

Taiwanese Leucothoidae (Crustacea: Amphipoda), Including Three New Species from Dongsha Atoll

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(Received 18 July 2018; Accepted 22 August 2018; Published 27 September 2018; Communicated by Benny K.K. Chan)

Citation: White KN, Machida RJ. 2018. Taiwanese Leucothoidae (Crustacea: Amphipoda), including three new species from Dongsha Atoll. Zool Stud 57:47. doi:10.6620/ZS.2018.57-47.

Kristine N. White and Ryuji J. Machida (2018) Examination of leucothoid amphipods from Penghu, Green Island, and Dongsha Atoll revealed 16 species not previously reported from Taiwan. *Leucothoe batillum* sp. nov., *Leucothoe cracentis* sp. nov., and *Paranamixis lunata* sp. nov. are described from Dongsha Atoll. The ranges of 13 *Leucothoe* species are expanded to include the South China and Philippine Seas, suggesting genetic or geographic-driven connectivity between the South and East China Seas and the Philippine Sea. *Leucothoe furina* (Savigny, 1816), originally described from the Mediterranean or Red Sea, is reported from Taiwan, which suggests the occurrence of another species complex in the Leucothoidae.

Key words: Leucothoidae, New species, Taiwan, Dongsha, Connectivity.

BACKGROUND

Leucothoid amphipods are common peracarid crustaceans, typically found as endocommensal associates of sessile invertebrate hosts from all marine ecosystems. They are intentionally collected living inside of sponges, ascidians or bivalve mollusks and incidentally collected living among coral rubble. Amphipods exhibit direct development and generally narrow geographical ranges. Including the species described here, Leucothoidae currently comprises 189 species in five genera: *Anamixis* Stebbing, 1897 (24 spp.); *Nepanamixis* Thomas, 1997 (4 spp.); *Paranamixis* Schellenberg, 1938 (16 spp.); *Leucothoe* Leach, 1814 (143 spp.); and *Paraleucothoe* Stebbing, 1899 (2 spp.).

Five leucothoid species have been previously reported from the South China and Philippine

Seas (Table 1), yet none have been documented from Taiwanese waters until now. Examination of material collected from Penghu, Green Island, and Dongsha Atoll, Taiwan has revealed several more leucothoid amphipod species that have not been previously reported from the South China or Philippine Seas. Two new species of *Leucothoe* and one new species of *Paranamixis* are here described from Dongsha Atoll.

MATERIALS AND METHODS

Leucothoid amphipods were collected via snorkeling and SCUBA from various locations around Penghu and Green Island, Taiwan in 2013 and from Dongsha Atoll in 2017 (Fig. 1). Amphipods were collected in situ from marine sponges using a specialized collecting device or from marine

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sponges, ascidians, clumps of *Halimeda* J.V. Lamouroux, 1812, and coral rubble samples that were processed following the methods of White (2013). Specimens were preserved in 99.5% EtOH. Specimens used for morphological analyses were transferred to glycerin, dissected, mounted on slides, and illustrated using a drawing tube attached to a compound microscope. Pencil drawings were scanned and digitally inked in Adobe® Illustrator CC 2015 using a Wacom® Tablet, following the methods of Coleman (2003). Type material is deposited at the National Museum of Marine Biology and Aquarium, Pingtung, Taiwan (NMMB); other material examined is maintained in the laboratory of the first author or deposited at the Biodiversity Research Museum Academia Sinica, Taiwan (AS).

RESULTS

SYSTEMATICS

Subphylum Crustacea Brünnich, 1772
Class Malacostraca Latreille, 1802
Order Amphipoda Latreille, 1816
Family Leucothoidae Dana, 1852

Genus *Leucothoe* Leach, 1814

***Leucothoe akaisen* White and Reimer, 2012c**
(Fig. 2A)

Leucothoe akaisen White and Reimer, 2012c: 18-22, figs. 3, 4, 15D.

