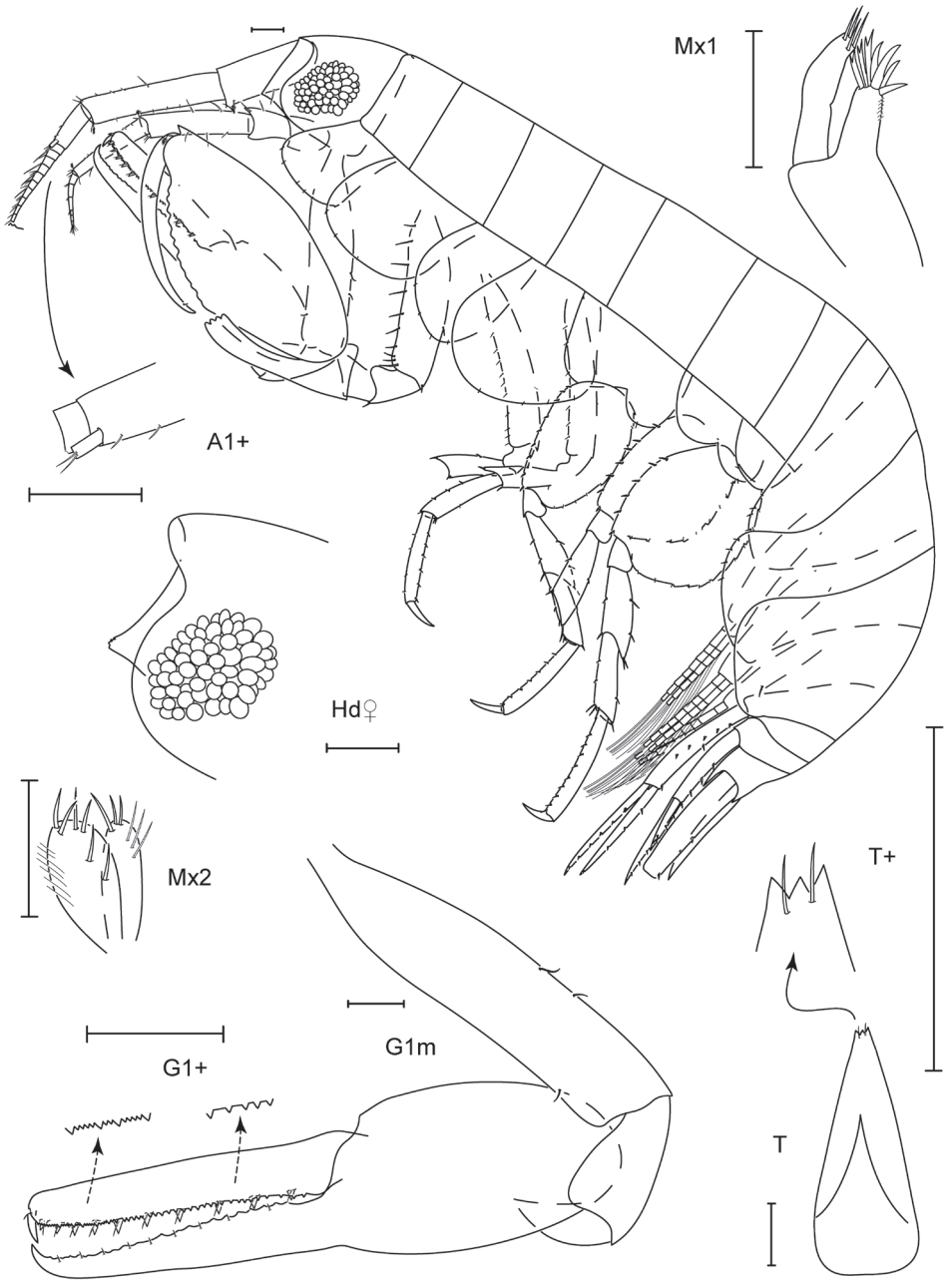

Figure 9. *Leucothoe lecroyae* sp. n., holotype male, 3.5 mm, RUMF-ZC-1763; paratype female, 3.3 mm, RUMF-ZC-1764.

mandible with small 2–layered lacinia mobilis. Maxilliped inner plates small with serrate robust setae; outer plate tuberculate. Gnathopod 1 coxa anterior margin serrate; carpus robust, proximal margin serrate; propodus palm serrate with triangular teeth.

Gnathopod 2 carpus distally truncate; propodus with 2 mediofacial setal rows. Pereopods 5–7 coxae with facial setae; bases posteriorly serrate. Female ventral cephalic keel anteroventral margin serrate; gnathopod 1 basis posterior margin with 6 short setae; gnathopod 2 carpus distally tapered.

Description (male). Head. Anterior margin rounded, anterodistal margin evenly rounded; ventral cephalic keel anterior margin transverse, anteroventral margin quadrate, ventral margin oblique; eyes with more than 10 ommatidia, oval. Antenna 1 0.4 × body length, flagellum 10+–articulate (broken), peduncle article 1 width less than 2 × article 2, accessory flagellum 1–articulate. Antenna 2 0.3 × body length, slightly shorter than antenna 1, flagellum 6–articulate. Mandibular palp ratio of articles 1–3 1.0: 2.8: 1.0, article 2 with 2 medium distal setae, article 3 with 2 distal setae, incisors strongly dentate; left mandible with 8 raker spines, lacinia mobilis large, strongly toothed; right mandible with 7 raker spines, with small 2–layered lacinia mobilis, strongly dentate. Upper lip asymmetrically lobate, anterior margin setose. Lower lip inner lobes fused, setose; outer lobes with moderate gape, anterior margins setose. Maxilla 1 palp 1–articulate, margins constricted and with 4 distal setae; outer plate with 7 distal robust setae and 6 short marginal setae. Maxilla 2 inner plate with 4 robust distal setae, 2 robust facial setae, and 7 slender marginal setae; outer plate with 3 robust distal setae and 3 slender distal marginal setae. Maxilliped inner plates distal margin with a v-shaped indentation, with short simple and serrate robust setae; outer plate inner margin tuberculate, reaching 0.3 × palp article 1, with simple marginal setae, facial setae absent; palp article 4 subequal in length with article 3, distally acute.

Pereon. Coxae 1–4 relative widths 1.0: 1.5: 1.2: 1.8. Gnathopod 1 coxa smooth, with tiny marginal setae, anterior margin serrate, anterior margin produced, rounded, distal margin straight, posterior margin excavate, facial setae absent; basis linear, anterior margin with 1 short seta, posterior margin with 2 short setae; ischium bare; carpus linear, distal length 7.1 × width, proximal margin serrate, distal margin bare; propodus straight, palm serrate with 10 distal setae and 10 distal triangular teeth; dactylus smooth, reaching 0.1 × propodus length. Gnathopod 2 coxa broader than long, subequal in size with coxa 3, smooth, with tiny marginal setae, anterior margin expanded, anterodistally rounded, distal and posterior margins straight, facial setae absent; basis distally expanded, anterior margin with 10 medium setae, posterior margin with 2 short setae; ischium with 1 posterodistal seta; carpus 0.4 × propodus length, curved, distally truncate, anterior margin dentate; propodus with 2 mediofacial setal rows, primary mediofacial setal row above midline, reaching 0.8 × propodus length, secondary mediofacial setal row with 4 setae, with 1 row of submarginal setae, posterior margin with 5 small robust setae, palm convex with 10 tubercles; dactylus curved, proximal margin smooth with 1 seta, anterior margin distally subacute, reaching 0.5 × propodus length. Pereopod 3 coxa length 1.3 × width, anterodistal corner overriding distal face of coxa 2 and extending below it, smooth, with tiny marginal setae, anterior margin straight, distal margin oblique, posterior margin straight, facial setae absent. Pereopod 4 coxa smooth, with tiny marginal setae, anterior margin produced, distal margin evenly rounded, posterior margin tapered, facial setae absent. Pereopods 5–7 coxae facial setae present; bases width length ratios 1: 1.4, 1: 1.3, 1: 1.2, serrate, setose.

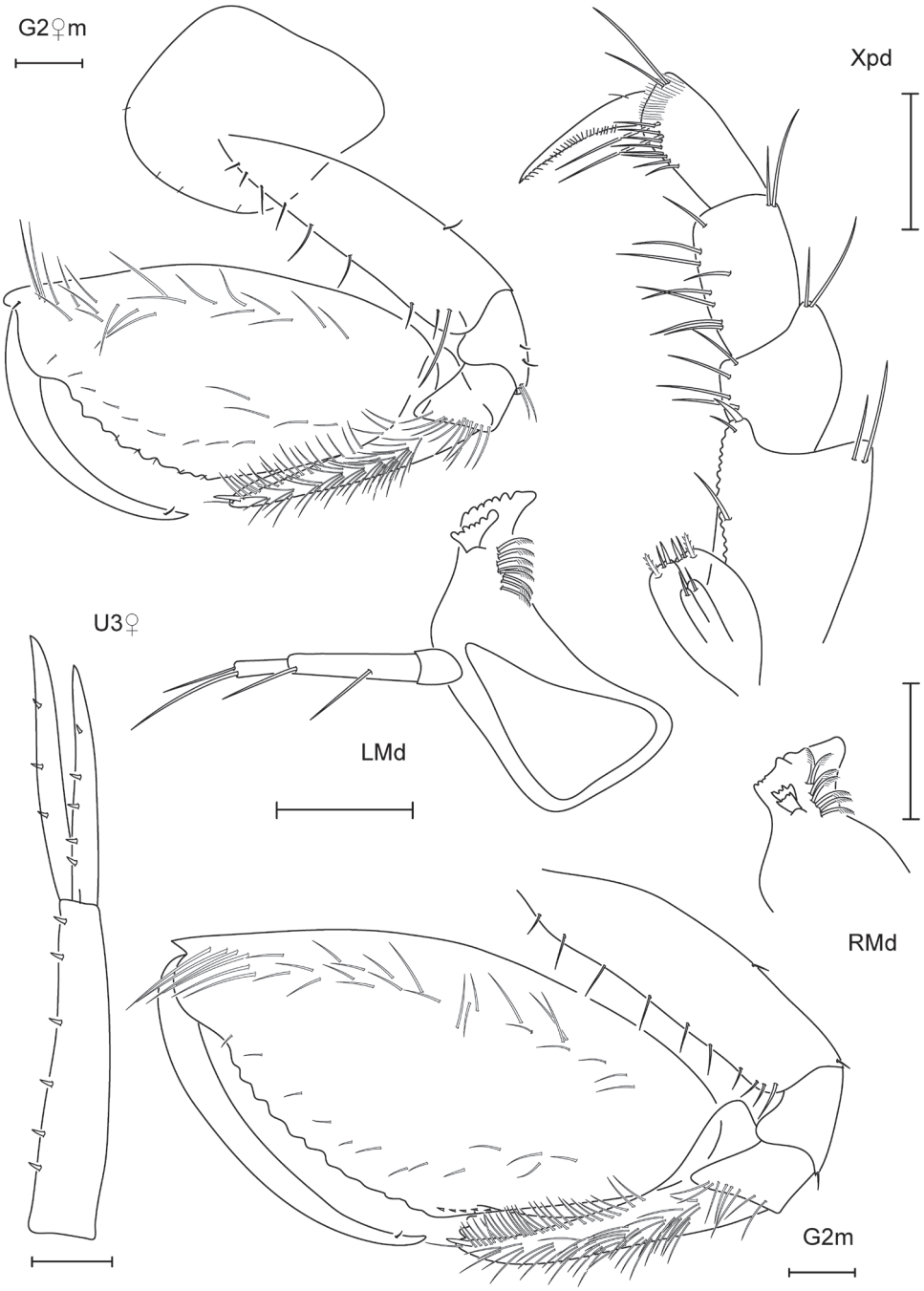

Figure 10. *Leucothoe lecroyae* sp. n., holotype male, 3.5 mm, RUMF-ZC-1763; paratype female, 3.3 mm, RUMF-ZC-1764.

Pleon. Epimera 1–2 with ventral setae, epimeron 3 bare; epimeron 3 posteroventral corner sinuous, rounded. Uropods 1–3 relative lengths 1.0: 0.8: 0.9. Uropod 1 peduncle subequal in length with inner ramus, outer ramus 0.9 × inner ramus length; inner ramus with 6 robust setae and outer ramus with 4 robust setae. Uropod 2 peduncle 0.9 × inner ramus length, outer ramus length 0.6 × inner ramus length; inner ramus with 4 robust setae and outer ramus with 3 robust setae. Uropod 3 peduncle 1.2 × inner ramus length, outer ramus length 0.9 × inner ramus length; inner ramus with 3 robust setae and outer ramus with 5 robust setae. Telson 2.3 × longer than wide, apex strongly tridentate.

Female (sexually dimorphic characters). Ventral cephalic keel anteroventral margin serrate. Gnathopod 1 basis posterior margin with 6 short setae. Gnathopod 2 basis posterior margin with 1 seta; ischium with 2 distal and 2 posterodistal setae; carpus distally tapered, anterior margin smooth; propodus posterior margin bare.

Etymology. Named for Sara E. LeCroy, in recognition of her contribution to amphipod taxonomy. Ms LeCroy has been a colleague and friend for the past 7 years and the first author is very grateful for all her support.

Ecology. In canals of sponges, brown sponge with holes on top only, *Rhadastrella* sp., RUMF-ZP-1, KNWOkinawa16A (Figure 24H), dark red chimney sponge, Axinellidae of Carter 1875, RUMF-ZP-12, KNWYaku3F (Figure 24D), orange lumpy sponge, Axinellidae (Figure 24J); and among coral rubble.

Relationships. *Leucothoe lecroyae* sp. n. is similar to *Leucothoe cheiriserra* Serejo, 1998, *Leucothoe gavialis* Myers, 1985, *Leucothoe hipposideros* White & Thomas, 2009, *Leucothoe squalidens* Ledoyer, 1984, and *Leucothoe hashi* sp. n. in having triangular teeth on the palm of gnathopod 1 propodus. It also shares a short dactylus on gnathopod 1, rounded head margin, and distally truncate gnathopod 2 carpus with *L. hashi* sp. n., but differs in having a more robust gnathopod 1 propodus and carpus, maxilla 1 palp 1–articulate, margins constricted, 2–layered lacinia mobilis on the right mandible, and wide pereopod 5–7 bases.

Remarks. *Leucothoe lecroyae* sp. n. is faint yellow in color (Figure 23C). This species has been collected on Yakushima Island and Amami–oshima Island region (both Kagoshima) and from the northwestern and eastern coasts of Okinawa–jima Island, Okinawa, Japan.

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

Leucothoe nagatekubi sp. n.

urn:lsid:zoobank.org:act:5416F771-FBE3-4D5F-A7A2-2D25A582ADA0
http://species-id.net/wiki/Leucothoe_nagatekubi
Figures 11, 12

Type material. Holotype male, 3.0 mm RUMF-ZC-1768, Mizugama, Okinawa–jima Island, Okinawa, reef wall (26°21'35"N, 127°44'22"E), in canals of orange encrusting

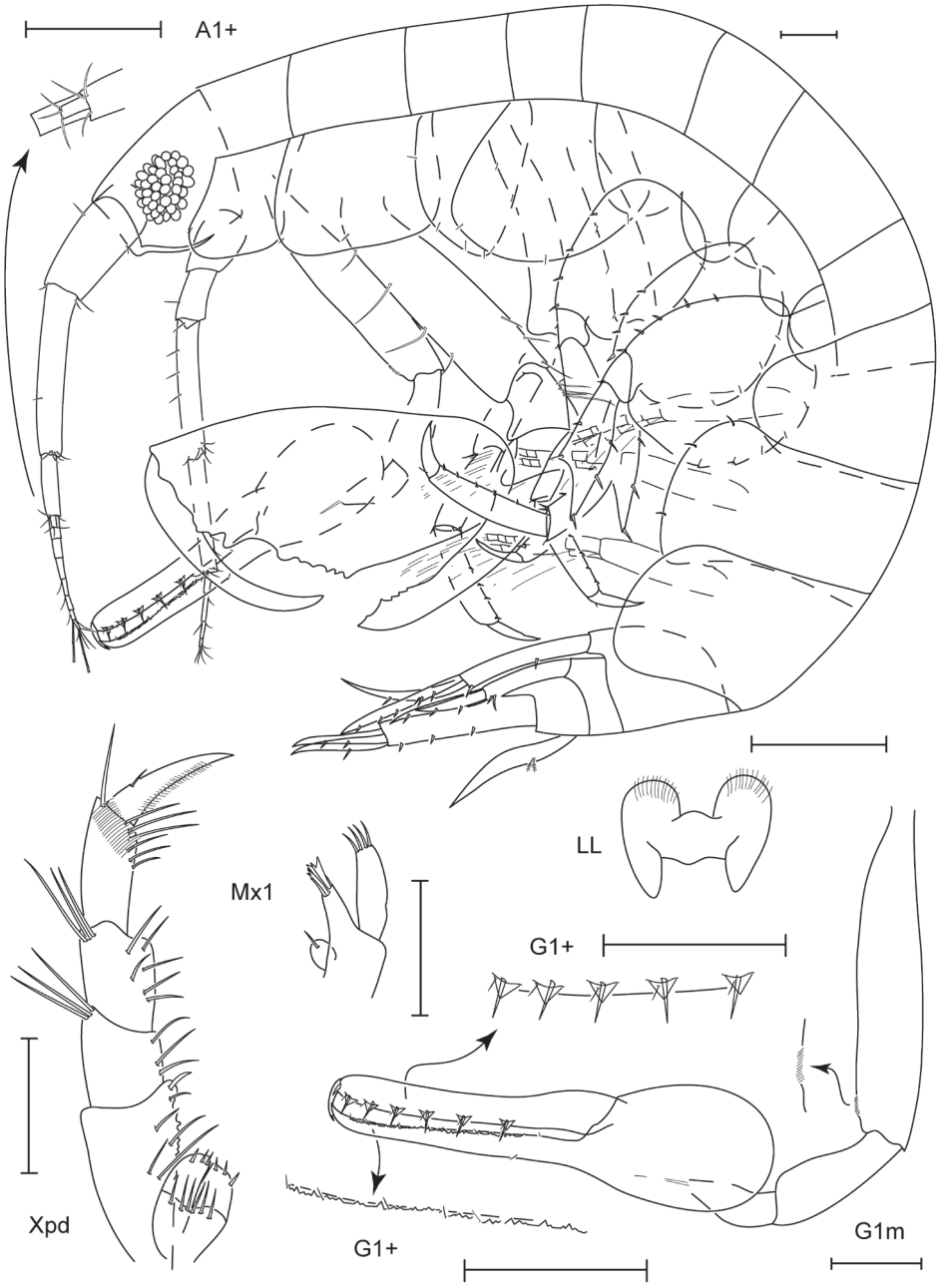

Figure 11. *Leucothoe nagatekubi* sp. n., holotype male, 3.0 mm, RUMF-ZC-1768.

sponge, *Clathria* of Schmidt 1862, 10 m, N.S. White, col., 26 February 2011 (KNWOkinawa34K). Paratype female, 3.4 mm RUMF-ZC-1769, Mizugama, Okinawa reef wall (26°21'35"N, 127°44'22"E), in canals of orange encrusting sponge, *Clathria*, 7 m, N.S. White, col., 20 October 2011 (KNWOkinawa69D)

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

Additional material examined. 9 specimens, NSMT-Cr 21896, KNWOkinawa69B; 9 specimens, RUMF-ZC-1770, KNWOkinawa69C.

Diagnosis (male). Head anterior margin truncate, anterodistal margin quadrate with cusp. Maxilla 1 palp 1–articulate. Maxilliped outer plate tuberculate with facial setae. Gnathopod 1 basis anterodistal margin with 7 very short, slender setae. Gnathopod 2 carpus elongate, distally tapered; propodus palm with large concavity. Pereopod 7 basis posteriorly serrate. Telson with plumose facial setae.

Description (male). Head. Anterior margin truncate, anterodistal margin quadrate with cusp; ventral cephalic keel anterior margin transverse, anteroventral margin quadrate, ventral margin distally excavate, rounded; eyes with more than 10 ommatidia, round. Antenna 1 0.3 × body length, flagellum 7–articulate, peduncle article 1 width less than 2 × article 2, accessory flagellum 1–articulate. Antenna 2 0.3 × body length, subequal in length with antenna 1, flagellum 4–articulate. Mandibular palp ratio of articles 1–3 1.0: 3.0: 1.7, article 2 with 2 medium distal setae, article 3 with 2 distal setae, incisors strongly dentate; left mandible with 5 raker spines, lacinia mobilis large, strongly toothed; right mandible with 7 raker spines, lacinia mobilis small, strongly 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 with 4 distal setae; outer plate with 5 distal robust setae. Maxilla 2 inner plate with 3 robust distal setae and 7 slender marginal setae; outer plate with 3 robust distal setae and 15 slender distal marginal setae. Maxilliped inner plates distal margin with a v-shaped indentation, with short robust setae; outer plate inner margin tuberculate, reaching 0.1 × palp article 1, with simple marginal setae, facial setae present; palp article 4 subequal in length with article 3, distally acute.

Pereon. Coxae 1–4 relative widths 1.0: 1.8: 1.1: 2.1. Gnathopod 1 coxa smooth, with tiny marginal setae, anterodistal margin produced, rounded with cusp, distal margin straight, posterior margin excavate, facial setae absent; basis linear, anterodistal margin with 7 very short, slender setae, posterior margin bare; ischium bare; carpus linear, distal length 13.1 × width, proximal margin serrate, distal margin with 1 short seta; propodus straight, palm with 6 distal triangular teeth and 6 distal setae; dactylus smooth, reaching 0.1 × propodus length. Gnathopod 2 coxa broader than long, subequal in size with coxa 3, smooth, with tiny marginal setae, anterior margin expanded anteriorly, anterodistally rounded, distal margin oblique, posterior margin straight, facial setae absent; basis distally expanded, anterior margin with 5 medium setae, distal margin with 2 setae, posterior margin with 3 setae; ischium with 3 posterior, 2 distal, and 3 posterodistal setae; carpus 0.5 × propodus length, curved, distally tapered, anterior margin smooth; propodus with 1 mediofacial setal row above midline, reaching 0.8 × propodus length, with 2 submarginal setae, posterior margin smooth, palm convex with 6 major tubercles and 1 major concavity; dactylus curved, proximal margin smooth with 1 seta, anterior margin distally acute, reaching 0.5 × propodus length. Pereopod 3 coxa length

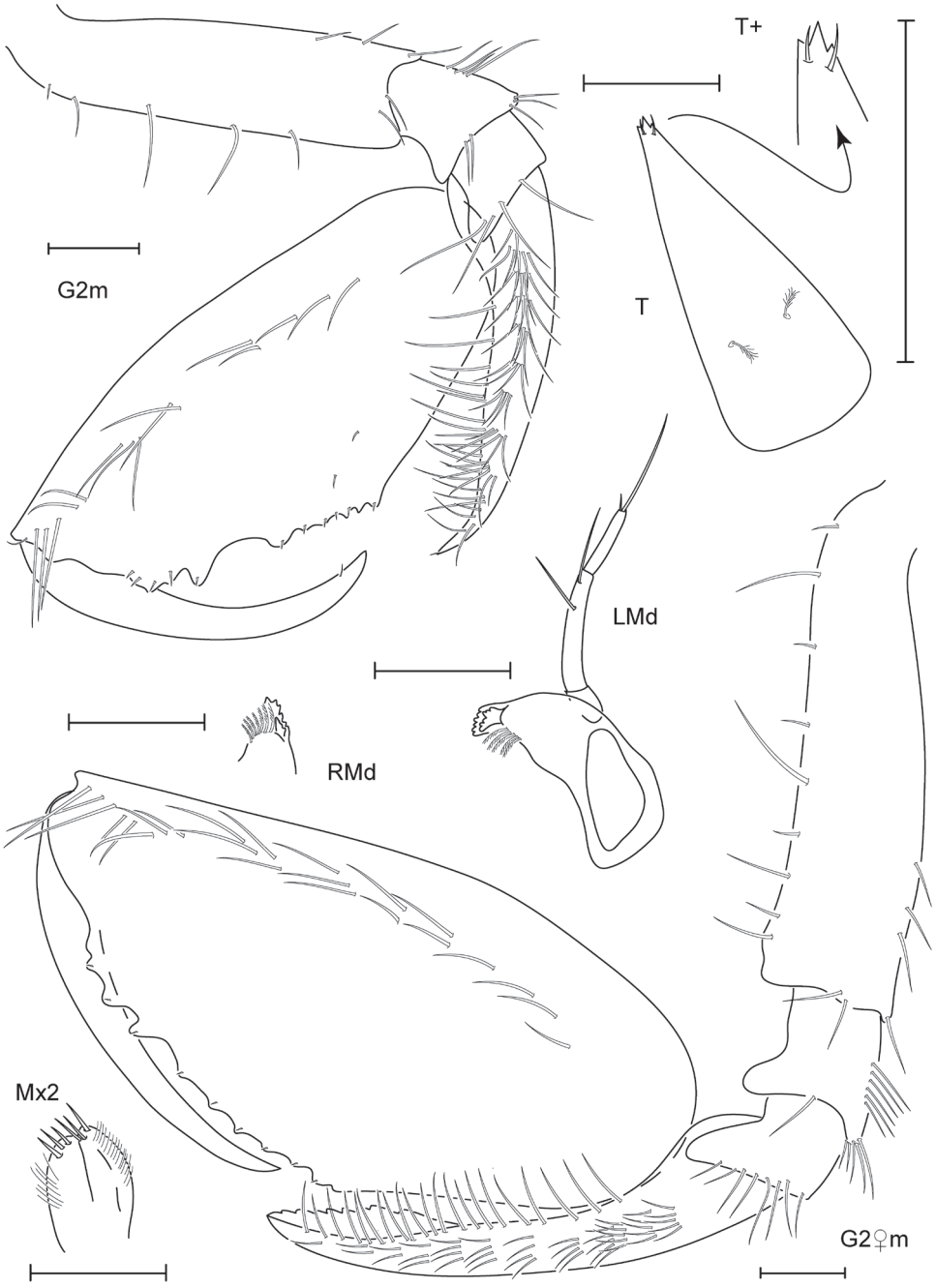

Figure 12. *Leucothoe nagatekubi* sp. n., holotype male, 3.0 mm, RUMF-ZC-1768; paratype female, 3.4 mm, RUMF-ZC-1769.

1.5 × width, anterodistal corner overriding distal face of coxa 2 and extending below it, smooth, with tiny marginal setae, anterior margin evenly rounded, distal margin oblique, posterior margin straight, facial setae absent. Pereopod 4 coxa smooth, with tiny marginal setae, anterior margin produced, distal margin evenly rounded, posterior margin tapered, facial setae absent. Pereopods 5–7 coxae facial setae absent; bases width length ratios 1: 1.3, 1: 1.3, 1: 1.2, posterior margins setose. Pereopods 5–6 bases posterior margins smooth, pereopod 7 basis posterior margin serrate.

Pleon. Epimera 1 and 3 bare, epimeron 2 with ventral setae; epimeron 3 posteroventral corner rounded. Uropods 1–3 relative lengths 1.0: 0.7: 0.9. Uropod 1 peduncle and outer ramus subequal in length with inner ramus; inner ramus with 5 robust setae and outer ramus with 2 robust setae. Uropod 2 peduncle 0.9 × inner ramus length, outer ramus 0.7 × inner ramus length; inner ramus with 1 robust seta and outer ramus with 2 robust setae. Uropod 3 peduncle 1.6 × inner ramus length, outer ramus 0.9 × inner ramus length; inner ramus with 1 robust seta and outer ramus with 2 robust setae. Telson 2.3 × longer than wide, with plumose facial setae, apex strongly tridentate.

Female (sexually dimorphic characters). Unknown.

Etymology. After the Japanese words 'nagai', meaning 'long', and 'tekubi', meaning 'wrist' and referring to the elongate carpus on gnathopod 2. (Pronounced na-ga-tay-koo-bee)

Ecology. In canals of orange encrusting sponge, *Clathria* sp., RUMF-ZP-5, KNWOkianawa69G (Figure 25D), found in caves.

Relationships. *Leucothoe nagatekubi* sp. n. is similar to *Leucothoe serrata* White & Thomas, 2009 in having an elongate gnathopod 2 carpus, narrow gnathopod 1 propodus and carpus, high mediofacial setal row on gnathopod 2 propodus, and wide pereopod 5–7 bases. It differs in the large indentation on the gnathopod 2 propodus palm, having a 1–articulate accessory flagellum on antenna 1, triangular teeth on gnathopod 1 propodus palm, and a 1–articulate maxilla 1 palp.

Remarks. *Leucothoe nagatekubi* sp. n. is pinkish-orange in color (Figure 24C). This species is endemic to the western coast of Okinawa–jima Island, Okinawa.

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

***Leucothoe nurununu* sp. n.**

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http://species-id.net/wiki/Leucothoe_nurununu
Figures 13, 14

Type material. Holotype male, 5.8 mm RUMF-ZC-1771, Channel between Iriomote–jima Island and Hatoma–jima Island, Okinawa, patch reef (24°26'34"N, 123°49'18"E), in canals of slimy black-purple sponge, Iotrochotidae of Dendy 1922 (probably *Iotrochota* of Ridley 1884), 10 m, K.N. White and N.S. White, col., 22 April 2011 (KNWIriomote2F). Paratype female, 6.5 mm RUMF-ZC-1772, same station data as holotype.

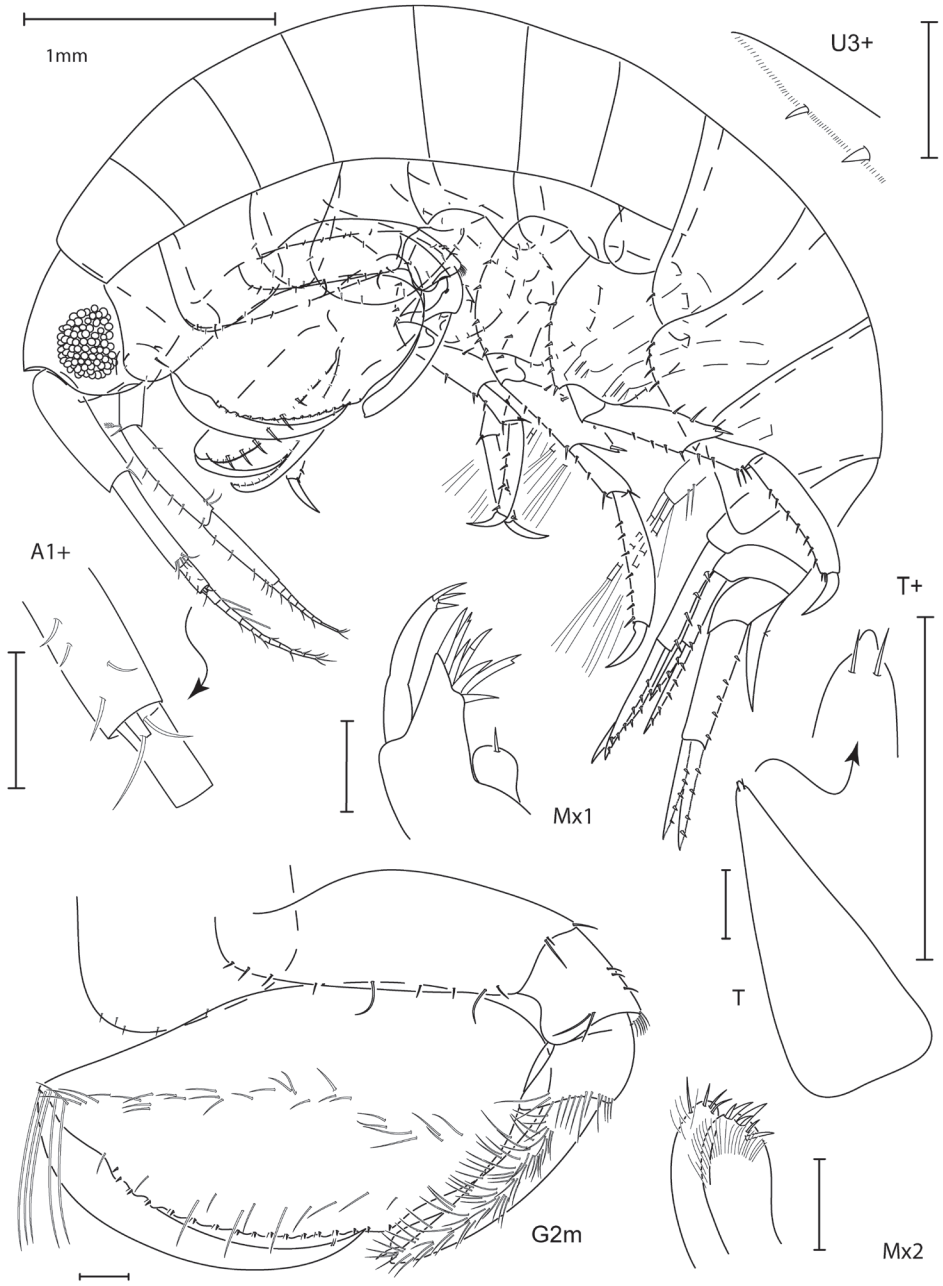

Figure 13. *Leucothoe nurununu* sp. n., holotype male, 5.8 mm, RUMF-ZC-1771.

Type locality. Iriomote Channel between Iriomote–jima and Hatoma–jima Islands (24°26'34"N, 123°49'18"E).

Additional material examined. 4 specimens, RUMF-ZC-1773, KNWIriomote2F; 4 specimens, NSMT-Cr 21897, KNWIriomote2F.

Diagnosis (male). Antenna 1 accessory flagellum 1–articulate. Maxilla 1 palp 1–articulate, margins constricted. Maxilliped outer plate with setulate-serrate marginal setae. Gnathopod 1 coxa with 2 mediofacial setae; propodus palm with square-shaped denticles. Gnathopod 2 carpus distally truncate; propodus with long submarginal setae. Pereopod 5 coxa with 2 facial setae. Telson apex with strongly rounded point. Female gnathopod 1 basis anterior margin with 16 short setae, posterior margin with 14 short setae; gnathopod 2 basis anterior margin with 14 short and 2 long curved setae.

Description (male). Head, anterior margin rounded, anterodistal margin evenly rounded; ventral cephalic keel anterior margin excavate, anteroventral margin subquadrate, ventral margin oblique; eyes with more than 10 ommatidia, round. Antenna 1 0.3 × body length, flagellum 11–articulate, peduncle article 1 width less than 2 × article 2, accessory flagellum 1–articulate. Antenna 2 0.3 × body length, subequal in length with antenna 1, flagellum 7–articulate. Mandibular palp ratio of articles 1–3 1.0: 2.6: 1.1, article 2 with 6–8 long distal setae, article 3 with 2 distal setae, incisors strongly dentate; left mandible with 12 raker spines, lacinia mobilis large, strongly toothed; right mandible with 13 raker spines, lacinia mobilis small, strongly dentate. Upper lip asymmetrically lobate, anterior margin setose. Lower lip inner lobes fused, setose; outer lobes with moderate gape, anterior margins setose. Maxilla 1 palp 1–articulate, margins constricted and with 3 distal setae; outer plate with 7 distal robust setae. Maxilla 2 inner plate with 6 robust distal setae and several slender facial setae; outer plate with 4 robust distal setae and 5 slender distal setae. Maxilliped inner plates distal margin with a v-shaped indentation, with short robust setae; outer plate inner margin smooth, reaching 0.2 × palp article 1, with simple and setulate-serrate marginal setae, facial setae absent; palp article 4 subequal in length with article 3, distally acute.

Pereon. Coxae 1–4 relative widths 1.0: 1.0: 0.8: 1.4. Gnathopod 1 coxa smooth, with tiny marginal setae, anterodistal margin produced, subquadrate, distal margin straight, posterior margin excavate, 2 mediofacial setae present; basis proximally widened, anterior margin with 7 short setae, posterior margin with 6 short setae; ischium bare; carpus linear, distal length 13.1 × width, proximal margin smooth, distal margin bare; propodus straight, palm with square-shaped denticles with 6 large and 20 small proximal setae; dactylus smooth, with 2 distal setae, reaching 0.5 × propodus length. Gnathopod 2 coxa as long as broad, subequal in size with coxa 3, smooth, with tiny marginal setae, anterior margin expanded anteriorly, anterodistally rounded, distal and posterior margins rounded, facial setae absent; basis slightly posteriorly expanded, anterior margin with 7 short and 2 long curved setae, posterior margin with 1 posterodistal seta, distal margin with 2 setae; ischium with 3 short posterior, 2 long distal, and 5 short posterodistal setae; carpus 0.4 × propodus length, curved, distally truncate, anterior margin smooth; propodus with 1 mediofacial setal row displaced to midline, reaching 0.8 × propodus length, with 1 row of short and long submarginal setae, posterior margin smooth, palmar corner pronounced, palm convex with small tubercles; dactylus curved, proximal margin smooth with 2 setae, anterior margin distally acute, reaching 0.6 × propodus length. Pereopod 3 coxa length 1.4 × width, anterodistal corner overriding distal face of coxa 2 and extending below it, smooth, with

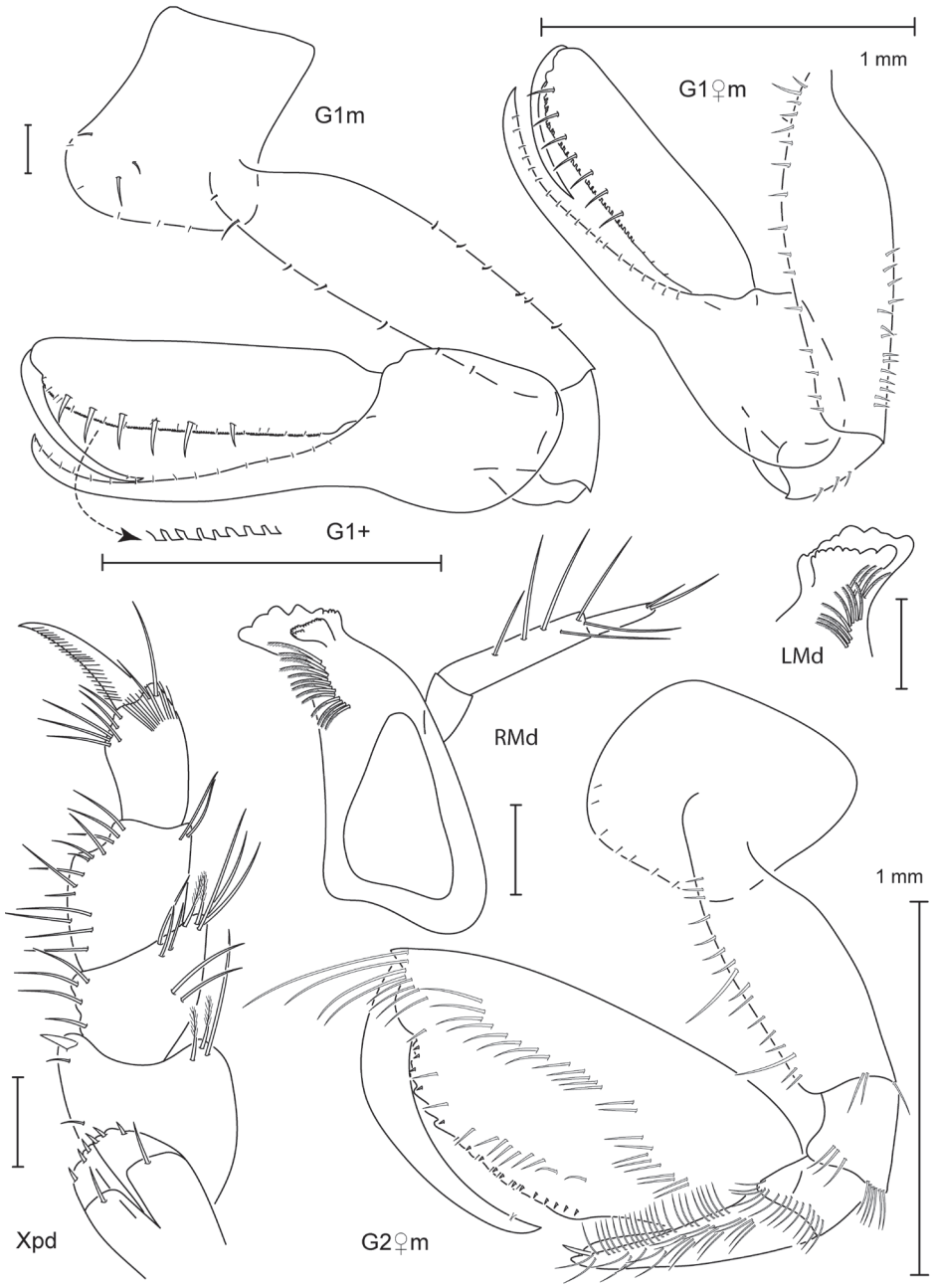

Figure 14. *Leucothoe nurununu* sp. n., holotype male, 5.8 mm, RUMF-ZC-1771; paratype female, 6.5 mm, RUMF-ZC-1772.

tiny marginal setae, anterior margin expanded, distal margin slightly convex, posterior margin tapered, facial setae absent. Pereopod 4 coxa smooth, with tiny marginal setae, anterior margin produced, distal margin evenly rounded, posterior margin excavate,

facial setae absent. Pereopod 5 coxa with 2 facial setae. Pereopods 6–7 coxae facial setae absent. Pereopods 5–7 bases width length ratios 1: 1.2, 1: 1.2, 1: 1.0, posterior margins smooth, setose.

Pleon. Epimera 1–2 with ventral setae, epimeron 3 bare; epimeron 3 posteroventral corner subquadrate. Uropods 1–3 relative lengths 1.0: 0.7: 1.0. Uropod 1 peduncle 0.8 × inner ramus length, outer ramus 0.9 × inner ramus length; inner ramus with 4 robust setae and outer ramus with 6 robust setae. Uropod 2 peduncle subequal in length with inner ramus, outer ramus 0.8 × inner ramus length; inner ramus with 5 robust setae and outer ramus with 3 robust setae. Uropod 3 peduncle 1.2 × inner ramus length, outer ramus 0.8 × inner ramus length; inner and outer rami lined with short marginal setae; inner ramus with 4 robust setae and outer ramus with 5 robust setae. Telson 2.3 × longer than wide, apex with strongly rounded point.

Female (sexually dimorphic characters). Gnathopod 1 basis anterior margin with 16 short setae, posterior margin with 14 short setae; ischium with 3 short posterior setae. Gnathopod 2 basis anterior margin with 14 short and 2 long curved setae; ischium with 3 distal and 6 posterodistal setae; carpus slightly less truncate than in the male.

Etymology. After the Japanese word 'nurunuru', meaning 'slimy' and referring to the host sponge. (Pronounced new-rue-new-rue)

Ecology. In canals of Iotrochotidae (probably *Iotrochota* sp.), RUMF-ZP-7, KNWIriomote2G (Figure 25A).

Relationships. *Leucothoe nurununu* sp. n. is similar to *Leucothoe commensalis* (Haswell, 1879), *Leucothoe procera* (Bate, 1857), *Leucothoe makromattos* White & Thomas, 2009, *Leucothoe daisukei* sp. n., and *Leucothoe akaoni* sp. n. in having a round anterior head margin and long gnathopod 1 dactylus. The pointed apex of the telson is similar to *L.commensalis* and *L. procera*, although the point is much stronger in *L. nurununu* sp. n. *Leucothoe nurununu* sp. n. differs from these two species in having maxilla 1 palp 1–articulate, margins constricted, wider pereopod 5–7 bases, and epimeron 3 posteroventral corner subquadrate. *Leucothoe nurununu* sp. n. also shares wide pereopod 5–7 bases and a setose posterior margin of gnathopod 1 basis with *L. makromattos*, *L. daisukei* sp. n., and *L. akaoni* sp. n., but differs in having maxilla 1 palp 1–articulate, margins constricted and square-shaped denticles on gnathopod 1 propodus palm.

Remarks. *Leucothoe nurununu* sp. n. is deep orange in color (Figure 23D). This species is endemic to Iriomote–jima Island.

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

***Leucothoe ouraensis* sp. n.**

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http://species-id.net/wiki/Leucothoe_ouraensis
Figures 15, 16

Type material. Holotype male, 3.3 mm RUMF-ZC-1774, Kita–nakase, Oura–wan Bay, Okinawa–jima Island, Okinawa, patch reef (26°32'40"N, 128°03'36"E), among

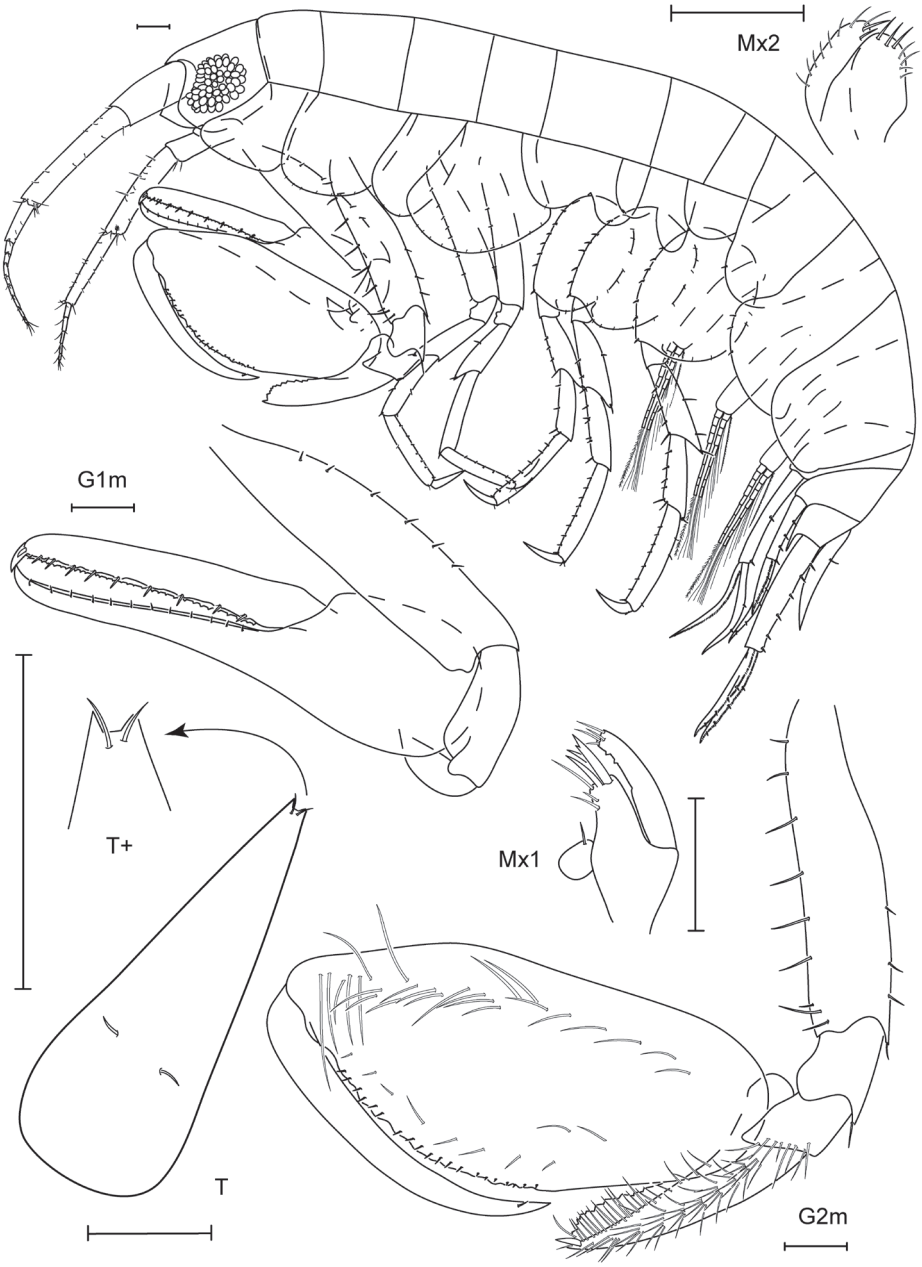

Figure 15. *Leucothoe ouraensis* sp. n., holotype male, 3.3 mm, RUMF-ZC-1774.

coral rubble, 30 m, K.N. White and N.S. White, col., 3 March 2011 (KNWOkinawa35F). Paratype female, 3.0 mm RUMF-ZC-1775, Tettou–mae–oki, Oura–wan Bay, Okinawa–jima Island, Okinawa, patch reef (26°32'43"N, 128°02'56"E), among coral rubble, 28 m, K.N. White, col., 4 April 2011 (KNWOkinawa37G).

Type locality. Oura–wan Bay, Okinawa–jima Island, Okinawa, Japan (26°32'40–43"N, 128°02'56"–03'36"E).

Additional material examined. 1 specimen, RUMF-ZC-1776, KNWOkinawa39H; 1 specimen, NSMT-Cr 21898, KNWOkinawa39L; 1 specimen, RUMF-ZC-1777, KNWOkinawa37C; 2 specimens, NSMT-Cr 21899, KNWOkinawa37N.

Diagnosis (male). Head anterior margin truncate, anterodistal margin quadrate. Ventral cephalic keel anteroventral margin with anteriorly projecting cusp. Right mandible lacinia mobilis cleft. Upper lip distal margin with row of short setae. Maxilla 1 palp 1–articulate, proximal margin serrate. Maxilliped outer plate tuberculate. Gnathopod 1 basis posterior margin with 6 short setae; propodus palm serrate; dactylus reaching 0.1 × propodus length. Gnathopod 2 carpus distally truncate; propodus with 2 mediofacial setal rows. Uropod 3 peduncle 1.2 × inner ramus length. Telson apex bidentate.

Description (male). Head. Anterior margin truncate, anterodistal margin quadrate; ventral cephalic keel anterior margin oblique, anteroventral margin with anteriorly projecting cusp, ventral margin convex; 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 absent. Antenna 2 0.3 × body length, subequal in length with antenna 1, flagellum 5–articulate. Mandibular palp ratio of articles 1–3 1.0: 2.4: 1.6, article 2 with 3 medium distal setae, article 3 with 2 distal setae, incisors weakly dentate; left mandible with 9 raker spines, lacinia mobilis large, strongly toothed; right mandible with 7 raker spines, lacinia mobilis small, strongly dentate, cleft. Upper lip asymmetrically lobate, anterior margin setose, distal margin with row of short setae. Lower lip inner lobes fused, setose; outer lobes with moderate gape, anterior margins setose. Maxilla 1 palp 1–articulate with 4 distal setae, proximal margin serrate; outer plate with 4 distal robust setae and 4 distal setae. Maxilla 2 inner plate with 3 robust distal setae and 4 slender marginal setae; outer plate with 2 robust and 2 slender distal setae and 6 slender distal marginal setae. Maxilliped inner plates distal margin with a v-shaped indentation, with short robust setae; outer plate inner margin tuberculate, reaching 0.1 × palp article 1, with simple marginal setae, facial setae present; palp article 4 subequal in length with article 3, distally acute.

Pereon. Coxae 1–4 relative widths 1.0: 1.2: 0.9: 1.7. Gnathopod 1 coxa smooth, with tiny marginal setae, anterior margin produced, rounded, distal margin straight, posterior margin excavate, facial setae absent; basis distally expanded, anterior margin bare, posterior margin with 6 short setae; ischium bare; carpus linear, distal length 13.6 × width, proximal margin smooth, distal margin bare; propodus straight, palm serrate with 9 distal setae; dactylus smooth, reaching 0.1 × propodus length. Gnathopod 2 coxa as long as broad, subequal in size with coxa 3, smooth, with tiny marginal setae, anterior margin straight, anterodistally rounded, distal margin evenly rounded, posterior margin straight, facial setae absent; basis distally expanded, anterior margin with 9 setae, posterior margin with 4 setae; ischium with 1 posterodistal seta; carpus 0.4 × propodus length, curved, distally truncate, anterior margin dentate; propodus with 2 mediofacial setal rows, primary mediofacial setal row above midline, reaching 0.8 × propodus length, secondary mediofacial setal row with 2 setae, with 1 row of submar-

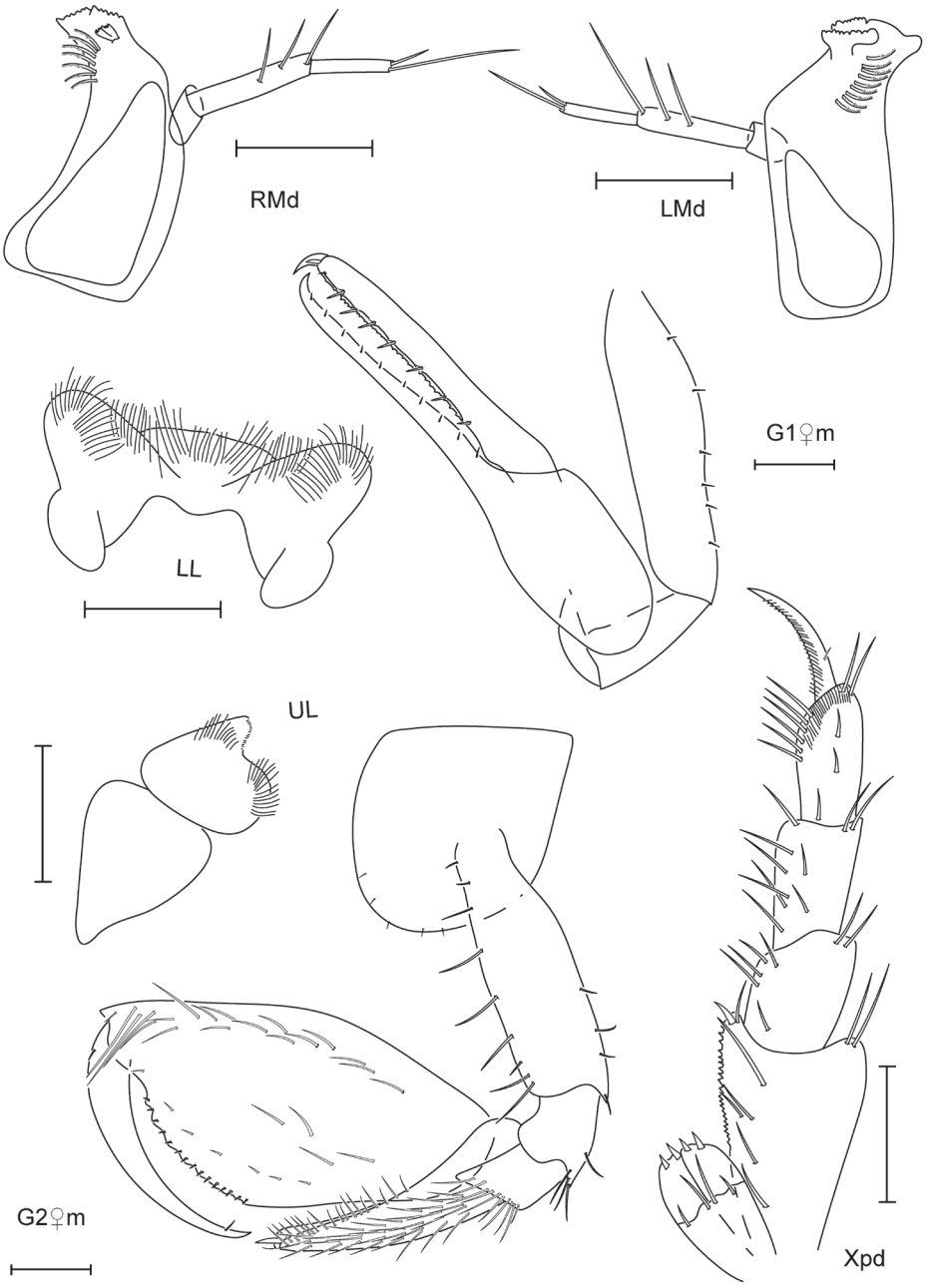

Figure 16. *Leucothoe ouraensis* sp. n., holotype male, 3.3 mm, RUMF-ZC-1774; paratype female, 3.0 mm, RUMF-ZC-1775.

ginal setae, posterior margin smooth, palm convex, dentate; dactylus curved, proximal margin smooth with 1 seta, anterior margin distally acute, reaching 0.6 × propodus length. Pereopod 3 coxa length 1.4 × width, anterodistal corner overriding distal face

of coxa 2 and extending below it, 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 produced, distal margin evenly rounded, posterior margin tapered, facial setae absent. Pereopods 5–7 coxae facial setae absent. Pereopods 5–7 bases width length ratios 1: 1.4, 1: 1.2, 1: 1.1; 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: 0.8: 1.1; outer rami lined with short marginal setae. Uropod 1 peduncle and outer ramus subequal in length with inner ramus; inner ramus with 2 robust setae; outer ramus without robust setae. Uropod 2 peduncle length 0.8 × inner ramus, outer ramus length 0.6 × inner ramus; inner ramus with 4 robust setae; outer ramus with 3 robust setae. Uropod 3 peduncle length 1.2 × inner ramus, outer ramus subequal in length with inner ramus; inner and outer rami lined with short marginal setae, each with 4 robust setae. Telson 2.7 × longer than wide, apex bidentate.

Female (sexually dimorphic characters). Gnathopod 2 ischium with posterior and posterodistal setae; carpus distally tapered, anterior margin smooth; propodus secondary mediofacial setal row with 4 setae.

Etymology. After the Japanese place name 'Oura', meaning 'large inlet' and referring to the type locality. (Pronounced oh-ooh-ra)

Ecology. In canals of brown-red chimney sponge, *Mycale* of Gray 1867, RUMF-ZP-8, KNWOkinawa37K (Figure 25B), brown-red holey sponge, *Mycale* (*Zygomycale*) *parishii* (Bowerbank, 1875), RUMF-ZP-9, KNWOkinawa37N (Figure 25G), brown bivalve encrusting sponge, ?*Mycale* of Gray, 1867, RUMF-ZP-10, KNWOkinawa37M (Figure 25H); and among coral rubble.

Relationships. *Leucothoe ouraensis* sp. n. is similar to *Leucothoe ctenochasma* Moore, 1987 in having gnathopod 1 dactylus reaching less than 0.1 × propodus length and a bidentate apex on the telson. This species differs from *L. ctenochasma* in having a truncate anterior head margin, quadrate anterodistal head margin, 1–articulate maxilla 1 palp, setose posterior margin on gnathopod 1 basis, and pereopods 5–7 bases broadly expanded and posteriorly smooth.

Remarks. *Leucothoe ouraensis* sp. n. is yellow-orange in color (Figure 23E). This species is endemic to the eastern coast of Okinawa–jima Island, Okinawa.

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

***Leucothoe togatta* sp. n.**
urn:lsid:zoobank.org:act:8846964A-A117-496F-B735-2B6039964F76
http://species-id.net/wiki/Leucothoe_togatta
Figures 17, 18

Type material. Holotype male, 4.2 mm RUMF-ZC-1778, Yoshida, Yakushima Island, Kagoshima, patch reef (30°23'58"N, 130°25'53"E), among coral rubble, 3–7 m, K.N.

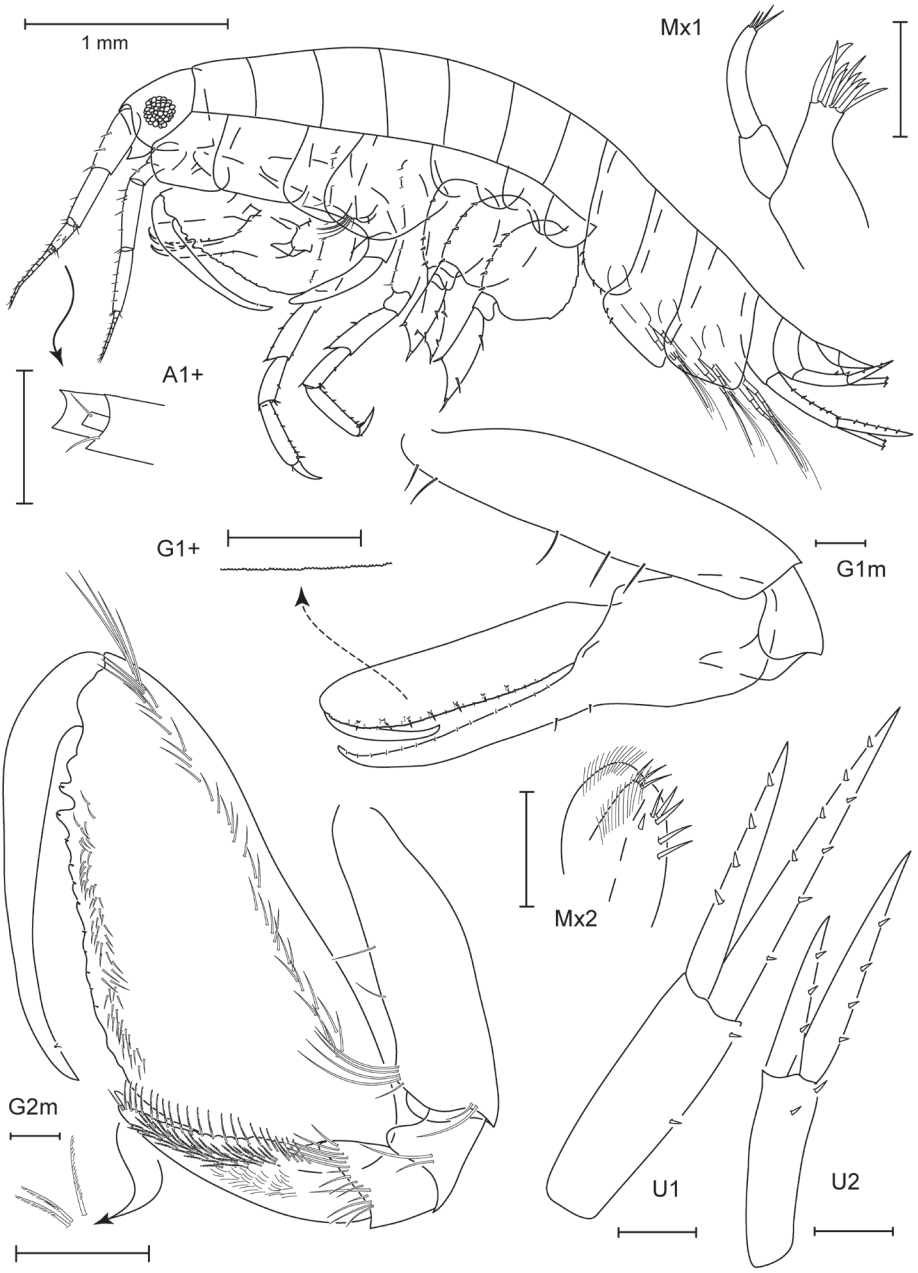

Figure 17. *Leucothoe togatta* sp. n., holotype male, 4.2 mm, RUMF-ZC-1778.

White and N.S. White, col., 26 May 2011 (KNWYaku2E). Paratype female, 5.4 mm RUMF-ZC-1779, same station data as holotype.

Type locality. Yoshida, Yakushima Island, Kagoshima, Japan (30°23'58"N, 130°25'53"E).

Additional material examined. 2 specimens, RUMF-ZC-1780, KNWYaku5M; 1 specimen, NSMT-Cr 21900, KNWOkinawa35A; 1 specimen, RUMF-ZC-1781, KNWOkinawa36E; 1 specimen, RUMF-ZC-1782, KNWYaku1F; 1 specimen, NSMT-Cr 21901, KNWOkinawa51D; 1 specimen, RUMF-ZC-1783, KNWYaku1G; 1 specimen, KNWOkinawa55E.

Diagnosis (male). Ventral cephalic keel anteroventral margin quadrate with large projection. Antenna 1 accessory flagellum 1–articulate. Mandibular palp article 2 with 11 long distal setae; article 2 with facial setae and 1 distal seta. Gnathopod 2 basis anterior margin with 7 long curved setae; carpus with setulate-serrate marginal setae; propodus with 3 mediofacial setal rows. Pereopod 7 basis posterior margin serrate. Female gnathopod 1 carpus elongate; gnathopod 2 basis anterior margin with 22 long curved setae, distal margin with 4 long curved setae; ischium with 3 long and 2 short distal setae, carpus distally truncate.

Description (male). Head. Anterior margin rounded, anterodistal margin evenly rounded; ventral cephalic keel anterior margin excavate, anteroventral margin quadrate with projection, ventral margin convex; eyes with more than 10 ommatidia, round. Antenna 1 0.3 × body length, flagellum 10–articulate, peduncle article 1 width less than 2 × article 2, accessory flagellum 1–articulate. Antenna 2 0.3 × body length, subequal in length with antenna 1, flagellum 8–articulate. Mandibular palp ratio of articles 1–3 1.0: 3.4: 2.0, article 2 with 11 long distal setae, article 3 with facial setae and 1 distal seta, incisors strongly dentate; left mandible with 10 raker spines, lacinia mobilis large, strongly toothed; right mandible with 11 raker spines, lacinia mobilis small, strongly 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 2–articulate with 4 distal setae; outer plate with 9 distal robust setae. Maxilla 2 inner plate with 5 robust distal setae, 1 robust facial seta, and several slender facial setae; outer plate with 3 robust distal setae and 13 slender distal marginal setae. Maxilliped inner plates distal margin with a v-shaped indentation, with short robust setae; outer plate inner margin smooth, reaching 0.1 × palp article 1, with simple marginal setae, facial setae absent; palp article 4 subequal in length with article 3, distally acute.

Pereon. Coxae 1–4 relative widths 1.0: 1.2: 0.9: 1.6. Gnathopod 1 coxa smooth, bare, anterodistal margin produced, subquadrate, distal margin straight, posterior margin excavate, facial setae absent; basis distally expanded, anterior margin with 5 medium setae, posterior margin bare; ischium bare; carpus linear, distal length 11.2 × width, proximal margin smooth, distal margin with 2 short setae; propodus straight, palm dentate with 7 robust and 12 distal setae; dactylus smooth, reaching 0.4 × propodus length. Gnathopod 2 coxa broader than long, subequal in size with coxae 3, smooth, bare, anterior margin straight, anterodistally rounded, distal and posterior margins straight, facial setae absent; basis slightly posteriorly expanded, anterior margin with 7 long curved setae, distal margin with 2 long setae, posterior margin bare; ischium with 2 distal setae; carpus 0.3 × propodus length, curved, distally tapered, anterior margin smooth, with setulate-serrate marginal setae; propodus

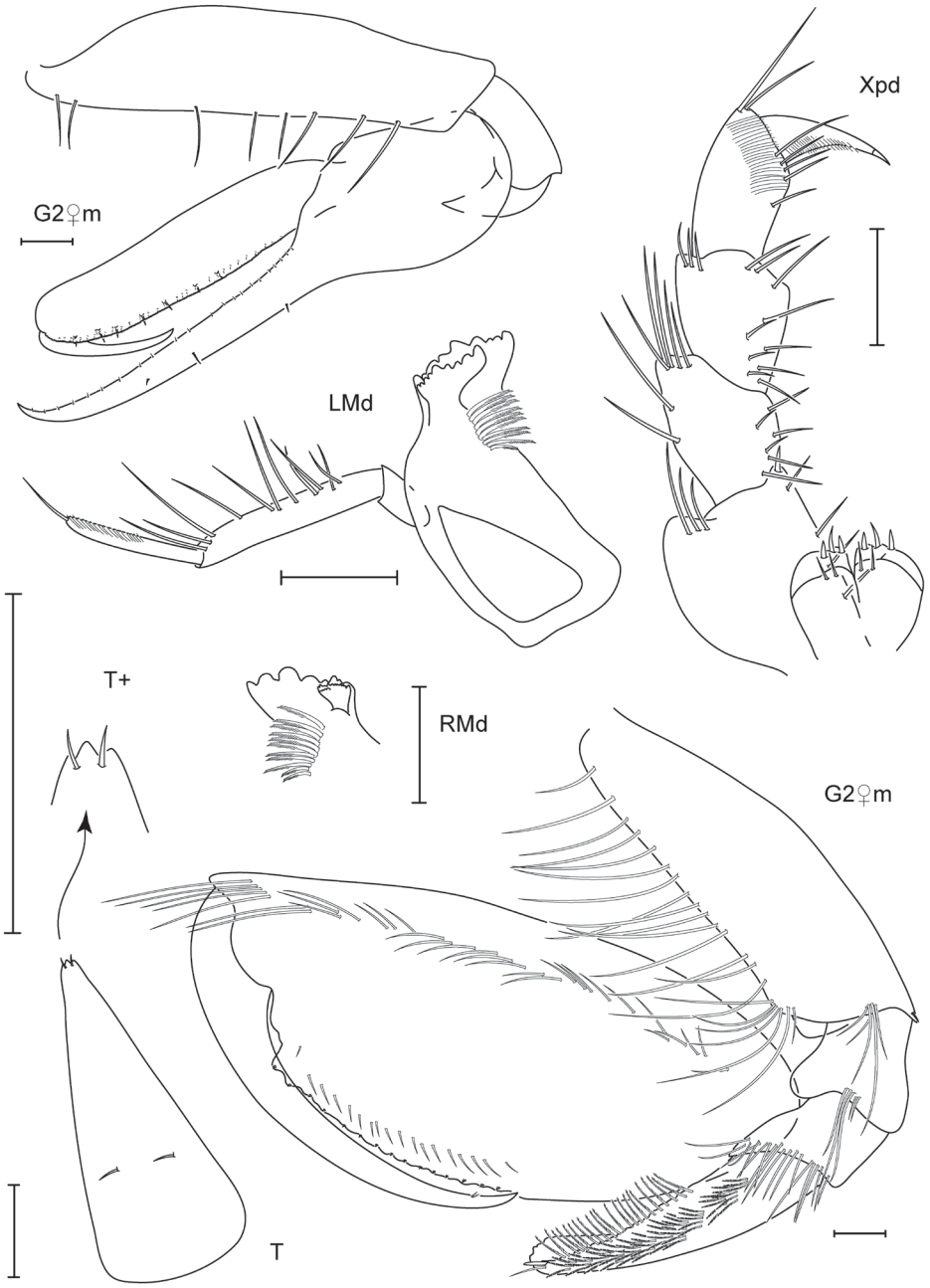

Figure 18. *Leucothoe togatta* sp. n., holotype male, 4.2 mm, RUMF-ZC-1778; paratype female, 5.4 mm, RUMF-ZC-1779.

with 1 mediofacial setal row above midline, reaching 0.8 × propodus length, with 3 rows of submarginal setae, posterior margin smooth, palm convex with 2 large and several small tubercles; dactylus curved, proximal margin smooth with 2 setae, ante-

rior margin distally acute, reaching 0.6 × propodus length. Pereopod 3 coxa length 1.3 × width, anterodistal corner overriding distal face of coxa 2 and 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 excavate, facial setae absent. Pereopods 5–7 coxae facial setae absent, bases width length ratios 1: 1.3, 1: 1.2, 1: 1.2, posterior margins bare; pereopods 5–6 bases posterior margins smooth, pereopod 7 basis posterior margin serrate.

Pleon. Epimera 1–2 with ventral setae, epimeron 3 bare; epimeron 3 posteroventral corner subquadrate. Uropods 1–2 relative lengths 1.0: 0.9. Uropod 1 peduncle 0.7 × inner ramus length, outer ramus 0.8 × inner ramus length; inner ramus with 4 robust setae on each margin; outer ramus with 4 robust setae. Uropod 2 peduncle 0.8 × inner ramus length, outer ramus 0.7 × inner ramus length; inner ramus with 4 robust setae; outer ramus with 3 robust setae. Uropod 3 missing. Telson 2.3 × longer than wide, with 2 simple facial setae, apex weakly tridentate.

Female (sexually dimorphic characters). Gnathopod 1 carpus length 10.8 × width; basis anterior margin with 8 long setae. Gnathopod 2 basis distally expanded, anterior margin with 22 long curved setae, distal margin with 4 long curved setae; ischium with 3 long and 2 short distal setae; carpus distally truncate, anterior margin dentate; propodus palm with 1 row of submarginal setae.

Etymology. After the Japanese word 'togatta', meaning 'sharp' and referring to the sharply pointed projection on the ventral cephalic keel. (Pronounced toe-ga-ta)

Ecology. In canals of hard brown sponge, yellow inside with groups of small holes on top, ?*Jaspis* of Gray, 1867 (Figure 25C); and among coral rubble.

Relationships. *Leucothoe togatta* sp. n. is similar to *Leucothoe ashleyae* Thomas & Klebba, 2006 and *Leucothoe saron* Thomas & Klebba, 2007 in having a rounded head margin, a 2–articulate maxilla 1 palp, high mediofacial setal row on gnathopod 2 propodus, wide pereopod 5–7 bases, and a tridentate telson. It also shares long curved setae on the distal margin of gnathopod 2 basis with *L. saron*. It differs from these species in having a ventral cephalic keel that is anteriorly excavate and anteroventrally quadrate with a projection. *Leucothoe togatta* sp. n. shares these keel characteristics with *Leucothoe amamiensis* White & Reimer, 2012a and *Leucothoe hashi* sp. n., but differs from *L. amamiensis* in the distally truncate gnathopod 2 carpus, from *L. hashi* in the robustness of gnathopod 1 propodus and length of gnathopod 1 dactylus, and from both species in the long curved setae on gnathopod 2 basis and robust row of submarginal setae on the gnathopod 2 propodus.

Remarks. *Leucothoe togatta* sp. n. is white in color (Figure 23G). This species has been collected only on Yakushima Island and from both western and eastern coasts of Okinawa–jima Island, Okinawa.

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

***Leucothoe toribe* sp. n.**
urn:lsid:zoobank.org:act:430610B7-66FE-49E0-A683-C0CDD538E2D5
http://species-id.net/wiki/Leucothoe_toribe
Figures 19, 20

Type material. Holotype male, 3.3 mm RUMF-ZC-1784, Manza, Okinawa–jima Island, Okinawa, reef wall (26°30'15"N, 127°50'39"E), among coral rubble, 10–23 m, K.N. White and N.S. White, col., 8 February 2011 (KNWOkinawa29K). Paratype female, 3.8 mm RUMF-ZC-1785, same station data as holotype.

Type locality. Manza, Okinawa–jima Island, Okinawa, Japan (26°30'15"N, 127°50'39"E).

Additional material examined. 4 specimens, RUMF-ZC-1786, KNWOkinawa22C; 5 specimens, NSMT-Cr 21902, KNWOkinawa23D; 2 specimens, RUMF-ZC-1787, KNWOkinawa23E; 1 specimen, NSMT-Cr 21903, KNWOkinawa25E; 4 specimens, RUMF-ZC-1788, KNWOkinawa27D; 6 specimens, NSMT-Cr 21904, KNWOkinawa29K; 6 specimens, RUMF-ZC-1789, KNWOkinawa30E; 1 specimen, RUMF-ZC-1790, KNWOkinawa33G; 12 specimens, NSMT-Cr 21905, KNWOkinawa39J.

Diagnosis (male). Head anterodistal margin concave. Mandibular palp article 3 shorter than article 1; left mandible with 5 robust marginal setae. Maxilla 1 palp 1–articulate. Maxilliped inner plates with facial setae. Gnathopod 1 basis distally expanded, posterior margin with 5 short proximal setae; carpus robust; propodus curved, palm smooth with 22 short distal setae; dactylus reaching 0.2 × propodus length. Gnathopod 2 carpus distally truncate, spoon-like, with setulate-serrate setae; propodus with 3 mediofacial setal rows; dactylus elongate. Pereopods 5–6 coxae with facial setae; epimeron 3 posteroventral corner sinuous.

Description (male). Head. Anterior margin transverse, anterodistal margin concave; ventral cephalic keel anterior margin transverse, anteroventral margin rounded, ventral margin excavate; 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. Antenna 2 0.3 × body length, slightly shorter than antenna 1, flagellum 6–articulate. Mandibular palp ratio of articles 1–3 1.0: 2.6: 0.8, article 2 with 2 medium distal setae, article 3 with 1 distal seta, incisors weakly dentate; left mandible with 1 row of 5 and 1 row of 4 raker spines, with 5 robust marginal setae, 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 with 4 distal setae; outer plate with 6 distal robust setae and 6 distal setae. Maxilla 2 inner plate with 3 robust distal and 3 robust marginal setae; outer plate with 4 robust distal setae and 4 sets of 2 slender distal marginal setae. Maxilliped inner plates distal margin with a v-shaped indentation, with short robust setae, facial setae present; outer plate inner margin smooth, reaching 0.3 × palp article 1, with simple marginal setae, facial setae absent; palp article 4 subequal in length with article 3, distally acute.

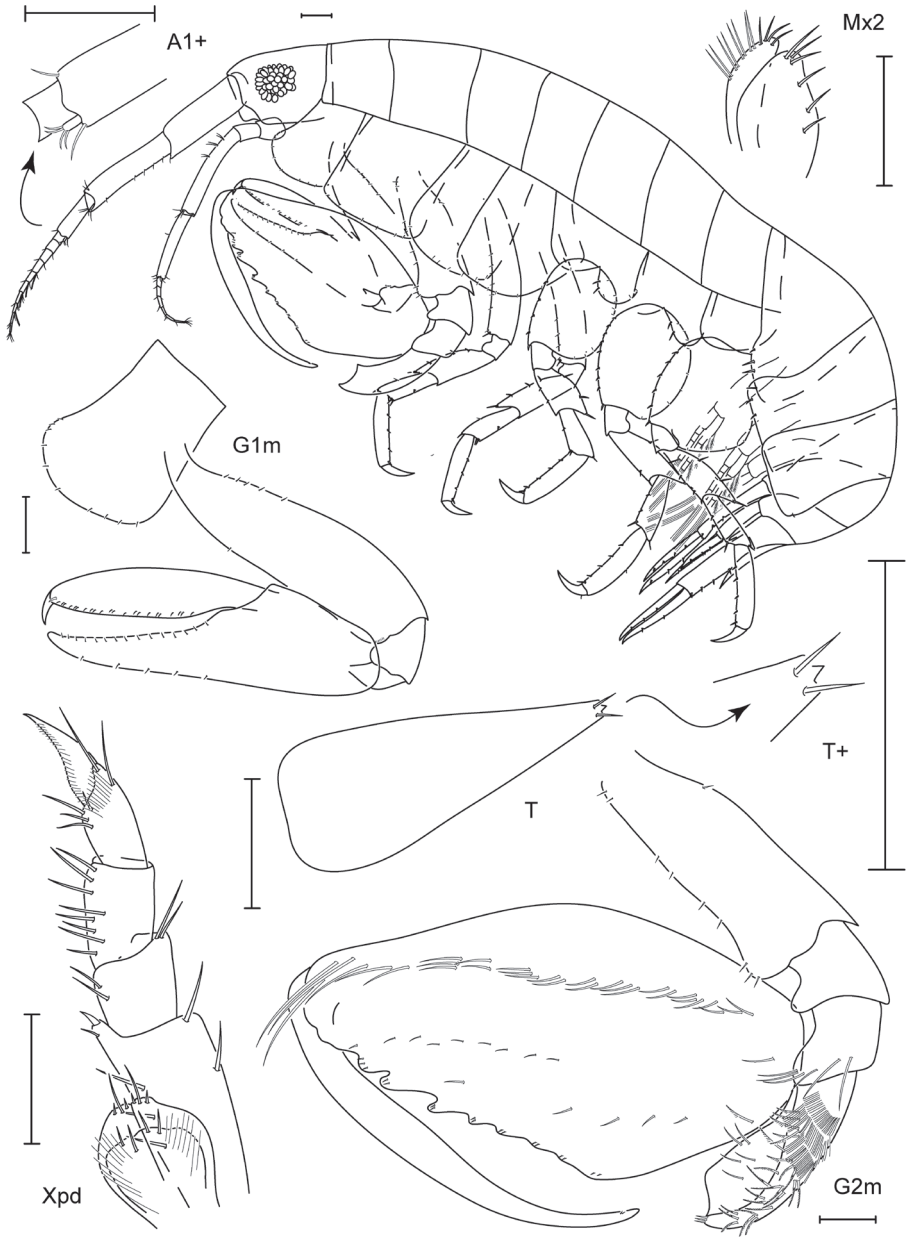

Figure 19. *Leucothoe toribe* sp. n., holotype male, 3.3 mm, RUMF-ZC-1784.

Pereon. Coxae 1–4 relative widths 1.0: 1.4: 1.1: 1.2. Gnathopod 1 coxa smooth, with tiny marginal setae, anterodistal margin produced, rounded, distal margin rounded, posterior margin excavate, facial setae absent; basis distally expanded, anterior margin with 1 short seta, anterodistal margin with several short slender setae, posterior margin with 5 setae; ischium bare; carpus linear, distal length 5.3 × width, proximal margin

smooth, distal margin with 5 short setae; propodus curved, palm smooth with 22 distal setae; dactylus smooth, reaching 0.2 × propodus length. Gnathopod 2 coxa as long as broad, subequal in size with coxa 3, smooth, with tiny marginal setae, anterior margin straight, anterodistally subquadrate, distal and posterior margins straight, facial setae absent; basis distally expanded, anterior margin with 9 short setae, posterior margin with 1 short seta; ischium bare; carpus 0.2 × propodus length, curved, distally truncate, spoon-like, anterior margin smooth with setulate-serrate setae; propodus with 3 mediofacial setal rows, primary mediofacial setal row above midline, reaching 0.9 × propodus length, secondary mediofacial setal row with 9 setae, tertiary mediofacial setal row with 4 setae, posterior margin smooth, palmar corner pronounced, palm convex with 4 major tubercles; dactylus curved, proximal margin smooth with 2 setae, anterior margin distally subacute, reaching 0.7 × propodus length. Pereopod 3 coxa length 1.5 × width, anterodistal corner overriding distal face of coxa 2 and extending below it, 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 produced, posterior margin excavate, facial setae absent. Pereopods 5–6 coxae facial setae present. Pereopod 7 coxa facial setae absent. Pereopods 5–7 bases width length ratios 1: 1.3, 1: 1.2, 1: 1.1, posterior margins smooth, setose.

Pleon. Epimera 1–2 with ventral setae, epimeron 3 bare; epimeron 3 posteroventral corner sinuous, rounded. Uropods 1–3 relative lengths 1.0: 0.7: 1.0. Uropod 1 peduncle subequal in length with inner ramus, outer ramus 0.8 × inner ramus length; inner ramus with 3 robust setae; outer ramus with 4 robust setae. Uropod 2 peduncle and outer ramus 0,7 × inner ramus length; inner and outer rami each with 3 robust setae. Uropod 3 peduncle and outer ramus subequal in length with inner ramus; inner ramus with 3 robust setae; outer ramus with 2 robust setae. Telson 2.5 × longer than wide, apex weakly tridentate.

Female (sexually dimorphic characters). Gnathopod 2 basis linear, posterior margin bare; ischium with 5 posterodistal setae; carpus 0.4 × propodus length, distally tapered.

Etymology. After the Japanese word 'toribe', meaning 'ladle' and referring to the spoon-like carpus on gnathopod 2. (Pronounced toe-ree-bay)

Ecology. In canals of green hard branching sponge, ?*Clathria* (*Thalysias*) *reinwardti* (Figure 25F); and among coral rubble.

Relationships. *Leucothoe toribe* sp. n. is similar to *Leucothoe alata* (Barnard, 1959), *Leucothoe nagatai* Ishimaru, 1985, and *Leucothoe obuchii* White & Reimer, 2012a in having gnathopod 1 carpus reaching 0.1–0.2 × propodus length, and a curved gnathopod 1 propodus, but differs in having a 1–articulate maxilla 1 palp, broad pereopod 5–7 bases, and a sinuous posteroventral margin on epimeron 3. *Leucothoe toribe* sp. n. shares the spoon-like gnathopod 2 carpus with *L. alata* as well.

Remarks. *Leucothoe toribe* sp. n. is faint pink in color, darkest along pereonite edges (Figure 23H). This species has been collected only on Yakushima Island, Kagoshima and from both western and eastern coasts of Okinawa–jima Island, Okinawa.

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

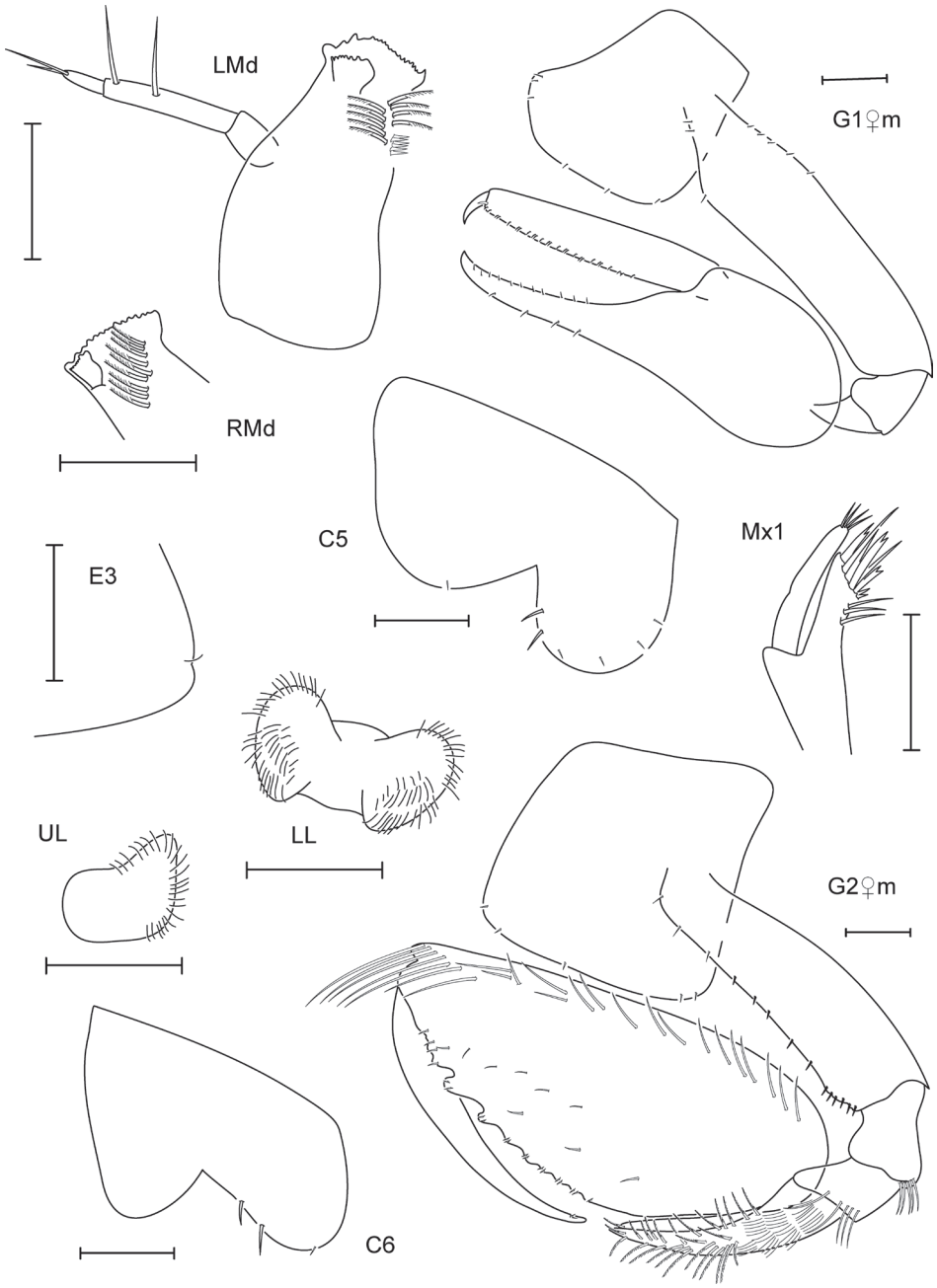

Figure 20. *Leucothoe toribe* sp. n., holotype male, 3.3 mm, RUMF-ZC-1784; paratype female, 3.8 mm, RUMF-ZC-1785.

***Leucothoe zanpa* sp. n.**
urn:lsid:zoobank.org:act:74A3D66E-F5F5-4110-A799-A69E9BAE1028
http://species-id.net/wiki/Leucothoe_zanpa
Figures 21, 22

Type material. Holotype male, 3.2 mm, RUMF-ZC-1791, Zanpa Cape, Okinawa–jima Island, Okinawa, reef wall (26°26'27"N, 127°43'03"E), in canals of large white ball sponge, Tetillidae, 30 m, Daisuke Ueno, col., 26 February 2011 (KNWOkinawa34A). Paratype female, 3.8 mm, RUMF-ZC-1792, same station data as holotype.

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

Additional material examined. 12 specimens, RUMF-ZC-1793, KNWOkinawa34A; 13 specimens, NSMT-Cr 21906, KNWOkinawa34A; 3 specimens, RUMF-ZC-1794, KNWOkinawa34B; 2 specimens, NSMT-Cr 21907, KNWOkinawa34B.

Diagnosis (male). Eyes rectangular. Antenna 1 0.6 × body length, peduncle article 1 width greater than 2 × article 2. Gnathopod 1 coxa about ½ as wide as coxa 2; basis proximally inflated, elongate; carpus and propodus elongate. Gnathopod 2 basis posterior margin with 2 long setae; ischium with 5 long posterodistal setae; propodus with 1 row of robust submarginal setae. Pereopod 5 coxa with facial setae; pereopods 5–7 bases very narrowly expanded. Uropod 3 peduncle 1.5 × inner ramus length. Telson apex truncate.

Description (male). Head. Anterior margin excavate, anterodistal margin subquadrate; ventral cephalic keel anterior margin excavate, anteroventral margin rounded, ventral margin straight; eyes with more than 10 ommatidia, rectangular. Antenna 1 0.6 × body length, flagellum 6–articulate, peduncle article 1 width greater than 2 × article 2, accessory flagellum absent. Antenna 2 0.5 × body length, slightly shorter than antenna 1, flagellum 3–articulate. Mandibular palp ratio of articles 1–3 1.0: 2.0: 1.3, article 2 with 4–5 short distal setae, article 3 with 2 distal setae, incisors strongly dentate; left mandible with 8 raker spines, lacinia mobilis large, strongly toothed; right mandible with 12 raker spines, lacinia mobilis small, strongly dentate. Upper lip asymmetrically lobate, anterior margin setose. Lower lip inner lobes fused, bare; outer lobes with large gape, anterior margins setose. Maxilla 1 palp 2–articulate with 4 distal setae; outer plate with 4 distal robust setae and 7 distal setae. Maxilla 2 inner plate with 5 robust distal setae and 1 slender facial seta; outer plate with 4 robust distal setae, 7 distal and 5 proximal slender marginal setae. Maxilliped inner plates fused, distal margin with a v-shaped indentation, with short robust setae; outer plate inner margin tuberculate, reaching 0.1 × palp article 1, with simple marginal setae, facial setae present; palp article 4 subequal in length with article 3, distally acute.

Pereon. Coxae 1–4 relative widths 1.0: 1.9: 1.7: 1.7. Gnathopod 1 coxa smooth, with tiny marginal setae, anterior margin straight, anterodistal margin subquadrate, distal margin straight, posterior margin excavate, facial setae absent; basis proximally inflated, anterior margin with 4 setae, posterior margin with 2 setae; ischium bare; carpus linear, distal length 14.1 × width, proximal margin with denticles, distal margin bare; propodus curved, palm serrate with 13 distal setae; dactylus smooth,

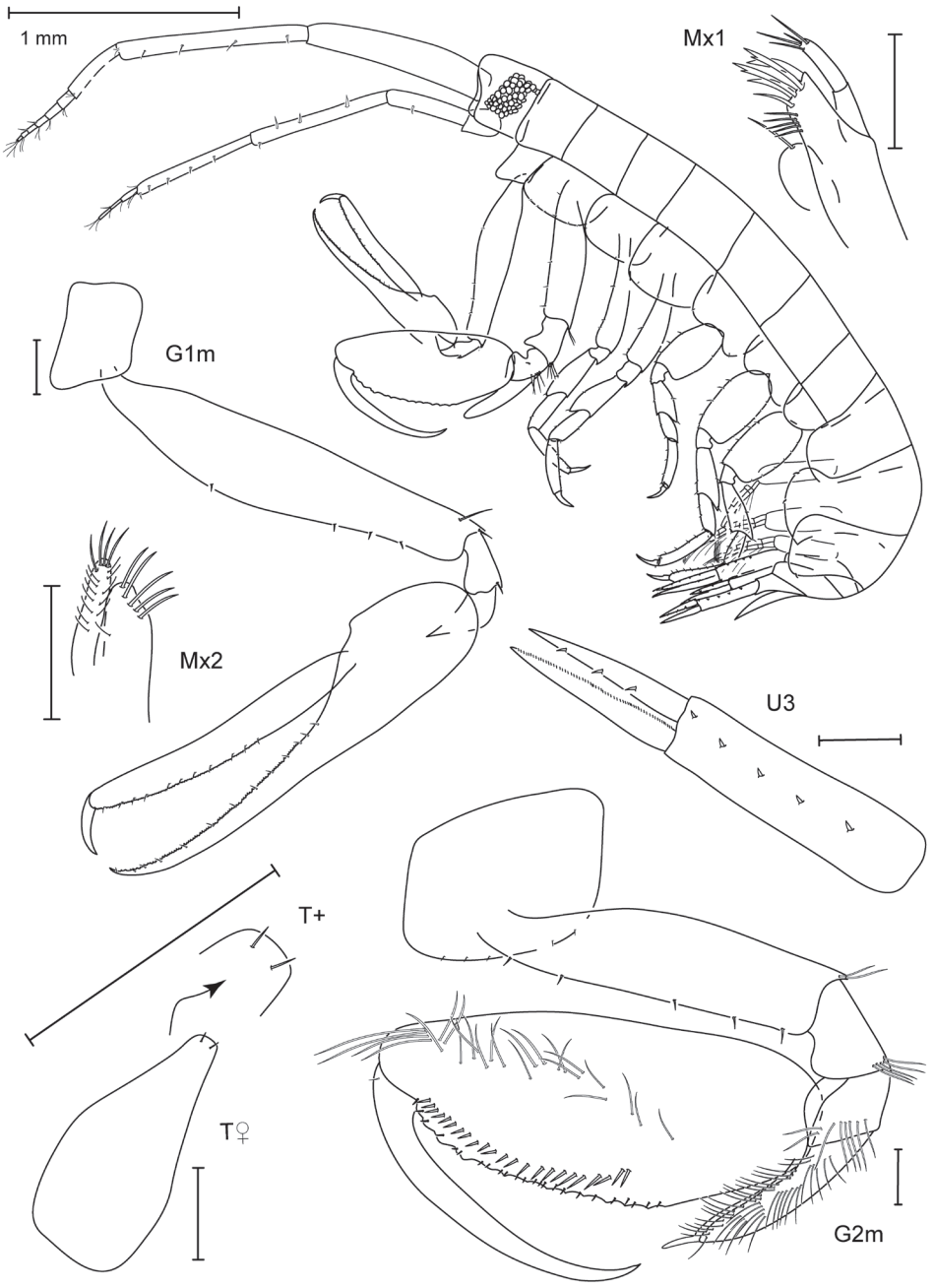

Figure 21. *Leucothoe zanpa* sp. n., holotype male, 3.2 mm, RUMF-ZC-1791.

reaching 0.2 × propodus length. Gnathopod 2 coxa longer than broad, subequal in size with coxa 3, smooth, with tiny marginal setae, anterodistally rounded, distal margin straight, posterior margin straight, facial setae absent; basis linear, anterior

margin with 5 short setae, posterior margin with 2 long setae; ischium with 5 long posterodistal setae; carpus 0.4 × propodus length, straight, distally tapered, anterior margin smooth; propodus with 1 mediofacial setal row displaced to midline, reaching 0.6 × propodus length, with 1 row of robust submarginal setae, posterior margin smooth, palm convex with many small tubercles; dactylus curved, proximal margin smooth, bare, anterior margin distally subacute, reaching 0.6 × propodus length. Pereopod 3 coxa length 0.8 × width, anterodistal corner overriding distal face of coxa 2, not extending below it, smooth, with tiny marginal setae, anterior margin evenly rounded, distal and posterior margins straight, facial setae absent. Pereopod 4 coxa smooth, with tiny marginal setae, anterior margin straight, distal margin evenly rounded, posterior margin straight, facial setae absent. Pereopod 5 coxa facial setae present, pereopods 6–7 coxae facial setae absent. Pereopods 5–7 bases width length ratios 1: 1.8, 1: 1.9, 1: 1.7, posterior margins smooth, setose.

Pleon. Epimera 1 and 3 bare, epimeron 2 with ventral setae; epimeron 3 posteroventral corner rounded. Uropods 1–3 relative lengths 1.0: 0.7: 0.8. Uropod 1 peduncle and outer ramus subequal in length with inner ramus; inner ramus with 1 robust seta; outer ramus lined with short marginal setae, with 5 robust setae. Uropod 2 peduncle 0.9 × inner ramus length, outer ramus 0.8 × inner ramus length; inner ramus with 2 robust setae; outer ramus lined with short marginal setae, with 2 robust setae. Uropod 3 peduncle 1.5 × inner ramus length, outer ramus subequal in length with inner ramus; inner ramus lined with short marginal setae, without robust setae; outer ramus with 3 robust setae. Telson 2.0 × longer than wide, apex truncate.

Female (sexually dimorphic characters). Antenna 1 0.2 × body length. Antenna 2 0.3 × body length, subequal in length with antenna 1. Gnathopod 1 basis proximally wider than in male, posterior margin with 11 long setae. Gnathopod 2 basis anterior margin with 10 short setae.

Etymology. After the Japanese place name 'Zanpa', meaning 'wave slicing' and referring to the type locality.

Ecology. In canals of large white ball sponge, Tetillidae (Figure 24I).

Relationships. *Leucothoe zanpa* sp. n. is similar to *Leucothoe oboa* Karaman, 1971, *Leucothoe occulta* Krapp-Schickel, 1975, and *Leucothoe pachycera* Della Valle, 1893, in having antennae 1 peduncle article 1 width greater than 2 × the width of article 2, but differs in having an excavate anterior head margin, tuberculate maxilliped inner plate, setose gnathopod 2 basis posterior margin, pereopods 5–7 bases without facial setae, bare epimera 1 and 3, subquadrate epimeron 3 posteroventral margin, and truncate telson apex. *Leucothoe zanpa* sp. n. is similar to *Leucothoe elegans* White & Reimer, 2012a in the gracefully elongate gnathopod 1, but differs in eye shape, antennae length, and pereopod 5–7 bases widths.

Remarks. *Leucothoe zanpa* sp. n. is white in color with faint purple stripes along pereonite edges (Figure 23B). This species is endemic to Zanpa Cape on the western coast of Okinawa–jima Island, Okinawa.

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

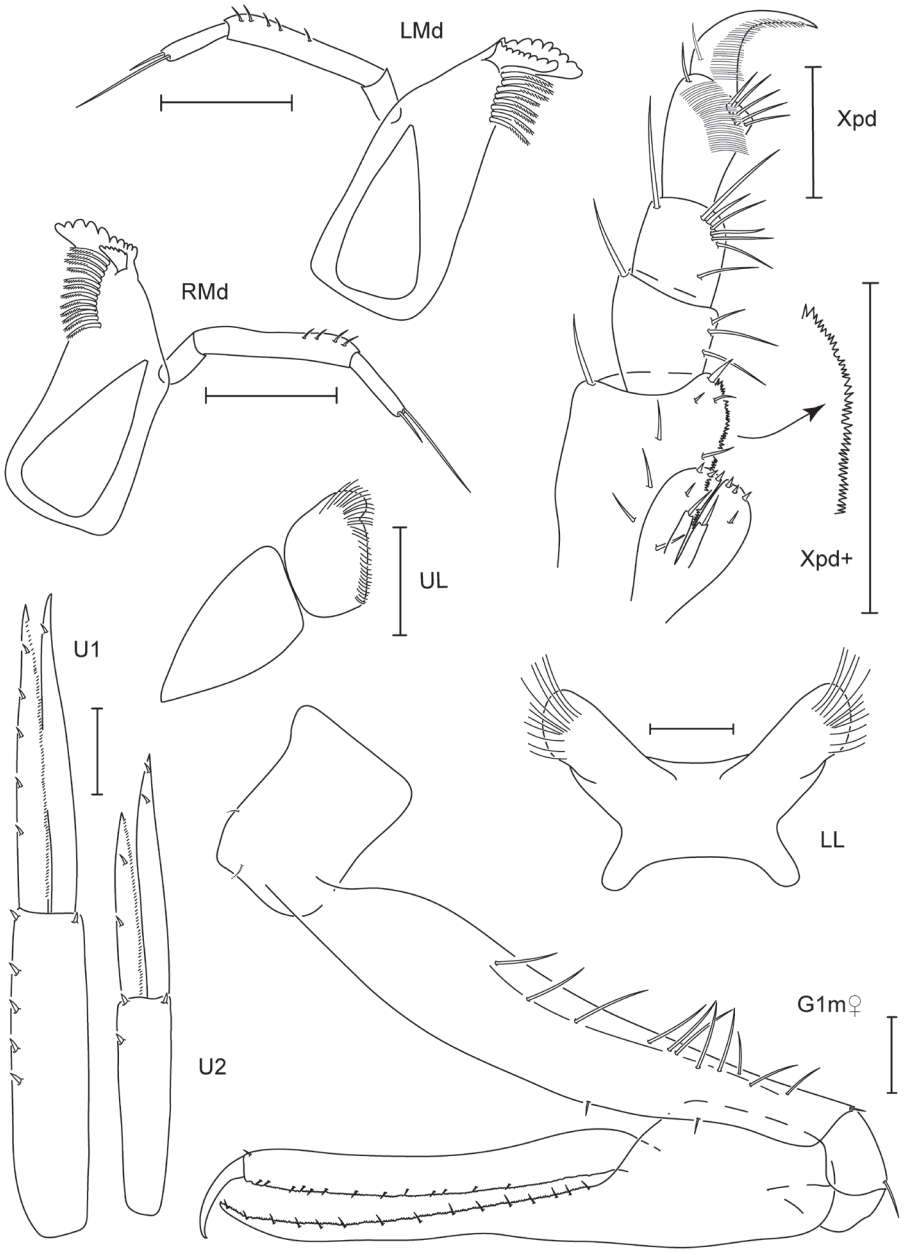

Figure 22. *Leucothoe zanpa* sp. n., holotype male, 3.2 mm, RUMF-ZC-1791; paratype female, 3.8 mm, RUMF-ZC-1792.

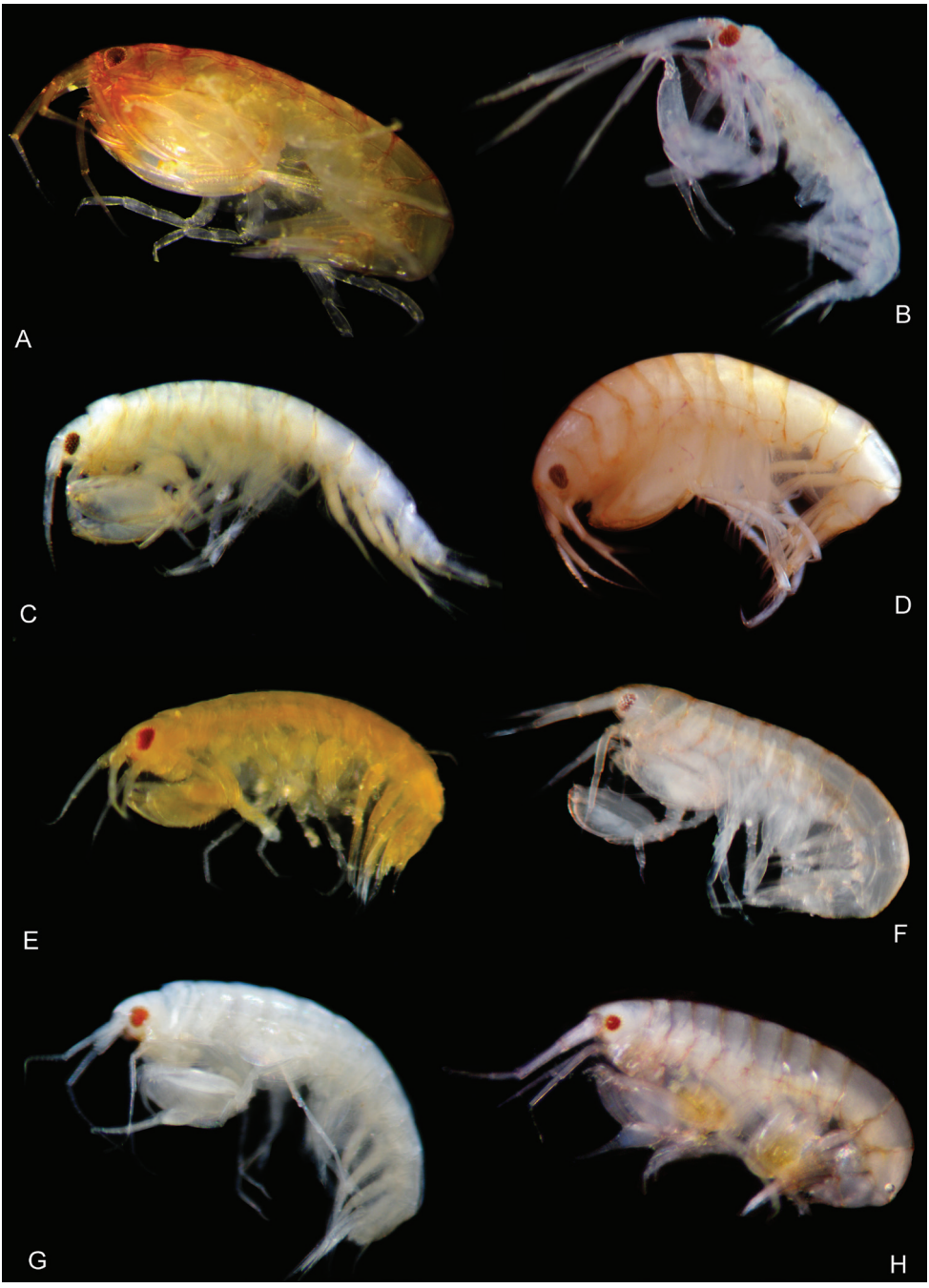

Figure 23. Color plate of new leucothoid amphipod species. **A** *Leucothoe akaoni* sp. n. **B** *Leucothoe zanpa* sp. n. **C** *Leucothoe lecroyae* sp. n. **D** *Leucothoe nurununu* sp. n. **E** *Leucothoe ouraensis* sp. n. **F** *Leucothoe daisukei* sp. n. **G** *Leucothoe togatta* sp. n. **H** *Leucothoe toribe* sp. n.

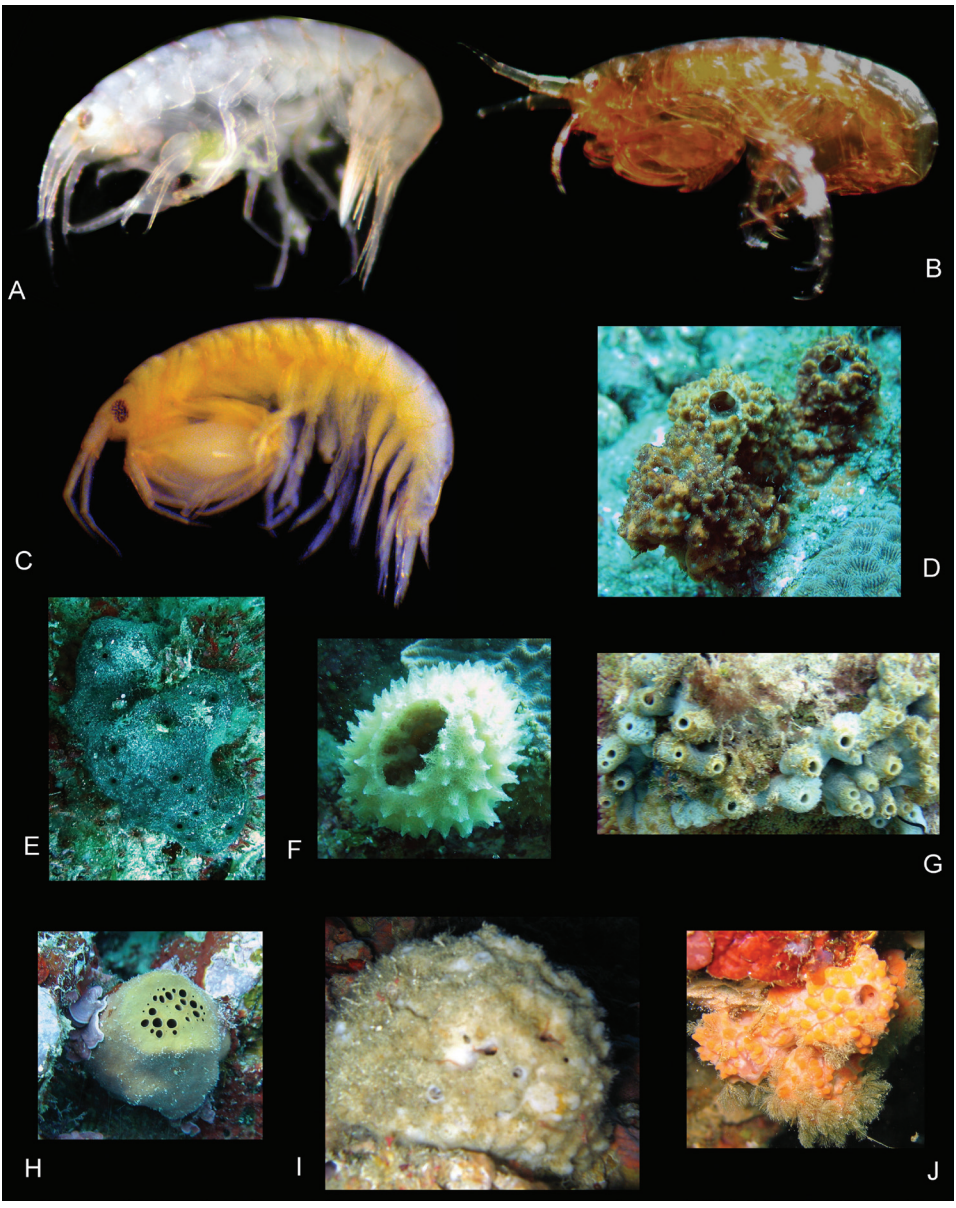

Figure 24. Color plate of new leucothoid amphipod species and sponge hosts. **A** *Leucothoe hashi* sp. n. **B** *Leucothoe bise* sp. n. **C** *Leucothoe nagatekubi* sp. n. **D** Axinellidae of Carter, 1875, RUMF-ZP-12 **E** ?*Axinyssa* of Lendenfeld, 1897 **F** *Callyspongia* of Duchassaing and Michelotti, 1864, RUMF-ZP-2 **G** *Haliclona* of Grant, 1836, RUMF-ZP-3 **H** *Rhabdastrella* of Thiele, 1903, RUMF-ZP-1 I Tetillidae of Sollas, 1886, RUMF-ZP-11 J Axinellidae of Carter, 1875.

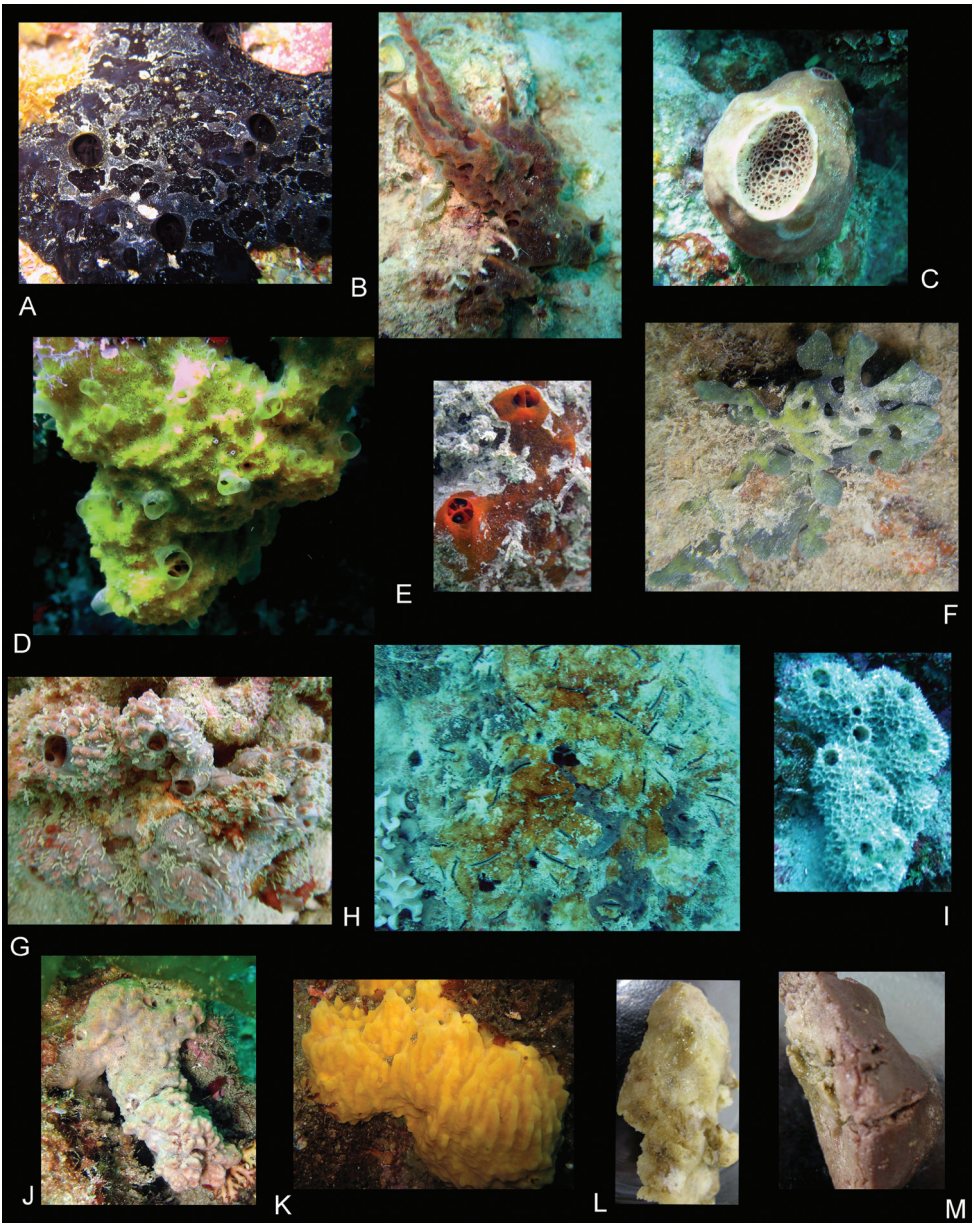

Figure 25. Color plate of sponge hosts. **A** Iotrochotidae of Dendy, 1922 (probably *Iotrochota* of Ridley, 1884), RUMF-ZP-7 **B** *Mycale* of Gray, 1867, RUMF-ZP-8 **C** ?*Jaspis* of Gray, 1867 **D** orange encrusting sponge, *Clathria* of Schmidt, 1862, RUMF-ZP-5 **E** ?*Clathria* (*Thalysias*) *reinwardti* Vosmaer, 1880, RUMF-ZP-4 **F** *Tedania* of Gray, 1867 **G** *Mycale* (*Zygomycale*) *parishii* (Bowerbank, 1875), RUMF-ZP-9 **H** ?*Mycale* of Gray, 1867, RUMF-ZP-10 I Niphatidae of Van Soest, 1980 (probably *Niphates* of Duchassaing and Michelotti, 1864), RUMF-ZP-6 **J** grey/purple hard sponge, *Clathria* (*Thalysias*) of Duchassaing and Michelotti, 1864 **K** orange flame sponge, *Ciocalypta* of Bowerbank, 1862 **L** orange stubby sponge, *Mycale* sp. **M** purple brown soft sponge, ?*Pericharax* of Poléjaeff, 1883.

Note

Sponge hosts for *Leucothoe elegans* White & Reimer, 2012a have been tentatively identified. These include: grey/purple hard sponge, *Clathria* (*Thalysias*) of Duchassaing and Michelotti 1864 (Figure 25J); dark red chimney sponge, Axinellidae (Figure 24D); orange flame sponge, *Ciocalypta* of Bowerbank 1862 (Figure 25K); purple brown soft sponge, ?*Pericharax* of Poléjaeff 1883 (Figure 25M); and orange stubby sponge, *Mycale* sp. (Figure 25L).

Identification Key for sponge-dwelling Leucothoidae of the Ryukyu Archipelago

(including *Leucothoe elegans* and *Leucothoe vulgaris* both White and Reimer 2012a)

1 Antenna 1 length greater than 0.5 × body length (males), peduncle article 1 width greater than 2 × article 2; eyes rectangular; coxa 1 about ½ width of coxa 2, telson apex truncate ..... ***Leucothoe zanpa***

– Antenna 1 length less than 0.5 × body length, peduncle article 1 width less than 2 × article 2; eyes round or oval; coxa 1 subequal to or slightly smaller than coxa 2, telson apex tridentate, bidentate, or with strong point (rounded or sharp) **2**

2 Gnathopod 1 propodus curved **3**

– Gnathopod 1 propodus straight **4**

3 Gnathopod 1 palm without ornamentation; gnathopod 2 carpus distally truncate, spoon-like (male) ..... ***Leucothoe toribe***

– Gnathopod 1 palm dentate; gnathopod 2 carpus distally tapered ..... ***Leucothoe elegans*** **White & Reimer, 2012a**

4 Maxilliped outer plate tuberculate; gnathopod 1 dactylus 0.2 or less × propodus length **5**

– Maxilliped outer plate smooth; gnathopod 1 dactylus length greater than 0.2 × propodus length **8**

5 Ventral cephalic keel anterior margin oblique, anteroventral margin with projection; gnathopod 1 basis distally expanded, propodus palm without large triangular teeth, dactylus reaching less than 0.1 × propodus length; telson apex bidentate ..... ***Leucothoe ouraensis***

– Ventral cephalic keel anterior margin transverse, anteroventral margin quadrate; gnathopod 1 basis linear, propodus palm with large triangular teeth, dactylus reaching 0.1–0.2 × propodus length; telson apex tridentate **6**

6 Head anterior margin truncate, anterodistal margin quadrate with cusp; maxilliped outer plate with facial setae; gnathopod 1 basis posterior margin bare, distal margin setose; gnathopod 2 carpus distally tapered, propodus with 1 mediofacial setal row ..... ***Leucothoe nagatekubi***

– Head anterior margin round, anterodistal margin round; maxilliped outer plate without facial setae; gnathopod 1 basis posterior margin setose, distal margin bare; gnathopod 2 carpus distally truncate, propodus with 2 mediofacial setal rows **7**

7 Antenna 1 accessory flagellum 1–articulate; mandibular palp article 3 shorter than article 1 and with 1 distal seta; maxilla 1 palp 1–articulate; gnathopod 1 basis anterior margin bare, carpus slender; pereopods 5–6 coxae without facial setae, pereopods 5–7 bases narrowly expanded..... ***Leucothoe hashi***

– Antenna 1 accessory flagellum absent; mandibular palp article 3 subequal in length with article 1 and with 2 distal setae; maxilla 1 palp 2–articulate; gnathopod 1 basis anterior margin setose, carpus robust; pereopods 5–6 coxae with facial setae, pereopods 5–7 bases broadly expanded ..... ***Leucothoe lecroyae***

8 Head anterodistal margin quadrate; gnathopod 2 propodus with 2 mediofacial setal rows; pereopods 5–7 bases narrowly expanded (length greater than 1.4 × width)..... ***Leucothoe bise***

– Head anterodistal margin rounded or subquadrate; gnathopod 2 propodus with 1 mediofacial setal row; pereopods 5–7 bases broadly expanded (length 1.4 × width or less) **9**

9 Ventral cephalic keel anteroventral margin with strong anterior projection; antenna 1 accessory flagellum 1–articulate; mandibular palp article 3 with 1 distal seta; gnathopod 2 propodus mediofacial setal row above midline; pereopod 7 basis posterior margin serrate..... ***Leucothoe togatta***

– Ventral cephalic keel anteroventral margin subquadrate or quadrate with small projection; antenna 1 accessory flagellum absent; mandibular palp article 3 with 2 distal setae; gnathopod 2 propodus mediofacial setal row displaced to midline; pereopod 7 basis posterior margin smooth..... **10**

10 Ventral cephalic keel anteroventral margin quadrate with small projection; maxilliped outer plate with facial setae; coxa 1 anterior margin serrate; gnathopod 1 ischium with posterior setae; ..... ***Leucothoe akaoni***

– Ventral cephalic keel anteroventral margin subquadrate; maxilliped outer plate without facial setae; coxa 1 anterior margin smooth; gnathopod 1 ischium bare..... **11**

11 Mandibular palp article 2 with 15 distal setae; gnathopod 1 coxa anterior margin serrate, basis posterior margin bare; gnathopod 2 basis anterior margin with 10 setae, carpus reaching less than 0.4 × propodus length, propodus palm with large projections; pereopod 5 coxa without facial seta..... ..... ***Leucothoe vulgaris*** **White & Reimer, 2012a**

– Mandibular palp article 2 with less than 10 distal setae; gnathopod 1 coxa anterior margin smooth, basis posterior margin setose; gnathopod 2 basis anterior margin with less than 10 setae, carpus reaching greater than 0.4 × propodus length, propodus palm with small projections; pereopod 5 coxa with facial setae..... **12**

12 Antenna 1 flagellum 11–articulate; maxilla 1 palp 1–articulate, margins constricted; maxilliped inner plates with simple setae; gnathopod 1 carpus proximal margin smooth; gnathopod 2 basis posterior margin bare, carpus distally truncate; telson apex with strongly rounded point ..... ***Leucothoe nurununu***

– Antenna 1 flagellum 6–articulate; maxilla 1 palp 1–articulate; maxilliped inner plates with simple and serrate setae; gnathopod 1 carpus proximal margin dentate; gnathopod 2 basis posterior margin setose, carpus distally tapered; telson apex tridentate ..... ***Leucothoe daisukei***

Discussion

Four of the *Leucothoe* species described here share the displaced gnathopod 2 propodus mediofacial row. This character is typically found in ascidian-dwelling species worldwide, suggesting that these species may also inhabit ascidian hosts, or that this character may not be an artifact of convergent evolution, as noted in White and Reimer (2012a). Six of the *Leucothoe* species described here 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.

The currently recognized biogeographic boundaries of the Ryukyu Archipelago (Hikida and Ota 1997, Ota 1998) do not appear to apply to leucothoid amphipods in this region, although this will require further examination. Four species (*Leucothoe nagatekubi* sp. n., *Leucothoe nurununu* sp. n., *Leucothoe ouraensis* sp. n., and *Leucothoe zanpa* sp. n.) were each found on only one island, while *Leucothoe hashi* sp. n. was collected throughout the entire archipelago. It is possible that these patterns in amphipod distributions are partly attributable to the ephemeral nature of their sponge hosts. Both sponge species and individuals in the Ryukyu Archipelago appear to be more prevalent in the winter months than in the summer.

Restricted distributional patterns were observed in *Leucothoe ouraensis* sp. n., which was collected only on the east coast of Okinawa–jima Island; *Leucothoe nagatekubi* sp. n., which was collected from one sponge host in caves at Mizugama on Okinawa–jima Island; *Leucothoe zanpa* sp. n., which was collected from only one sponge species at 30 meters at Zanpa Cape on Okinawa–jima Island; and *Leucothoe nurununu* sp. n. was collected from only one sponge species at one location near Iriomote–jima Island. Interestingly, *Leucothoe akaoni* sp. n., *Leucothoe toribe* sp. n., and *Leucothoe togatta* sp. n. were all collected from Okinawa–jima Island in the mid-Ryukyus as well as from Yakushima Island, the northernmost island in the Ryukyus.

The host data collected here are invaluable in understanding the ecology of these amphipods. Sponges are often a preferred habitat for leucothoid amphipods, functioning as a food resource and as protection from predators (Thomas 1997, Thomas and Klebba 2007). Knowing the preferred habitat of amphipods will allow easier collection of additional specimens in the future. Furthermore, such data can also help us to understand the difference(s) between apomorphic and convergent morphological

characters. Due to the difficulty in identifying sponges and lack of sponge specialists in the Ryukyu Archipelago, tentative identifications, photos, and descriptive data are provided here and pieces of host sponges have been deposited in the University of the Ryukyus Museum (Fujukan).

Most of the species reported here were collected from 1–4 sponge host species and from coral rubble. Presumably, these amphipods are inhabiting sponges in the crevices of the coral rubble. Perhaps the ephemeral nature of the sponges is also forcing the amphipods to adapt to new and available hosts, which may explain the higher number of species found in the genus *Leucothoe* than found in the anamixid clade of the Leucothoidae. *Leucothoe nagatekubi* sp. n., *Leucothoe nurununu* sp. n., and *Leucothoe zanpa* sp. n. show higher specialization or host preference. Each of these species were collected from only one host at one location. With the exception of the large white ball sponge, Tetillidae (Figure 24I), individual sponges hosted only one leucothoid species at each location. *Leucothoe akaoni* sp. n., *Leucothoe daisukei* sp. n., *Leucothoe hashi* sp. n., and *Leucothoe zanpa* sp. n. were collected from the same white ball sponge at Zanpa Cape.

The very high diversity of new leucothoid species discovered in the Ryukyu Archipelago to date supports the theory of Roberts et al. (2002), stating that Indo–Pacific reefs are the most diverse areas in the world with high levels of endemicity.

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A new species of *Rhopalosiphum* (Hemiptera, Aphididae) on *Chusquea tomentosa* (Poaceae, Bambusoideae) from Costa Rica

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Abstract

The new species *Rhopalosiphum chusqueae* Pérez Hidalgo & Villalobos Muller, is described from apterous viviparous females caught on *Chusquea tomentosa* in Cerro de la Muerte (Costa Rica). The identity of the species is supported both by the morphological features and by a molecular phylogenetic analysis based on a fragment of the mitochondrial DNA containing the 5' region of the cytochrome c oxidase 1 (COI) and on the nuclear gene coding for the Elongation factor-1 alpha (EF1α). The taxonomic position of the new species is discussed. An identification key to the Aphidinae species living on plants of Bambusoideae (Poaceae) is presented.

Keywords

Rhopalosiphum, aphids, new species, molecular, Costa Rica

Introduction

The high diversity of organisms in Costa Rica has been referred to as a product of diverse ecosystems resulting from the interaction between complex microclimates, soils, topography, and a variety of biological processes, as well as the position of the country in the land-bridge between North and South America. Costa Rica's biodiversity comprises more than 500,000 species of organisms, approximately 84% of which are yet to be described. This percentage is even higher (90%) if we take insects, fungi, bacteria and viruses into account (Sánchez-Azofeifa et al. 2001). As for the number of aphid species present in Costa Rica, the list was recently extended (Pérez Hidalgo et al. 2009; Zamora Mejías et al. 2010; Villalobos Muller et al. 2010) and research is ongoing.

During an expedition in 2008 in the area of Cerro de la Muerte (Cordillera de Talamanca), Costa Rica, three apterous viviparous females and several nymphs were collected on *Chusquea tomentosa* (Fig. 1). At first, they were assigned to the subtribe Rhopalosiphina Mordvilko, 1914 (Aphidini Latreille, 1802). This identification was confirmed in the laboratory when it was verified that the marginal papillae on abdominal segments I and VIII were in dorsal position to the corresponding stigmata. The morphological characters of the specimens resembled those of the genus *Rhopalosiphum* Koch, 1854, though the length of the setae were reminiscent of species in the subgenus *Paraschizaphis* Hille Ris Lambers, 1947 (*Schizaphis* Börner, 1931).

According to Valenzuela et al. (2009), *Rhopalosiphum* and *Schizaphis* form a monophyletic group with *Melanaphis* van der Goot, 1917, the separation between them being unclear. The vein structure of the wings separates *Schizaphis* from *Rhopalosiphum*, however, as there were no alates available, molecular analyses were carried out to verify the relationship with the genus *Rhopalosiphum* through qualitative and quantitative characters. Molecular analyses are normally used to determine species and resolve taxonomic problems in the family Aphididae (Lozzier et al. 2008; Foottit et al. 2008, 2009; Lee et al. 2010; Pike et al. 2010).

A microscopic morphotaxonomic study of the specimens enabled the hypothesis that they could not be assigned to any known species, and strengthened the hypothesis that they be assigned to *Rhopalosiphum*. Molecular phylogenetic analysis based (1) on a fragment of the mitochondrial DNA containing the 5' region of the cytochrome c oxidase 1 (COI) and (2) on the nuclear gene coding for the Elongation factor-1 alpha (EF1α) were used to verify both hypotheses.

Several species included in the subfamily Aphidinae are known living on plant species of the subfamily Bambusoideae (Poaceae), but only two belong to *Rhopalosiphum* (Aphidini): *Rhopalosiphum arundinariae* (Tissot, 1933) and *R. rufiabdominale* (Schrank, 1899), and none to the genus *Schizaphis*.

Figure 1. A View of the area where the types of *Rhopalosipum chusqueae* were captured, in Cerro de la Muerte (Costa Rica), with *Chusquea tomentosa* **B** view of the plant **C** and **D** details of the area where the aphids were located.

Material and methods

Material studied

Three apterous viviparous female and several nymphs (sample CRI-235) were recorded on *Chusquea tomentosa* Y. Widmer et L. G. Clark (Poaceae: Bambusoideae: Bambuseae: Chusquinae) in Ojo de Agua (Cerro de la Muerte, Cordillera de Talamanca, Costa Rica) (9°36'N, 83°47'W), 2968 m, 26.ii.2008.

Morphological study

Thirty-three quantitative characteristics and the qualitative features of shape, sclerotization, pigmentation and cuticular ornamentation, were considered. The method used for measurements is that normally employed in our studies (Nieto Nafría and Mier Durante 1998). A camera lucida fitted to the microscope was used for the drawings and the microphotographs were taken with a Leica DC digital camera with IM 1000 version 1.10 software.

DNA extraction and PCR amplification

Total DNA was extracted separately from two samples, one of them containing a single nymph and the second the contents of the abdomen of 3 apterous adults, all kept in 96% ethanol. We followed the HotSHOT (Hot Sodium Hydroxide and Tris) method (Truett et al. 2000).

PCR amplification of the two gene fragments analyzed was carried out on 3 µl of the extracted DNA. A 710 bp fragment of the 5' region of the mitochondrial cytochrome c oxidase subunit 1 (COI) was amplified using primers LCO1490 and HCO2198, described by Folmer et al. (1994). PCR conditions for COI amplification were as follows: 94°C for 1 min; 35 cycles of 94°C for 30 s, 48°C for 1 min and 68°C for 1 min; a final extension step of 7 min at 68°C was included after cycling. Amplification of the Elongation factor-1 alpha (EF1α) gene fragment was performed using two consecutive PCR reactions with primers Efs175 (Moran et al. 1999) and Efr1 (5'GTGTGGCAATSCAANACNGGAGT3') in the first reaction and then primers Efs175 and Efr2 (5'TTGGAAATTTGACCNGGGTGRTT3') in the second hemi-nested reaction. PCR conditions used in the first reaction were: 94°C for 1 min; 40 cycles of 94°C for 30 s, 50°C for 1 min and 68°C for 1.5 min; a final extension step of 7 min at 68°C was included after cycling. The hemi-nested PCR was done similarly but using 52°C for the annealing step and using 1 µl of the first PCR product.

Sequencing and analysis of DNA sequences

PCR products were purified by ammonium precipitation and reconstituted in 10 μL of LTE buffer (10mM Tris, 0,1mM EDTA). Direct sequencing of amplified fragments was done in both directions using PCR primers (Efr2 was used as reverse primer for sequencing the EF1α fragment). Sequencing was conducted using the Big Dye Terminator v3.1 Cycle Sequencing Kit (Applied Biosystems) following the manufacturer's instructions, and samples were loaded onto an ABI 3700 automated sequencer.

Chromatograms were revised and sequences corresponding to each sample assembled using the Staden package v1.6.0 (Staden et al. 2000). Multiple alignments were carried out with Clustal X v1.81 (Thompson et al. 2002) with gap opening and gap extension penalties of 10.0 and 0.2, respectively, and subsequently manually revised.

Phylogenetic analysis of COI sequences were done using *MEGA* version 4 (Tamura et al. 2007). For EF1α sequences ModelTest (Posada and Crandall 1998) was used to find the evolutionary model that best fitted sequence data and phylogenetic reconstruction was done using RAxML (Stamatakis et al. 2008).

Results

Morphological data

A study of the qualitative and quantitative (metric and meristic) characters of the specimens enabled us to establish the hypothesis that they belong to the genus *Rhopalosiphum* as, apart from the above-mentioned character of the marginal papillae on the abdomen, (1) when alive they are ovoid and when preserved the body is not very long and the margins are curved (Figs 2A, 2B), (2) the dorsal cuticle of the thorax and abdomen is membranous, except for the presence of intersegmental sclerites and a pair of large sclerites on abdominal segment VIII (Figs 2A, 2B), (3) the dorsal cuticle has a more or less regular reticulate area formed by coalescent spinules (Figs 2Ba, 2Bb, 2F, 2G), (4) the siphunculi are longer than the cauda and clearly constricted underneath the apical edge (Figs 2A, 2B, 2D), and (5) there are few setae on the cauda.

A comparison of the characters of these specimens with those of apterae in other species of *Rhopalosiphum* and *Schizaphis* also strengthened the hypothesis that they could not be assigned to any known species.

Molecular data

A 710 bp DNA fragment containing a portion of the mitochondrial COI gene was amplified through PCR from the two samples analysed. Useful sequences obtained

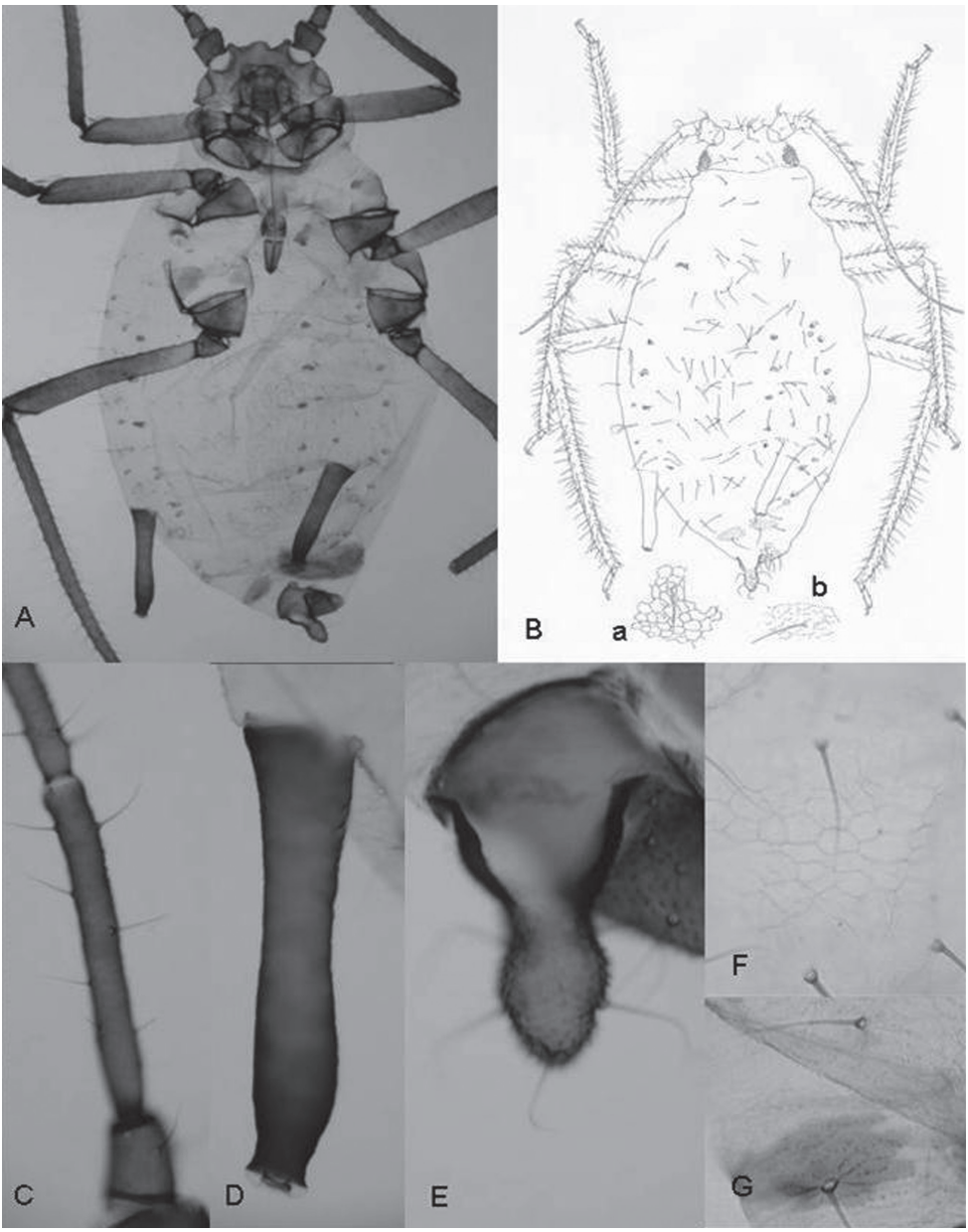

Figure 2. *Rhopalosiphum chusqueae* sp. n. **A, B** *Habitus* **C** antennal segment III **D** siphunculus **E** cauda. **F** (and **B-a**) detail of the cuticule of abdominal segment 3 **G** (and **B-b**) detail of cuticule of abdominal segment 8.

from each sample consisted of 658 nucleotides. Identical sequences were obtained for both samples so that a single sequence was finally assigned and deposited in Genbank (accession number HE604204). The online identification engine available at the Barcode of Life Data Systems (BOLD) (Ratnasingham and Hebert 2007) using the COI

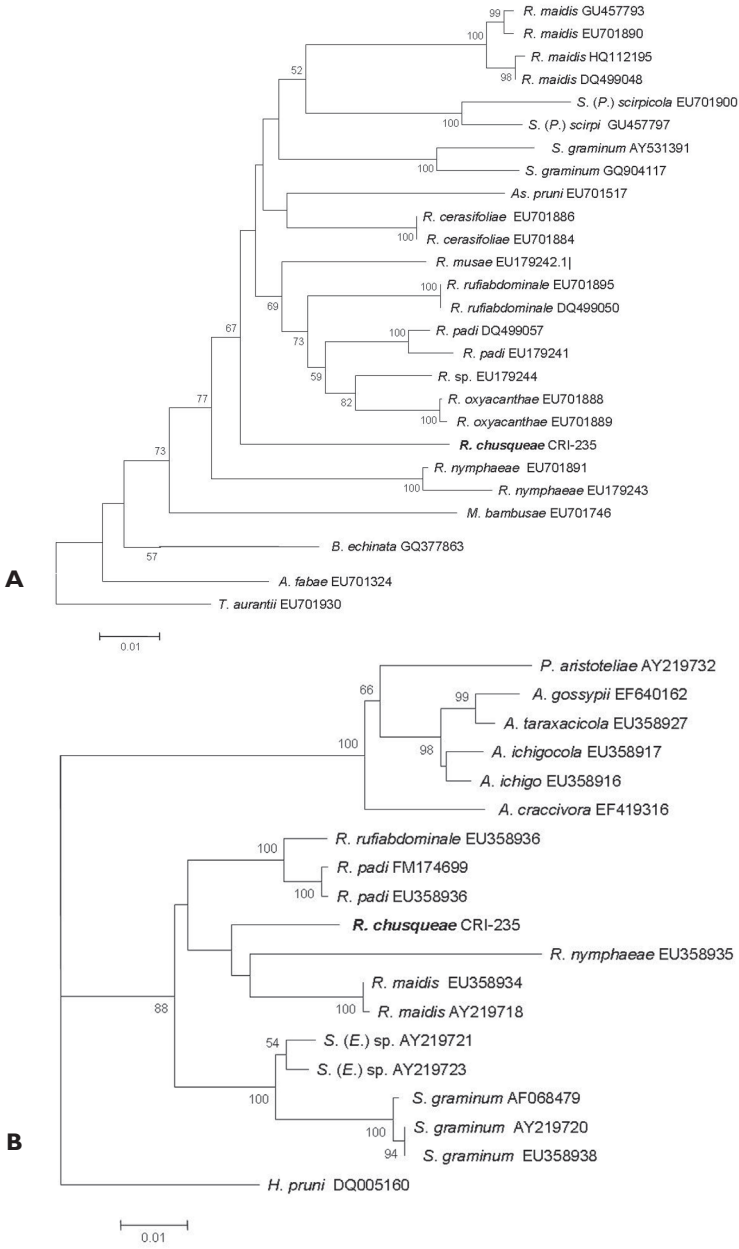

Figure 3. A Neighbour joining tree based on Kimura 2P distances obtained for the COI sequences from our new species (*Rhopalosiphum chusqueae*) and different Aphidini representatives obtained from the NCBI database. **B** Maximum Likelihood tree obtained for the EF1α sequences for our new species (*Rhopalosiphum chusqueae*) and different Aphidini representatives obtained from the NCBI database. Bootstrap support values obtained after 1000 replicates in A and 100 in B are indicated above branches if higher than 50%. Initials for genera are as follows: A, *Aphis*; As, *Asiphonaphis*; B, *Braggia*; H, *Hyalopterus*, M, *Melanaphis*; P, *Paradoxaphis*; R, *Rhopalosiphum*; S, *Schizaphis* (*Schizaphis*); S. (E.), *Schizaphis* (*Euschizaphis*); S. (P.), *Schizaphis* (*Paraschizaphis*); T, *Toxoptera*.

species database, failed to find any record corresponding to any identified species that matched our sequence. After a BLASTN search against the non-redundant nucleotide database at the NCBI, sequences from different *Rhopalosiphum* species were most similar to our sequence (93–94% identical) followed by *Schizaphis* sequences (92–93% identical). We then aligned our sequence with sequences from all *Rhopalosiphum* species available at the NCBI database and from species representative of closely related genera (*Schizaphis*, *Melanaphis*, etc.) that we had previously retrieved from the database, and built a phylogenetic tree (Fig. 3A). The tree shows that the sequence from our unknown species groups with relatively high support within a monophyletic clade that contains all other *Rhopalosiphum* and *Schizaphis* COI sequences occupying a rather basal position within that clade.

For the Elongation factor-1 alpha (EF1α) gene fragment, we obtained an identical sequence from the two analyzed samples of 987 bp which was deposited in the Genbank with accession number HE604205. Using sequences available for EF1α in NCBI for different *Rhopalosiphum* and closely related species within Aphidini, an ML tree was built that included the sequence obtained for our unknown species (Fig. 3B). As with the COI sequence, our unknown species grouped with strong support within a monophyletic clade that also included sequences from *Schizaphis* and *Euschizaphis*. However, unlike the COI tree, both *Rhopalosiphum* and *Schizaphis*-related sequences separated into two distinct clades, though with very low bootstrap support.

Discussion and conclusion

Molecular data using both mitochondrial COI and nuclear EF1α gene sequences confirmed that the *Rhopalosiphum chusqueae* specimens belong to the same monophyletic clade as other *Rhopalosiphum* species occupying a rather basal position in the group likely closely related to other divergent *Rhopalosiphum* species such as *R. nymphaeae*. Both trees revealed the close relationship between *Rhopalosiphum* and *Schizaphis* genera. Although COI sequences are widely used in taxonomy, their utility for phylogeny reconstructions seems rather limited as their phylogenetic signal is somewhat weak in comparison with other markers (Wilson 2010). Contrarily, EF1α is widely used in phylogenetic reconstructions and its use in insect phylogeny has been shown to be informative (Simon et al. 2009; Wilson 2010). In this respect, although the COI analysis did not recover the monophyly of *Rhopalosiphum* and *Schizaphis* genera separately, ML analysis of EF1α separated both genera and clearly *Rhopalosiphum chusqueae* grouped within the *Rhopalosiphum* clade, which, along with our morphometric data discussed above, supports its assignation to the *Rhopalosiphum* genus.

Approximately 15 species are classified in the genus *Rhopalosiphum* (Remaudière and Remaudière 1997; Zhang and Qiao 1997; Eastop and Blackman 2005; Blackman and Eastop 2006) associated with arboreal Rosaceae (*Prunus* or Pyroidea) as the primary host and with Poaceae, Cyperaceae or, less frequently, other plants as the sec-

ondary host if their cycle is dioecious, or only with one of them if their cycle is monoecious. Most of the species probably originate in North America, with a subsidiary centre of dispersal in Central Asia (Blackman and Eastop 1994; Halbert and Voegtlin 1998; Blackman and Eastop 2006). Five of its species have an exclusively Nearctic distribution: *R. arundinariae* (Tissot), *R. cerasifoliae* (Fitch), *R. enigmae* Hottes & Frison, *R. laconae* Taber, *R. nigrum* Richards, and *R. padiformis* Richards; and another four Nearctic species have been introduced in other parts of the world: *R. parvae* Hottes & Frison and *R. rufulum* Richards in Europe, *R. musae* Schouteden has been recorded in areas of Europe, Central Asia, Africa and Australia, and *R. oxyacanthae* (Schrank) is known in Central- and South-America, Europe, Asia and Australia**.** To date, only four species, linked mainly to crops, have been recorded in Central American countries: *R. maidis* (throughout Central America), *R. nymphaeae* in Panama, *R. padi* in Costa Rica and Panama, and *R. rufiabdominale* in Honduras, Costa Rica and Panama (Evans and Halbert 2007; Quirós et al. 2009; Villalobos Muller et al. 2010); *R. oxyacanthae* is also known in Central America, without country (Blackman and Eastop 2006).

Species of *Rhopalosiphum* most resembling the new species due to their morphological characters are *R. rufiabdominale* and *R. padiformis*. The former originated from East Asia (Blackman and Eastop 2006) and is currently widely distributed. *R. padiformis* originates from North America. *R. chusqueae* sp. nov. coincides with both species in the length of the setae, with *R. padiformis* in the number of antennal segments and shape of the cauda, and with specimens of *R. rufiabdominale* in the 4 setae on abdominal segment VIII (*R. rufiabdominale* has 3 to 8 setae on this segment). It is easily distinguished from them because the antennae in *R. rufiabdominale* are five-segmented and the dorsal setae in *R. padiformis* are not pointed and abdominal segment VIII only has 2 setae. Bamboo species are the host plants of the mentioned *R. rufiabdominale* and *R. arundinariae*; this last species can be easily differentiated from *R. chusqueae* by the shape of the cauda (short and more or less triangular or rounded) and siphunculus (more or less tapering) and by much shorter setae on body dorsum and appendages.

In view of the above, a new species can be established, the description of which follows.

***Rhopalosiphum chusqueae* Pérez Hidalgo & Villalobos Muller, sp. n.**
urn:lsid:zoobank.org:act:D3A0466B-3858-46A8-A4BB-4618BDD956D3
http://species-id.net/wiki/Rhopalosiphum_chusqueae

Holotype. Apterous viviparous female number 1 of measurement series, caught on *Chusquea tomentosa*, Pérez Hidalgo & Villalobos Muller *leg*., deposited in the Aphidological Collection of the University of León (CZULE), sample CRI-235.

Paratypes. 2 apterous viviparous females (in separated slides) caught with the holotype.

Etymology. The specific epithet, *chusqueae* is the genitive singular of the generic name of the aphid's host plant.

Apterous viviparous females (Figure 2). When alive globular oval and brown with white spots of wax on abdomen. Mounted 2.20–2.72 mm and pale in general with head, antennae, legs, siphunculi and cauda dark-brown.

Antennae 0.63–0.79 times body length. Antennal segment III (0.32–0.43 mm) shorter than segment IV (0.21–0.25 mm) plus V (0.20–0.26 mm); with setae 55–65 μm long and 1.8–2.6 times the articular diameter of the segment. Terminal process of segment VI (0.44–0.47 mm) 3.9–4.4 times the base (0.32–0.43 mm). Rostrum 0.52–0.61 mm long, reaching middle coxae, 0.19–0.27 times the body length. Ultimate rostral segment 0.13–0.15 mm long, approximately 1.7 times its basal width and 1.1 second segment of hind tarsus; it carries two accessory setae. Marginal papillae present on prothorax, on the abdominal segment 1 and 7, which are dorsally placed to the respective spiracles, and sometimes on segments 3 and 6. Dorsum of the abdomen with spinules forming reticulate ornamentation. Dorsal setae on abdominal segment 3 with delicate, pointed and 25–30 μm long and 3.0–3.9 times the articular diameter of antennal segment III and shorter than ventral ones, which are 90–110 μm long. Siphunculi slightly swollen with marked narrowing below the flange, 0.41–0.45 mm long, 0.16–0.20 times the body length and 2.1–2.2 times cauda. Abdominal segment 8 with two sclerites and four setae 90–110 μm long, delicate and pointed. Genital plate with 2 discal setae and near 26 posterior ones. Cauda finger-like, 0.19–0.21 mm long and carrying 5 setae.

Distribution and host-plant. *Chusquea tomentosa* (Poaceae, Bambusoideae) is the only known host of *R. chusqueae*. This bamboo is endemic to the country and can be found in several areas of the Cordillera de Talamanca at an altitude of between 2450 and 3000 m (Widmer 1997; Hammel et al. 2003). Species of *Chusquea* (approximately 120 described) can be found at between 800 and 3800 m in dry and humid forests from Mexico to Chile and Argentina (Clark 1989). As species in the genus *Rhopalosiphum* are not strictly stenophagous, *R. chusqueae* may also live on other species of *Chusquea*, or even on other bamboos and live in other parts of America.

On the plant, the aphids live close to the nodes well protected by the leaves (Figs 1C, 1D) and not easily detectable, as shown by fruitless efforts to locate other colonies.

So far, only one aphid species had been recorded on *Chusquea*: *Hysteroneura setariae* (Thomas) on *Chusquea abietifolia* Griseb, in Cuba (Holman 1974).

Blackman and Eastop (1994) present two identification keys to the aphid species living on *Arundinaria* and on *Bambusa*, genera that include arboreal bamboos; several of these aphid species belong to the subfamily Aphidinae. Blackman and Eastop (2006) report the presence of aphid species on several genera of non-arboreal bamboos such as *Chusquea*, *Pseudosasa*, *Sinoarundinaria*, *Thamnocalamus*, *Thysanolaena*, and also *Arundinaria* (other bamboo genera are included but no Aphidinae species have been recorded on them), and for the identification of these species the reader is forwarded to the "keys [of 1994] to aphids on *Arundinaria* and *Bambusa*", or to the "keys [of

2006] to apterae on *Digitaria* and other genera of herbaceous Poaceae". To make the identification work easier, it seems useful to present one compendium-key to the identification of apterous viviparous females of Aphidinae species recorded on species of Bambusoideae in the World.

This key has been prepared using the general structure and several couplets in all of those keys by Blackman and Eastop; thirteen Aphidinae species and subspecies have been included, and are: *Hysteroneura setariae* (Thomas, 1878), *Melanaphis arundinariae* (Takahashi, 1937), *M. bambusae* (Fullaway, 1910), *M. meghalayensis bengalensis* Raychaudhuri [D.N.] and Banerjee [C.], 1974, *M. meghalayensis meghalayensis* Raychaudhuri [D.N.] and Banerjee [C.], 1974, *M. pahanensis* (Takahashi, 1950), *M. sacchari* (Zehntner, 1897), *Rhopalosiphum arundinariae* (Tissot, 1933) and *R. rufiabdominale* (Schrank, 1899) (Aphidinae Aphidini Rhopalosiphina), and *Sitobion bambusicola* (Ghosh [L.K.], 1986), *S. fragariae* (Walker, 1848), *S. miscanthi* (Takahashi, 1921) and *S. papillatum subnudum* Remaudière, 1985 (Aphidinae Macrosiphini).

1 Siphunculus without apical zone of polygonal reticulation. Abdominal segments I and VII with marginal tubercles (papillae) placed dorsally to the respective spiracular apertures. Cuticle of dorsum of the abdomen membranous, a sclerotized patch absent.....**2**

– Siphunculus with apical zone of polygonal reticulation (at least two rows of cells). Abdominal segments I and VII usually without marginal tubercles (papillae), but if they are present then spinal papillae present on head and several abdominal segments. Dorsum of the abdomen with a sclerotized patch more or less extended and pigmented **12**

2 Aphids spindle-shaped, green when alive. Siphunculus very small (less than 0.7 times cauda), thin, cylindrical and narrow-based, flangeless, and with not functional aperture .....***Hyalopterus pruni* [and other *Hyalopterus* spp.]**

– Aphids broad oval-shaped. Siphunculus 0.5–2.5 times cauda (if less than 0.6 times then less than 2 times longer than its basal width), shaped differently and with functional aperture.....**3**

3 Siphunculus short, usually thick or rather thick, less than (often much less than) 2.4 times longer than its basal width, 0.4–1.2 times cauda, and usually with a well-developed, rather swollen flange.....**4**

– Siphunculus usually longer than cauda (if less than 1.2 times cauda then it is more than 2.4 times its basal width and/or has a small flange), tapering, cylindrical or swollen **9**

4 Setae on antennal segment III at most 1.5 times the basal diameter of the segment. [Alatae viviparous females with wing veins dark bordered].....**5**

– Setae on antennal segment III at least 2.0 times the basal diameter of the segment. [Alatae viviparous females with wing veins not dark bordered].....**6**

5 Cauda with only 4-6 setae. Coxae dark.....***Melanaphis bambusae***

– Cauda with 7-20 setae. Coxae pale .....***Melanaphis sacchari***

6 Antennae five-segmented. Siphunculus 1.5 times its basal width at least ..... ***Melanaphis arundinariae***

– Antennae six-segmented. Siphunculus 1.4 times its basal width at most **7**

7 Siphunculus 1.1–1.4 times its basal width. Terminal processus of antennal segment VI at most 2.3 times the base ..... ***Melanaphis pahanensis***

– Siphunculus 0.8–0.9 times its basal width. Terminal processus of antennal segment VI at least 2.2 times the base..... **[*Melanaphis meghalayensis*] 8**

8 Cauda with 4–6 setae and anterior half of the genital plate with 4–7 setae.... ***Melanaphis meghalayensis meghalayensis***

– Cauda with 7–10 setae and anterior half of the genital plate with 2 setae..... ***Melanaphis meghalayensis bengalensis***

9 Setae on antennal segment III shorter than the basal width of the segment... **10**

– Setae on antennal segment III longer than the basal width of the segment.... **11**

10 Cauda at least 1.5 times its basal width, finger-shaped, with basal constriction, paler than cauda, and usually with 4 setae. [Alate viviparous females with only one oblique vein in hindwing] ..... ***Hysteroneura setariae***

– Cauda a little longer that its basal width, cone-shaped, without basal constriction, as dark as siphunculi, and with approximately 8 setae. [Alate viviparous females with two oblique veins in hindwing]... ***Rhopalosiphum arundinariae***

11 Antennae usually five-segmented. Setae on antennal segment III 3.0–5.0 times the basal width of the segment. Abdominal segment VIII with 3–8 setae. Ultimate rostral segment 1.3–1.8 times second segment of the hind tarsus. Terminal processus of antennal segment VI 4.0–6.5 times the base.... ***Rhopalosiphum rufiabdominale***

– Antennae six-segmented. Setae on antennal segment III 1.8–2.6 times the basal width of the segment. Abdominal segment VIII with 4 setae. Terminal processus of antennal segment VI 3.9-–4.4 times the base ..... ***Rhopalosiphum chusqueae* sp. n.**

12 Spinal tubercles (papillae) present on the head and abdominal segments (V) VI-VIII; marginal ones present on prothorax and abdominal segments (I) II–V and infrequently on VII..... ***Sitobion papillatum subnudum***

– Spinal tubercles (papillae) absent; marginal ones on abdominal segment II–V usually absent, and always absent on abdominal segments I and VII..... **13**

13 Cauda dusky (but not as dark as siphunculi) and with a rather pointed apex. Siphunculus 2.0–2.1 times cauda. Aphids yellowish when alive ..... ***Sitobion bambusicola***

– Cauda pale (very contrasted with siphunculi) with a variably shaped apex. Siphunculus 1.4–2.7 times cauda. Aphids variable in colour when alive.... **14**

14 Siphunculi 1.75–2.25 times cauda, which has a rather rounded apex..... ***Sitobion fragariae***

– Siphunculi 1.4–1.9 times cauda, which has a rather pointed apex..... ***Sitobion miscanthi***

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Two new genera and two new species of Mantophasmatodea (Insecta, Polyneoptera) from Namibia

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Abstract

Two new species and two new genera (*Pachyphasma, Striatophasma*) of Mantophasmatodea are described from Namibia. *Pachyphasma brandbergense* is endemic to the Brandberg massif; *Striatophasma* occupies an extensive area south of the region inhabited by *Mantophasma*. Phylogenetic analyses (see Predel et al. in press) suggest a sistergroup relationship of *Striatophasma* and the South African Austrophasmatidae.

Keywords

Mantophasmatodea, Polyneoptera, Lower Neoptera, *Pachyphasma*, *Striatophasma*, Namibia, Taxonomy

Introduction

When Mantophasmatodea was described in 2002 (Klass et al. 2002), 88 years had passed since the last discovery of a new extant insect order (Grylloblattodea by Walker 1914). Hence the interest in this new taxon was tremendous. Within a few years

studies on morphology, genetics, behaviour and peptides of Mantophasmatodea were published (e.g. Klass et al. 2003, Dallai et al. 2003, Predel et al. 2005, Beutel and Gorb 2008, Eberhard and Picker 2008). Simultaneously the number of described species as well as the geographic distribution increased: being originally described with one species from Namibia and one from southern Tanzania, a remarkable species diversity was found, particularly in South Africa (Picker et al. 2002, Klass et al. 2003, Eberhard and Picker 2008, Predel et al. in press). Up to now a total of 16 extant species in ten genera have been described (Klass et al. 2002, Klass et al. 2003, Zompro et al. 2003, Zompro and Adis 2006, Eberhard et al. 2011). The phylogenetic relationships within Mantophasmatodea as well as the taxonomic status of several genera have been subject of debate (Klass et al. 2003, Zompro et al. 2003, Zompro 2005, Zompro and Adis 2006, Damgaard et al. 2008, Eberhard et al. 2011) However, the separation and morphological description of species is sometimes difficult especially when based on few specimens. In a separate manuscript (Predel et al. in press) peptide mass fingerprints in combination with peptide sequencing were used to test the intraordinal phylogeny of Southern African Mantophasmatodea. Figure 1 shows a simplified version of the cladogram retrieved by Predel et al. (in press). Their analyses resulted in two monophyletic lineages: one containing all South African Austrophasmatidae (*Austrophasma* Klass et al., 2003, *Hemilobophasma* Klass et al., 2003, *Karoophasma* Klass et al., 2003, *Lobatophasma* Klass et al., 2003, *Namaquaphasma* Klass et al., 2003 and *Viridiphasma* Eberhard et al., 2011) and the Namibian genus *Striatophasma* gen. n. while the second clade contains all remaining Namibian species which are currently grouped in Mantophasmatidae. Within Mantophasmatidae *Praedatophasma* Zompro & Adis, 2002 + *Tyrannophasma* Zompro et al., 2003 and *Mantophasma* Zompro et al., 2002 + *Pachyphasma* gen. n. were retrieved as sistergroups. The present article describes these two new genera and species discovered by Predel et al. (in press).

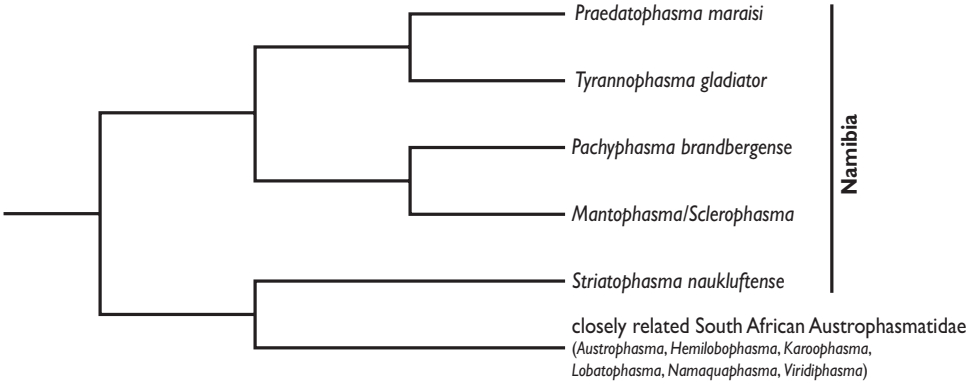

Figure 1. Simplified tree (midpoint-rooted) from a Bayesian phylogenetic analysis of peptide hormone sequences from southern African Mantophasmatodea (adapted from Predel et al. in press).

Methods

The terminology for the head and thorax follows Seifert (1995). The terms for abdominal structures are those used by Klass et al. (2003). The coloration refers to living specimens. Species descriptions are based on a designated holotype but all available specimens were taken into account in order to assess the intraspecific variation.

The information for the specimens is given in a standard manner, i.e., locality, geographic coordinates, elevation, date of collection (month indicated in lower case Roman numerals), habitat information, collector, depository, and preparation. Female (♀) and male (♂) symbols indicate the sex.

The following measurements are a selection from the proposed standards of Zompro et al. (2003) [abbreviations used by Zompro et al. (2003) in parentheses]: total length (a), length of pronotum (b), width of pronotum (c), length of mesonotum (b), width of mesonotum (c), length of metanotum (b), width of metanotum (c), length of the head (d), width of the head (f), head width over eyes (g), width between eyes (h), length of eye (i) and width of eye (j). Specimens were examined under a Zeiss Stemi SV11 with a calibrated ocular micrometer. A Leica MZ 12,5 with a camera lucida was used for line drawings.

A pair of each newly described species was dehydrated using increasing steps of ethanol up to 100%, dried at the critical point (Emitech K850 critical point dryer) and subsequently sputter-coated (Emitech K500). Scanning electron microscopy was performed on a Philips XL30 ESEM using a special specimen holder (Pohl 2010). Parts of each species are illustrated in the standard views of dorsal, lateral and ventral. The head is also in frontal view (frons being vertically) and the terminalia are in caudal view.

Peptide mass fingerprints and sequences were obtained by direct profiling of neuroendocrine tissues from single specimens using MALDI-TOF mass spectrometry as described in Predel et al. (in press.)

The specimens referred below along with the abbreviations used in the text will be deposited in the following collections: NMNW – National Museum of Namibia, Windhoek, Namibia; ZFMK – Zoologisches Forschungsinstitut und Museum Alexander Koenig, Bonn, Germany; ZMUB – University of Bergen, Zoological Museum, Bergen, Norway.

Taxonomy

***Striatophasma* gen. n.**
urn:lsid:zoobank.org:act:8B1618EC-5FBD-4C51-9301-7E0076EA742D
http://species-id.net/wiki/Striatophasma

Description and diagnosis. *Striatophasma* gen. n. is placed as sistergroup to all remaining South African Austrophasmatidae sensu Klass et al. (2003) based on peptide

hormone sequences (Predel et al. in press). Except for *Austrophasma gansbaaiense* and *Viridiphasma clanwilliamense* (Eberhard et al. 2011), it can be easily distinguished from the Austrophasmatidae sensu Klass et al. (2003) by its greenish colour. From all South African Austrophasmatidae, *Striatophasma* is separated by the lack of a butterfly-shaped dark median spot below the antennal base, genae that protrude from the compound eyes, the presence of spination in most body parts and its distribution in Namibia. From other Namibian mantophasmatodeans it can be distinguished by the presence of a brown dorso-median longitudinal stripe in males in combination with greenish body colouration. Asymmetric male genitalia and compound eyes that do not protrude from the genae distinguish *Striatophasma* from the East African *Tanzaniophasma*.

The new genus is characterized by a unique sequence of the adipokinetic hormone (pQVNF**T**P**S**Wamide; Predel et al. in press). The adipokinetic hormone sequence of all taxa currently grouped in Mantophasmatodae (*Mantophasma*, *Sclerophasma*, *Tyrannophasma*, *Praedatophasma*, *Pachyphasma*) is pQVNFSPGWamide (Gäde et al. 2005; Predel et al. 2011) and that of South African Austrophasmatidae is pQVNF**T**PGWamide (Predel et al. 2005).

Type species. *Striatophasma naukluftense* sp. n.

Other included species. None thus far.

Etymology. The generic group name *Striatophasma* is a composition from the Latin word striatus meaning striped and the ending -phasma which is commonly used to term mantophasmatodeans. The gender is neuter.

Striatophasma naukluftense sp. n.

urn:lsid:zoobank.org:act:C839900C-B908-4793-96E8-E9C80F06AA12
http://species-id.net/wiki/Striatophasma_naukluftense
Figs 2–10

Holotype. Male, NAMIBIA: Naukluft Mountains, northern slope (Fig. 3), -24.15, 16.32, 1200–1400 m, 04.v.2006, R. Predel (NMNW), specimen in ethanol.

Paratypes, NAMIBIA: Naukluft Mountains: three males and four females; same data as holotype, one male and one female in ethanol (NMNW); one male and one female in ethanol (ZMUB); one female in ethanol and one male and one female critical point dried, sputter coated with gold (ZFMK). Nauchas: three males, -23.61, 16.37, 1750 m, 08.iv.2008, R. Predel (collection R. Predel), all in ethanol. Remhoogte: two males and two females, -23.96, 16.30, 1475 m, 08.iv.2008 R. Predel (collection R. Predel), specimen in ethanol.

Description male. Measurements (male holotype followed by paratypes according to locality in parentheses, critical point dried specimen nor measured, in mm): total length (a): 27.1 (Naukluft mountains: 23.1, 27.3) (Nauchas: 23.6, 23.0, 22.3) Remhoogte (28.3, 25.6); length of pronotum (b): 4.0 (Naukluft: 4.1, 3.9) (Nauchas: 2.6, 2.9, 3.1) (Remhoogte: 3.6, 4.0); width of pronotum (c): 3.7 (Naukluft: 3.6, 3.0)

Figure 2. Habitus photography of *Striatophasma naukluftense* sp. n.; copula with smaller ♂ on top of ♀.

(Nauchas: 3.3, 3.3, 3.4) (Remhoogte: 3.4, 3.7); length of mesonotum (b): 3.7 (Naukluft: 3.6, 3.7) (Nauchas: 3.4, 3.7, 3.7) (Remhoogte: 4.0, 4.1); width of mesonotum (c): 3.1 (Naukluft: 3.1, 3.0) (Nauchas: 2.9, 2.9, 3.0) (Remhoogte: 3.1, 3.3) ; length of metanotum (b): 3.2 (Naukluft: 2.4, 2.8) (Nauchas: 2.9, 2.9, 2.9) (Remhoogte: 3.1, 3.1); width of metanotum (c): 2.9 (Naukluft: 2.9, 2.9) (Nauchas: 2.7, 2.7, 2.9) (Remhoogte: 3.0, 3.1); length of the head (d): 3.9 (Naukluft: 3.3, 3.1) (Nauchas: 3.1, 3.3, 3.4) (Remhoogte: 3.9, 4.6); width of the head (f): 4.3 (Naukluft: 4.0, 3.9) (Nauchas: 3.7, 3.9, 4.0) (Remhoogte: 3.6, 3.7); head width over eyes (g): 4.6 (Naukluft: 4.4, 4.1) (Nauchas: 4.1, 4.1, 4.3) (Remhoogte: 4.0, 4.4); width between eyes (h): 2.7 (Naukluft:

Figure 3. Type locality of *Striatophasma naukluftense* sp. n, Naukluft Mountains, Namibia.

2.6, 2.4) (Nauchas: 2.4, 2.6. 2.6) (Remhoogte: 2.9, 2.9); length of eye (i): 1.7 (Naukluft: 1.7, 1.7) (Nauchas: 1.7, 1.9, 1.9) (Remhoogte: 2.0, 2.1); width of eye (j): 1.0 (Naukluft: 0.9, 1.0) (Nauchas: 1.0, 1.0, 1.1) (Remhoogte: 1.1, 1.1).

Head (Fig. 4): globular, orthognathous, posteriorly covered by pronotum, bright green with brown dorsal stripe; compound eyes yellow-brownish with black spots; tip of lacinia and labial palps yellow. Head width similar to width of thorax, about as wide as long; sparsely covered with setae. Compound eyes tapered dorso-laterally and prominent, kidney-shaped, antero-ventral edge tapered, about twice as long as high; interoccular distance ca. the length of one eye, on vertex larger than on ventral eye margin; ocelli absent. Coronal and frontal suture indistinct, subgenal ridge well developed. Gena higher than compound eyes; ventral parts of occipital ridge very prominent; antennal sockets in between eyes, distinct; interantennal distance ca. diameter of one antennal socket; antennifer present; anterior tentorial pits dorsally of anterior mandibular articulation; frons with three bulges, one in between antennal sockets, two ventro-mesal of antennal sockets; frontoclypeal and temporal ridge not recognizable. Clypeus trapezoid, with well-developed clypeolabral ridge, four long setae in the dorsal clypeal area; oval sclerite in between clypeus and labrum present. Labrum flat, anteriorly rounded, with few short setae. Maxilla well developed, green with tip of lacinia yellow; maxillary palp yellow, five segmented, ca. 1.5 times longer than lacinia, covered with setae, palpomere one and two as long as wide, palpomere three 2.5 times as long

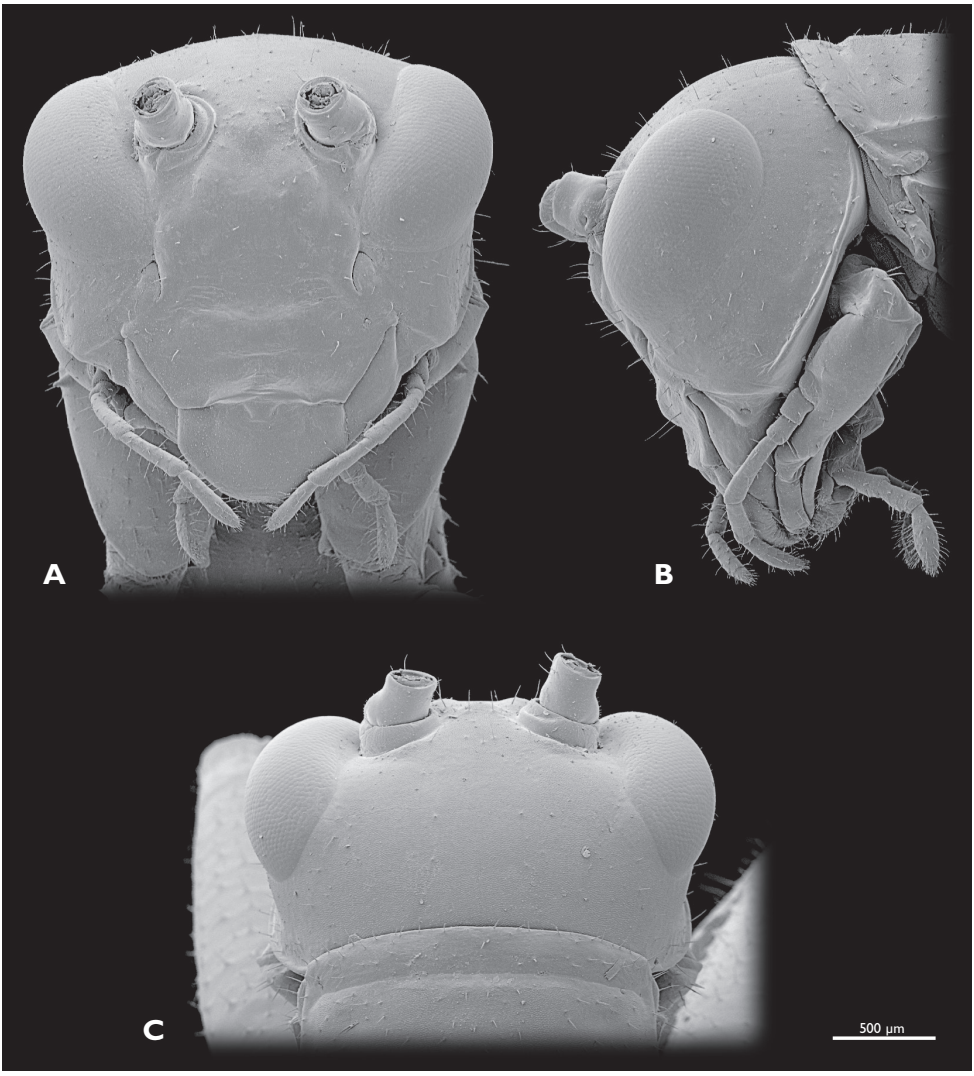

Figure 4. Head of ♂ *Striatophasma naukluftense* sp. n., SEM- micrographs **A** frontal view **B** lateral view **C** dorsal view.

as wide, palpomeres four and five ca. twice as long as wide. Labium green, tip of three segmented palp yellow. Scape and pedicel bright green. Scape as long as wide. Pedicle half as wide as scape, twice as long as wide dilating towards the tip. Flagellum yellow-greenish; ca. as long as the entire animal; 25 flagellomeres.

Thorax (Fig. 5): bright green, dorso-medially with longitudinal brown stripe that contains small green areas. Entire thorax covered with spines. Pronotum oval, scarcely covered with fine setae, with bulge positioned anterior-laterally; pronotum reachs over head and mesonotum. 2 cervicalia present, second postero-dorsally to first. Pleura subdivided into epimeron and episternum. Coxae large, covered with setae.

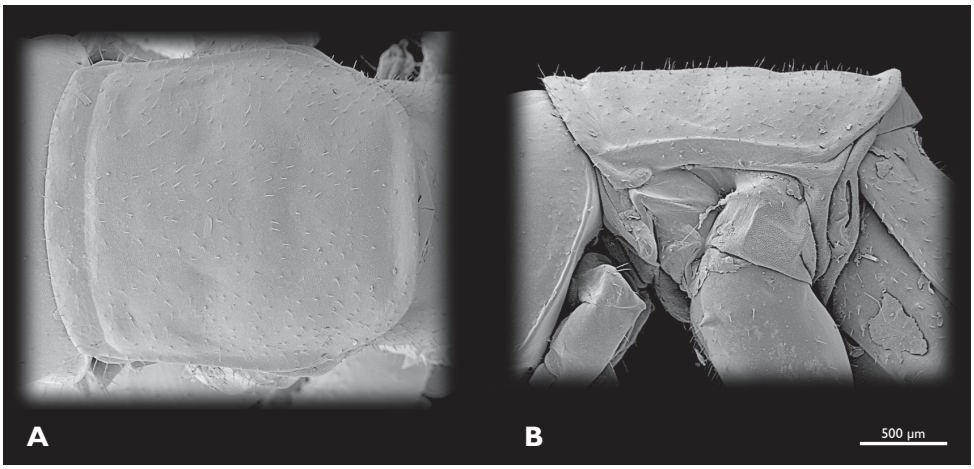

Figure 5. Prothorax of ♂ *Striatophasma naukluftense* sp. n., SEM- micrographs **A** dorsal view **B** lateral view.

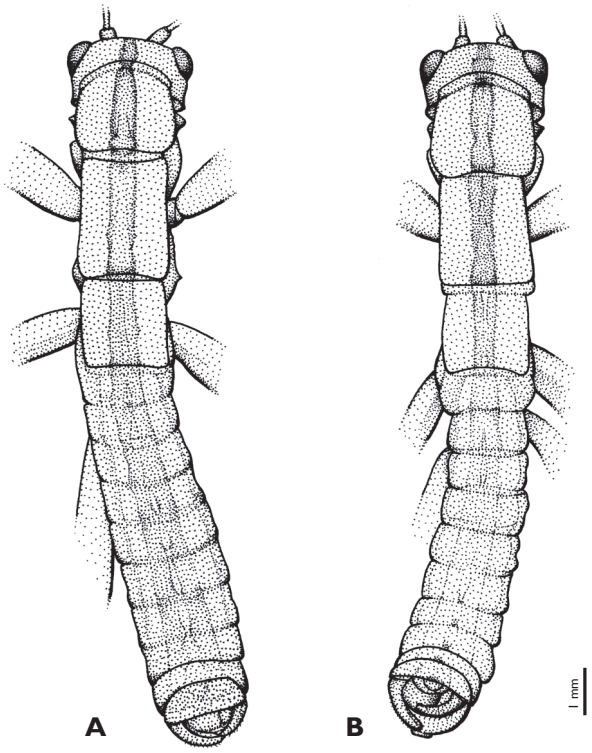

Figure 6. Variations of brown longitudinal stripe in *Striatophasma naukluftense* sp. n. **A** Holotype, male from Naukluft mountains **B** Paratype, male from Nauchas.

Legs: bright green, spikes in the tibial region black; covered with setae. Prothoracic leg more massive than meso- and metathoracic ones; femur three times as long as wide, with two ventro-median rows of green spikes. Tibia green, mesally whitish, ca. 6 times as long as wide, with two ventro-median rows of black spikes. Tarsus with five tarsomeres, first three green, fourth and fifth yellow, proximal four tarsomeres with euplantulae; arolium very large, yellow with black margin.

Wings: completely absent.

Abdomen: longer than thorax and head combined; bright green, meso-dorsal brown longitudinal stripe, enlarging posteriorly; populations of Naukluft mountains, Nauchas and Remhoogte differ in the shape of the stripe (Fig. 6). Tergites with lateral longitudinal brown stripe. Abdomen covered with setae. Abdominal tergum I same width as metathorax; terga slightly broadening towards tergum VIII, terga IX and X narrowing again. Pleura bright green. Sterna bright green with median brown stripe.

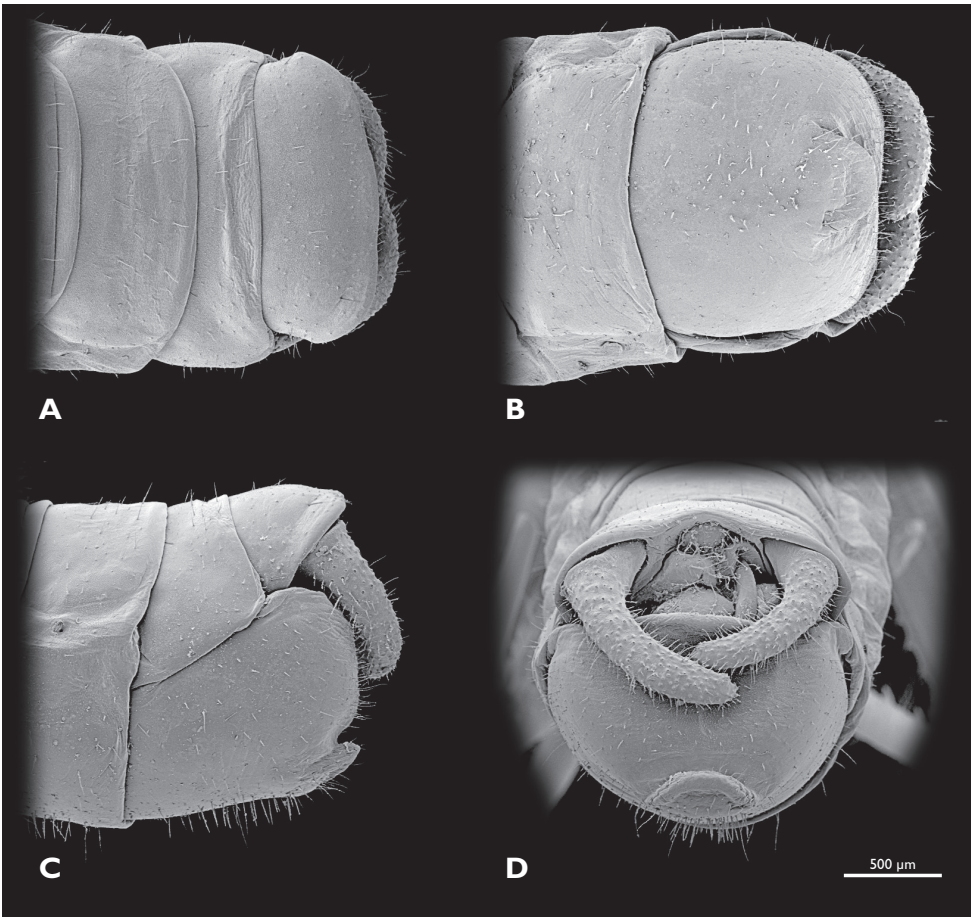

Figure 7. Terminalia of ♂ *Striatophasma naukluftense* sp. n., SEM- micrographs **A** dorsal view **B** ventral view **C** lateral view **D** caudal view.

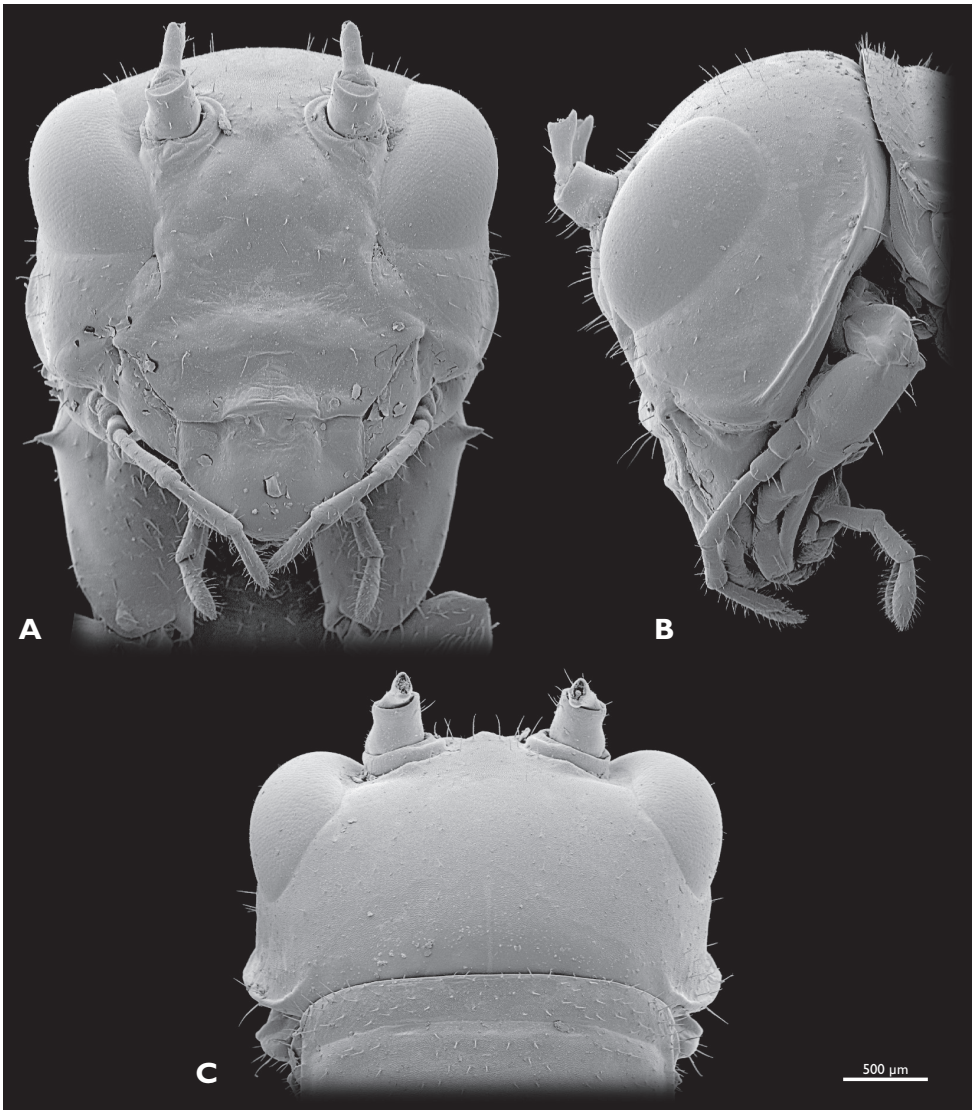

Figure 8. Head of ♀ *Striatophasma naukluftense* sp. n., SEM- micrographs **A** frontal view **B** lateral view **C** dorsal view.

Male terminalia (Fig. 7): tergum IX bright green, mesal brown stripe; shorter than tergum VIII, postero-ventral border with dorsal bend in lateral view. Tergum X bright green, mesal brown stripe, roof-shaped in lateral view. Subgenital plate (sternite IX) green with brown-reddish areas; process of subgenital plate broad, dorsal part arch-shaped when seen from posterior, broadly emarginated dorsally. Cerci one segmented, base green, distally brown-reddish; densely covered with setae; diameter mesally round, uniformly curved, slightly narrowed towards the apex; dorsal projec-

tion of cercus very small, located directly dorsally to apex; cerci extending towards the middle of the subgenital plate.

Description female. For the female only differences to the male are described.

Measurements (critical point dried specimen not measured, in mm): total length (a): (Naukluft: 23.6, 29.0, 31.9) (Remhoogte: 32.0, 35.4); length of pronotum (b): (Naukluft: 4.0, 3.9, 4.3) (Remhoogte: 4.3, 4.4); width of pronotum (c): (Naukluft: 3.7, 3.7, 3.7) (Remhoogte: 4.1, 4.3); length of mesonotum (b): (Naukluft: 3.9, 3.4, 3.0) (Remhoogte: 4.6, 4.6); width of mesonotum (c): (Naukluft: 3.3, 3.3, 3.3) (Remhoogte: 3.9, 3.9); length of metanotum (b): (Naukluft: 3.1, 2.9, 3.3) (Remhoogte: 3.1, 3.7); width of metanotum (c): (Naukluft: 3.1, 3.1, 3.1) (Remhoogte: 3.7, 3.7); length of the head (d): (Naukluft: 4.4, 3.7, 3.7) (Remhoogte: 4.9, 5.7); width of the head (f): (Naukluft: 4.7, 4.4, 4.5) (Remhoogte: 4.6, 4.7); head width over eyes (g): (Naukluft: 4.9, 4.6, 4.7) (Remhoogte: 4.7, 5.3); width between eyes (h): (Naukluft: 3.1, 2.7, 3.0) (Remhoogte: 3.4, 3.7); length of eye (i): (Naukluft: 1.2, 1.1, 1.1) (Remhoogte: 1.3, 1.3); width of eye (j): (Naukluft: 2.1, 1.9, 2.0) (Remhoogte: 2.4, 2.7).

Head (Fig. 8): moss green, dorso-median brown stripe absent; labrum, tip of lacinia and labial palps yellow; compound eyes brownish with reddish stripe. Mouthparts similar to male. Compound eyes prominent, kidney-shaped, dorso-laterally positioned, smaller than in the male, twice as long as high. Interoccular distance ca. 1.5 times the diameter of one eye, on vertex smaller than on ventral eye margin. Temporal ridge distinct. Distance between antennal sockets ca. 1.5 times the diameter of one antennal socket.

Thorax (Fig. 9): moss green with dark green meso-dorsal stripe; thoracic nota with lateral brown dots.

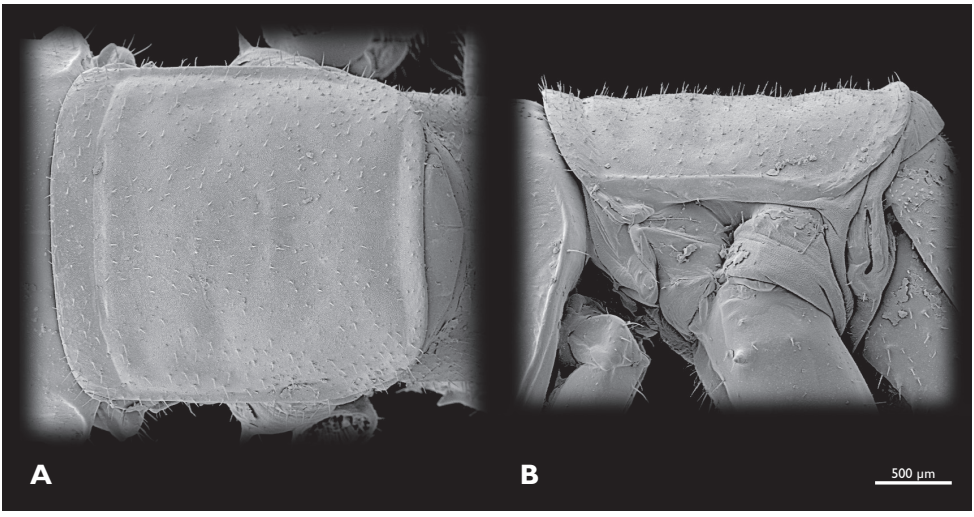

Figure 9. Prothorax of ♀ *Striatophasma naukluftense* sp. n., SEM- micrographs **A** dorsal view **B** lateral view.

Legs: reddish-green, with brown dots where setae emerge; covered with setae; two ventro-median rows of spikes present on tibia and femur; spikes on tibia black.

Abdomen: moss green, dark green meso-dorsal stripe representing dorsal vessel, lateral margins of terga whitish. Tergum I as broad as metanotum. Pleura and sternites moss green.

Female terminalia (Fig. 10): tergum IX moss green, half the length of tergum VIII. Tergum X moss green, twice as long as tergum IX; apex rounded posteriorly; epiproct moss green, short, twice as broad as long; paraprocts moss green, densely covered with setae. Cerci moss green, densely covered with setae, cone shaped, reaching the tips of the paraprocts. Sternite VIII moss green, acuminated posteromesally. Gonapophysis VIII long and slender, distally blunt with ventrocaudal process. Gonocoxite IX trapezoid in lateral view; gonoplac triangular, heavily sclerotised.

Etymology. The species is named after the type locality, the Naukluft Mountains.

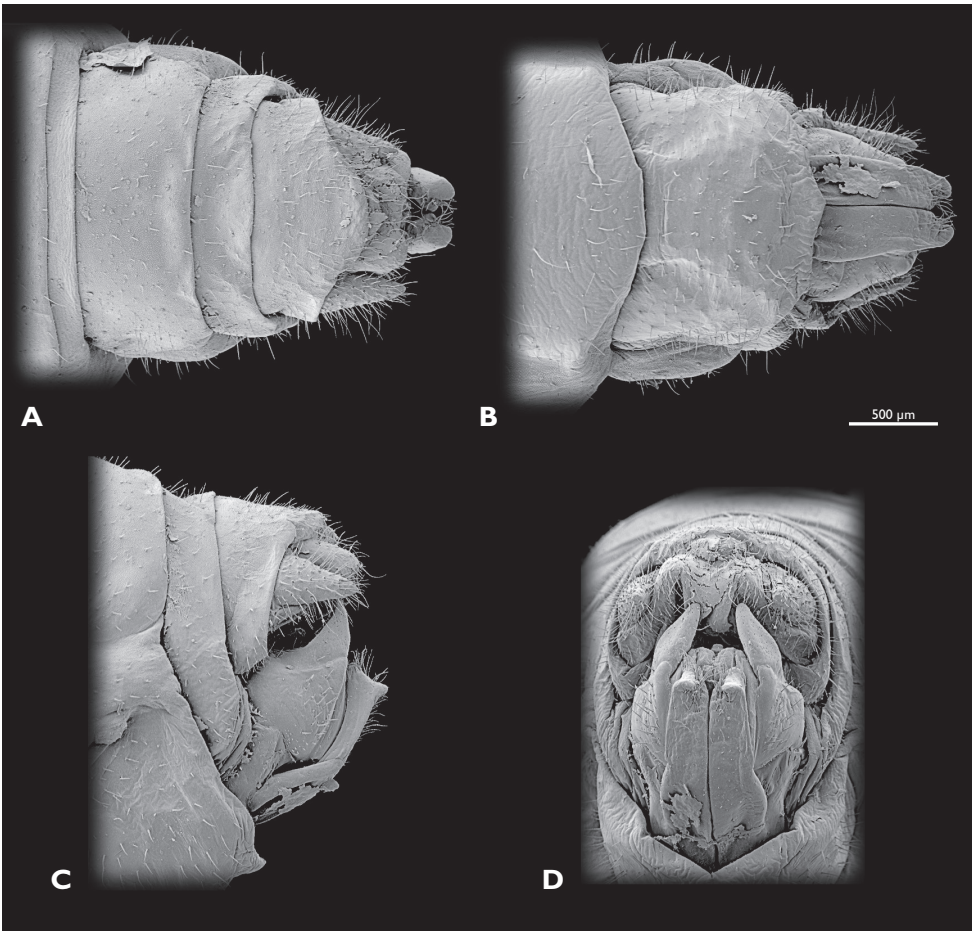

Figure 10. Terminalia of ♀ *Striatophasma naukluftense* sp. n., SEM- micrographs **A** dorsal view **B** ventral view **C** lateral view **D** caudal view.

Comments. Specimens were mainly found in dwarf shrubs. Adult specimens are obviously not associated with grass tussocks.

***Pachyphasma* gen. n.**
urn:lsid:zoobank.org:act:E43A1051-968A-4DFE-BB94-EDD0AB742B07
http://species-id.net/wiki/Pachyphasma

Description and diagnosis. Based on peptide hormone sequences, *Pachyphasma* gen. n. is placed as sistergroup to *Mantophasma*/*Sclerophasma* (Predel et al. in press). The clade *Pachyphasma* gen. n. + *Mantophasma*/*Sclerophasma* was determined as sistergroup to *Tyrannophasma* + *Praedatophasma*. *Pachyphasma* gen. n. can be distinguished from all other mantophasmatodeans by an abdomen that is shorter than the thorax and a metanotum that is broader than the abdominal tergum I. *Pachyphasma* was found in the same biotope/habitat as *Tyrannophasma gladiator*, but on flowering bushes of Compositae while *Tyrannophasma* mainly inhabits grass tussocks but never these bushes.

The new genus is characterized by several distinct neuropeptide sequences, e.g. periviscerokinin-1 (EAAGLIAFPRTamide) (Predel et al. in press). The respective mass signal ($[M+H]^+$: 1144.6) can be detected in preparations of abdominal perisympathetic organs of males/females/nymphs.

Type species. *Pachyphasma brandbergense* sp. n.

Other included species. None thus far.

Etymology. the generic group name *Pachyphasma* is a composition from the Greek word pachys meaning thick and the ending -phasma which is commonly used to term mantophasmatodeans. The gender is neuter.

***Pachyphasma brandbergense* sp. n.**
urn:lsid:zoobank.org:act:A01E0850-5300-433B-A83A-A68C12C0755D
http://species-id.net/wiki/Pachyphasma_brandbergense
Figs 11–18

Holotype male. NAMIBIA: Brandberg Plateau, south of Königstein, with sclerophyllous vegetation (Fig. 12), -21.16, 14.58, +/-2000 m, 26.iv. 2006, R. Predel. (NMNW), specimen in ethanol.

Paratypes NAMIBIA: Brandberg Plateau, south of Königstein: four males and eight females; same data as holotype; one male and two females in ethanol, one pair in copula in ethanol (NMNW); one male and two females in ethanol (ZMUB); two females in ethanol and one male and one female critical point dried, sputter coated with gold (ZFMK). Two juveniles and six heavily damaged specimens (1 juvenil, 2♀, 3♂) were excluded from the type-series (collection R. Predel).

Description male. Measurements (male holotype followed by paratypes in parentheses, critical point dried male and male in copula not measured, in mm): total length

Figure 11. Habitus photography of ♀ *Pachyphasma brandbergense* sp. n.

(a): 23.0 (18.1, 17.9); length of pronotum (b): 3.9 (2.9, 3.1); width of pronotum (c): 3.0 (3.0, 3.4); length of mesonotum (b): 3.6 (2.7, 2.9); width of mesonotum (c): 2.9 (2.7, 3.4); length of metanotum (b): 3.0 (2.7, 2.3); width of metanotum (c): 2.7 (2.4, 2.6); length of the head (d): 4.4 (4.0, 3.9); width of the head (f): 4.0 (3.7, 3.9); head width over eyes (g): 4.4 (4.3, 4.3); width between eyes (h): 3.0 (2.7, 2.6); length of eye (i): 2.0 (2.0, 2.1); width of eye (j): 1.0 (1.0, 1.0).

Head (Fig. 13): nearly triangular when seen frontally, orthognathous. Bright green; thin dorso-median brown longitudinal stripe; broader lateral brown longitudinal stripes posterior of the compound eyes; vertex, frons and subgena with reddish areas; head capsule with brown spots where setae emerge; compound eyes grey with reddish stripe; mouthparts including palpi and labrum greenish. Head capsule slightly broader than thorax; sparsely covered with setae. Compound eyes kidney-shaped, prominent, globular, about 1.5 times as long as high; interoccular distance ca. the length of eye, on vertex larger than on ventral eye margin; ocelli absent. Coronal and frontal suture as well as

Figure 12. Type locality of *Pachyphasma brandbergense* sp. n, Brandberg Plateau, Namibia.

frontoclypeal and temporal ridge indistinct; subgenal ridge distinct, with bend ventrally of compound eye; distance between antennal sockets same as diameter of one socket; anterior tentorial pits dorsomesally of anterior articulation of mandible. Frons with three bulges, two ventromedial of antennal sockets, one in between the antennal sockets. Clypeus trapezoid, with four long setae dorsally; oval sclerite in between clypeus and labrum. Labrum greenish, anteriorly rounded, flat sparsely covered with setae. Maxilla of orthopteroid type, sparsely covered with setae; maxillary palp five-segmented, green, palpomeres two to five covered with setae, palpomere one and two short, nearly as wide as long, palpomere three 2.5 times longer than wide, palpomere four and five ca. twice as long as wide. Labial palp three segmented, green. Scape and pedicel bright green. Scape conical, at base as long as wide. Pedicle half as wide as scape, twice as long as wide. Flagellum yellow-greenish; nearly as long as the entire animal; 25 flagellomeres.

Thorax (Fig. 14): compact. Bright green; thin meso-dorsal brown stripe that ends in the anterior third of metanotum; lateral edges of all three nota with thick brown stripe; lateral margin of nota white; pleurae bright green with reddish areas. Completely covered with setae; brown spots where setae emerge along entire thorax. Pronotum nearly squared; overlapping head and mesonotum. Mesonotum not as wide as pronotum, nearly squared. Metanotum narrower than mesonotum; narrowing posteriorly. Coxae large.

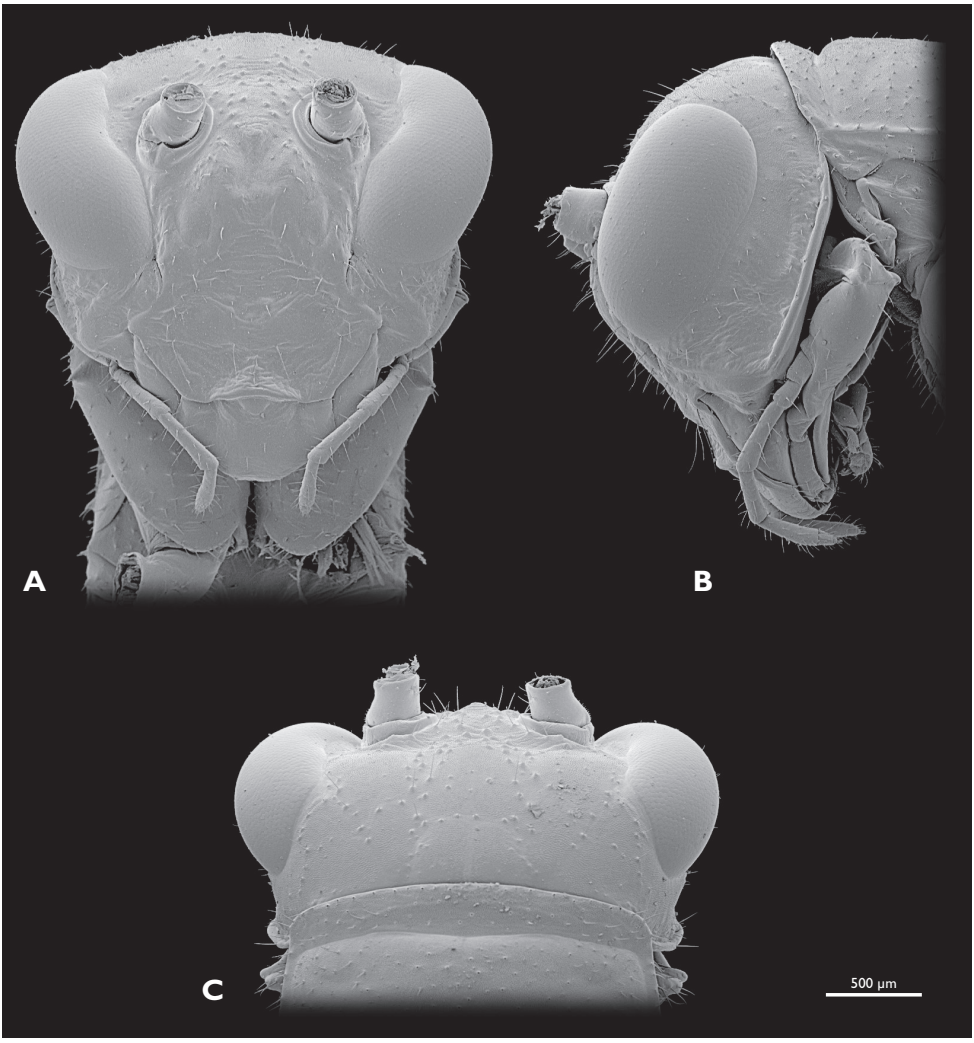

Figure 13. Head of ♂ *Pachyphasma brandbergense* sp. n., SEM- micrographs **A** frontal view **B** lateral view **C** dorsal view.

Legs: bright green. Completely covered with setae; brown spots where setae emerge. Prothoracic leg more massive than meso- and metathoracic leg. Tarsus with 5 brownish tarsomeres; proximal four with euplantulae; large arolium present.

Wings: completely absent.

Abdomen: shorter than thorax: enlarging posteriorly; completely covered with setae. Bright green; lateral brown longitudinal stripes on tergites. Abdominal tergum I narrower than metanotum; terga slightly broadening towards tergum VIII; terga IX and X narrowing again. Pleura bright green with yellowish stripe. Sterna bright green.

Male terminalia (Fig. 15): tergum IX bright green, lateral brown stripe; ca. same length as tergum VIII; postero-ventral border rounded. Tergum X bright green; lat-

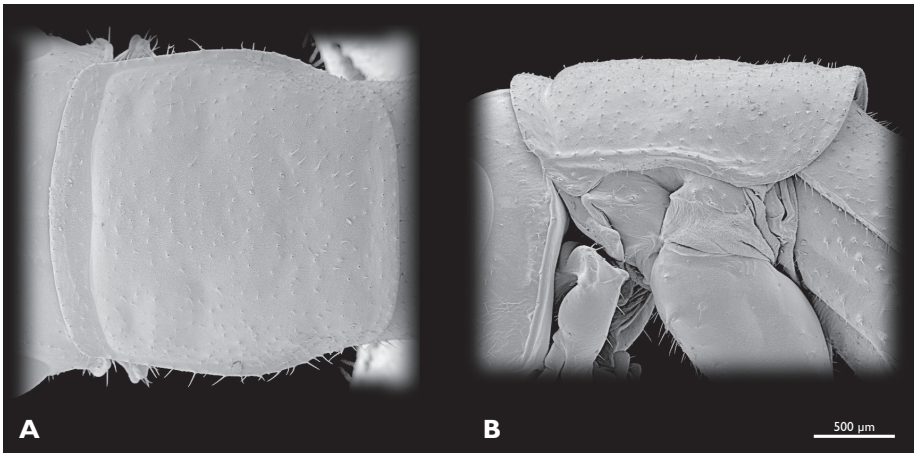

Figure 14. Prothorax of ♂ *Pachyphasma brandbergense* sp. n., SEM- micrographs **A** dorsal view **B** lateral view.

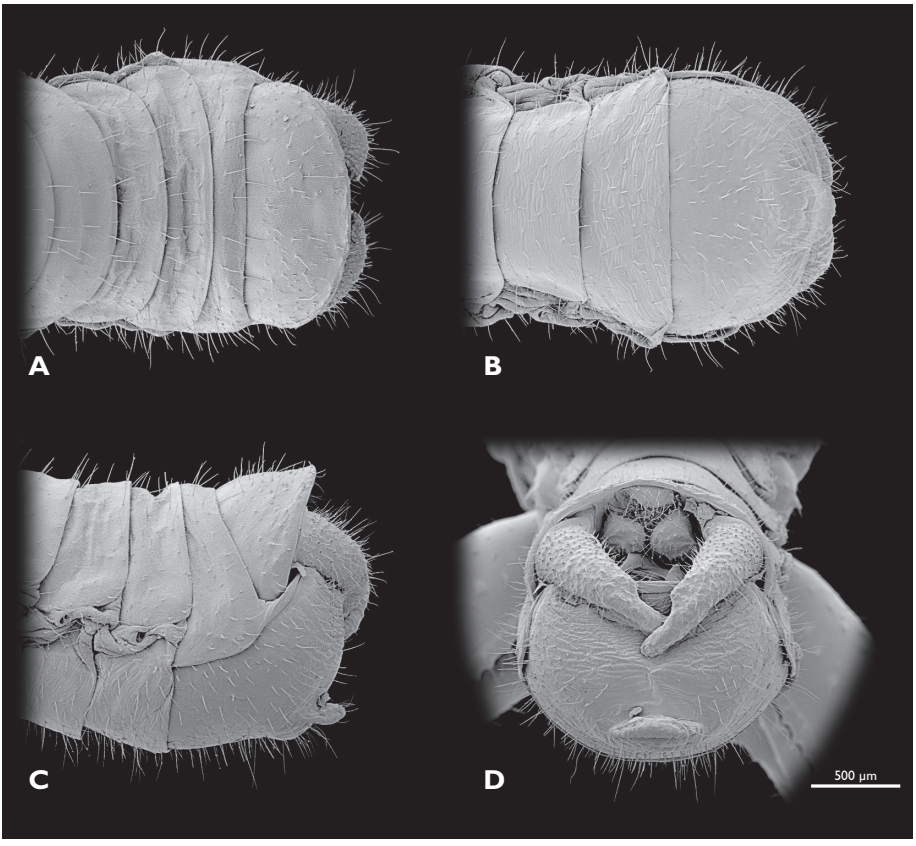

Figure 15. Terminalia of ♂ *Pachyphasma brandbergense* sp. n., SEM- micrographs **A** dorsal view **B** ventral view **C** lateral view **D** caudal view.

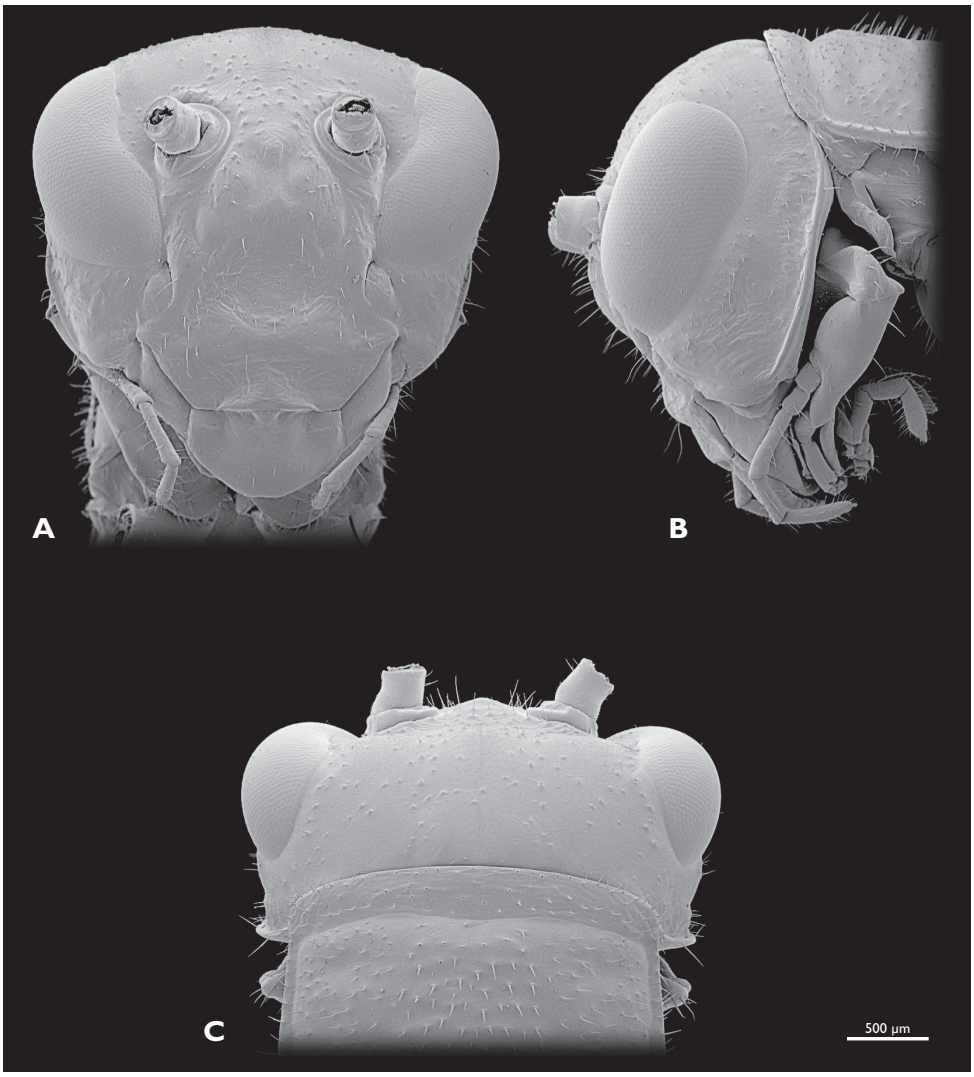

Figure 16. Head of ♀ *Pachyphasma brandbergense* sp. n., SEM- micrographs **A** frontal view **B** lateral view **C** dorsal view.

eral brown longitudinal stripes; roof-shaped in lateral view. Subgenital plate (sternite IX) green; broadly emarginated dorsally; process of subgenital plate broad; dorsal part horizontal in posterior view. Cerci one segmented; green; densely covered with setae; diameter mesally oval; uniformly curved; dorsal projection of cercus very prominent and located at two-third of length of cercus; cerci extending towards middle of subgenital plate.

Description female. For the female only differences to the male are described.

Measurements (critical point dried female and female in copula not measured, in mm):

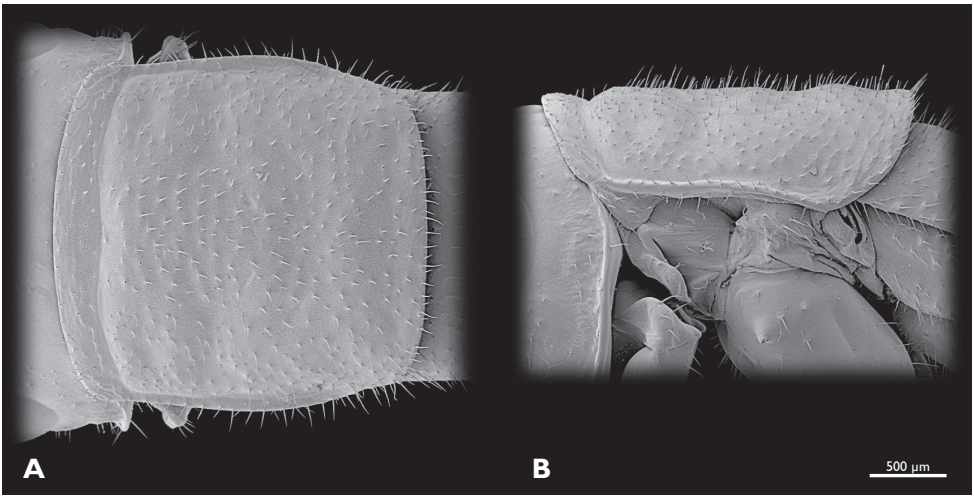

Figure 17. Thorax of ♀ *Pachyphasma brandbergense* sp. n., SEM- micrographs **A** dorsal view **B** lateral view.

Total length (a): 20.1, 17.4, 28.3, 27.8, 15.9, 20.3; length of pronotum (b): 4.0, 4.1, 4.0, 3.9, 3.6, 3.7; width of pronotum (c): 4.3, 4.3, 3.8, 3.9, 4.1, 3.7; length of mesonotum (b): 3.1, 2.9, 3.6, 3.7, 2.9, 2.9; width of mesonotum (c): 3.7, 3.7, 3.4, 3.3, 3.7, 3.1; length of metanotum (b): 2.9, 2.2, 2.3, 2.3, 2.6, 2.4; width of metanotum (c): 3.6, 3.4, 3.7, 3.4, 3.6, 3.1; length of the head (d): 1.1, 1.2, 1.2, 1.1, 1.0, 1.1; width of the head (f): 5.2, 4.4, 4.4, 4.5, 4.4, 4.2; head width over eyes (g): 5.4, 5.1, 5.0, 4.9, 4.7, 4.6; width between eyes (h): 3.4, 2.9, 2.9, 3.0, 2.9, 2.9; length of eye (i): 2.5, 2.3, 2.3, 2.1, 2.3, 2.3; width of eye (j): 1.1, 1.2, 1.3, 1.1, 1.1, 1.1.

Head: (Fig. 16): globular. Bright green; thin dorso-median brown longitudinal stripe; broader lateral brown longitudinal stripes posterior of compound eyes. Compound eyes less bulged than in male. Scape and pedicel green; 25 flagellomeres.

Thorax (Fig. 17): compact. Bright green; thin meso-dorsal brown longitudinal stripe; thick lateral brown longitudinal stripe on notae; lateral margin of nota white; pleura bright green.

Abdomen: bright green, dark green meso-dorsal longitudinal stripe; pleura bright green with yellowish longitudinal stripe; sternites bright green.

Female terminalia (Fig. 18): tergum IX bright green. Tergum X moss green; 1.5 times as long as tergum IX; apex rounded posteriorly. Paraprocts bright green; sparsely covered with setae. Cerci bright green; densely covered with setae; triangular; protruding further caudally than paraprocts. Sternite VIII bright green; posterior margin rounded. Gonapophysis VIII long and slenderd distally blunt; with very short ventrocaudal process. Gonocoxite IX trapezoid in lateral view. Gonoplac triangular; heavily sclerotised.

Etymology. The species is named after the type locality, the Brandberg massif.

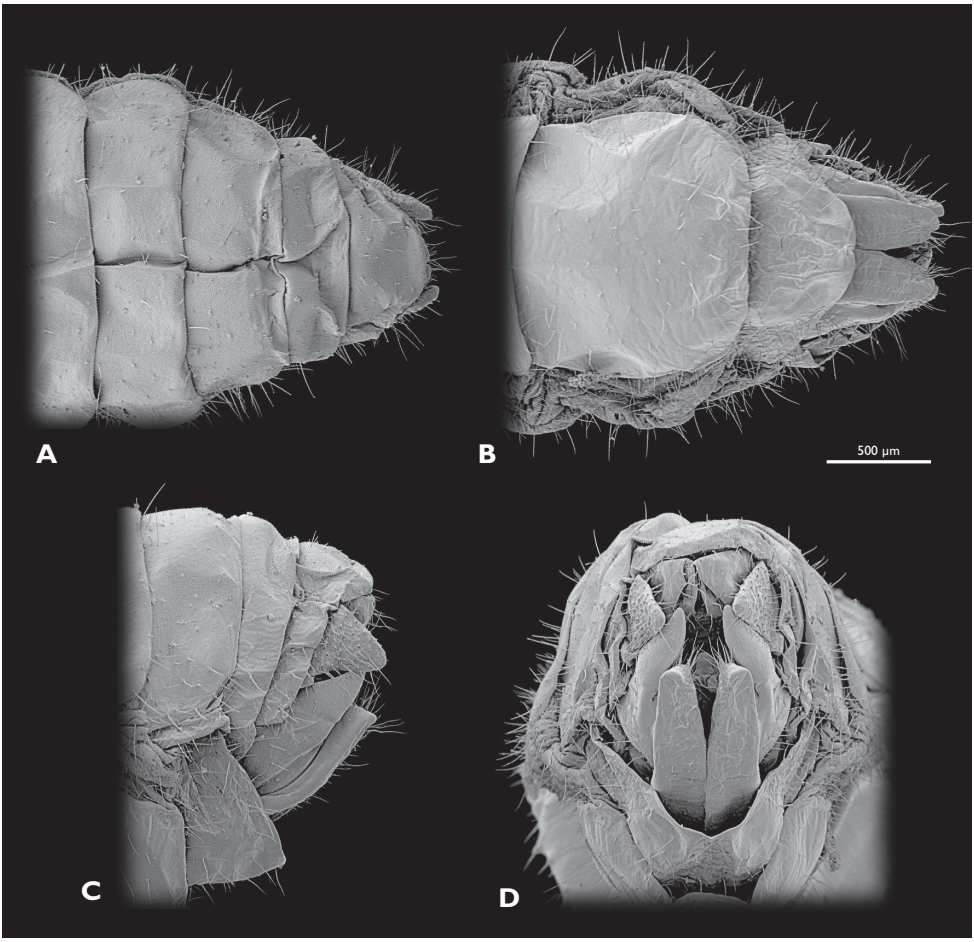

Figure 18. Terminalia of ♀ *Pachyphasma brandbergense* sp. n., SEM- micrographs **A** dorsal view **B** ventral view **C** lateral view **D** caudal view.

Discussion

The discovery of the two new genera of Mantophasmatodea results from extensive collecting activities during the last years (Fig. 19). With it, it can be expected that, at least in Namibia, the majority of higher taxa are now known. It is particularly remarkable, that within the large distributional range of *Mantophasma*, additional mantophasmatodean taxa have not been found (see Predel et al. in press). *Pachyphasma brandbergense* may represent a phylogenetic relict which survived only on the Brandberg Massif, an isolated biotope outside the currently accessible range of *Mantophasma*. At the plateau of the Brandberg massif, *Pachyphasma brandbergense* occurs sympatrically with

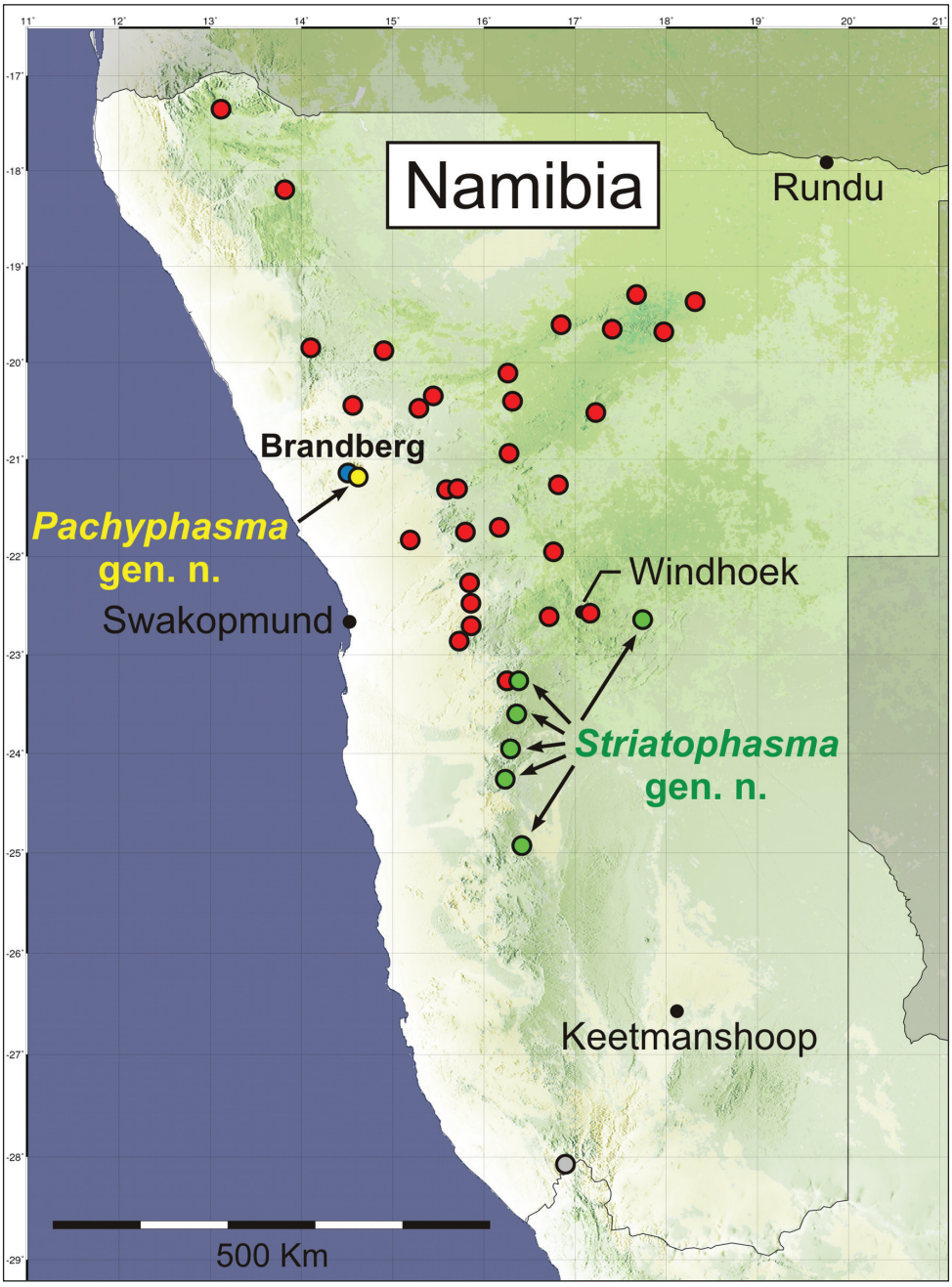

Figure 19. Collection localities of Mantophasmatodea from Namibia. Red, *Mantophasma* (incl. *Sclerophasma paresisense*); green, *Striatophasma* gen. n.; blue, *Tyrannophasma*; yellow, *Pachyphasma* gen. n.; gray, *Praedatophasma* (Predel et al. in press).

the much larger *Tyrannophasma gladiator*. Nevertheless, both species occupy different ecological niches.

In contrast to *Pachyphasma* gen. n., the newly described *Striatophasma* gen. n. represents a widely distributed taxon. Its northernmost known distributional limit seems to be equivalent to the southern limit of *Mantophasma* (Predel et al. in press). The general distribution of these taxa suggests that *Striatophasma* is better adapted to conditions of lower rainfall and scattered vegetation. In the field, different morphotypes from different localities of *Striatophasma* were found with a variable development of the brown dorsal stripe in males (Fig. 6).

Thus far, the monophyly of *Pachyphasma* and *Striatophasma* is supported by distinct morphological features and a number of specific peptide hormone sequences which clearly separate these taxa from all other (Predel et al. in press). Most peptide hormones are synthesized in the central nervous system and are released via neurohemal organs which accumulate these messenger molecules. In insects, the ganglia of the different tagmata (head, thorax, abdomen) have each their specific external release sites with tagma-specific peptide hormones which can be analysed by mass spectrometry (see Predel et al. 2005). It is beyond the scope of this manuscript and also beyond our current state of knowledge to present a morphology-based diagnostic key for the separation of all mantophasmatodeans. More data, particularly about within-species variation, are required to address this problem. For the differentiation of the major lineages of Mantophasmatodea, however, mass fingerprints of peptide hormones provide unambiguous information (see Predel et al. 2005, in press) which can be used in a dichotomic key. This character set is already studied in detail with respect to Mantophasmatodea and can be obtained from single specimens (males, females or larvae). It is thus possible to assign newly collected specimens to previously analyzed taxa simply and rapidly and we encourage entomologists to contact one of us in case of problems in obtaining such data. Alternatively, we offer to perform immediate and free of charge analyses for the collector if living or frozen specimens can be provided (we are also working on the development of methods to analyze insects preserved in ethanol).

Dichotomic key based on peptide barcoding (peptide hormones; RC, retrocerebral complex; aPSO/tPSO, abdominal/thoracic perisympathetic organ):

1	RC (952.4 + 1350.6)	**Austrophasmatidae sensu Klass et al. 2003 (*Hemilobophasma, Austrophasma, Karoophasma, Namaquaphasma, Lobatophasma, Viridiphasma*)**
–	RC without (952.4 and 1350.6)	**2 (remaining Mantophasmatodea)**
2	RC (982.4 + 1369.6)	***Striatophasma***
–	RC (938.4 + 1369.6)	**3**
3	aPSO (1144.7), tPSO (1066.5)	***Pachyphasma***
–	aPSO without (1144.7), tPSO without (1066.5)	**4**

4 aPSO (1735.8), tPSO (1174.6) ..... ***Praedatophasma***
– aPSO without (1735.8), tPSO without (1174.6) **5**
5 aPSO (1772.8), tPSO (819.5) ..... ***Tyrannophasma***
– aPSO without (1742.8) tPSO without (819.5) .....
..... ***Mantophasma, Sclerophasma, Tanzaniophasma***

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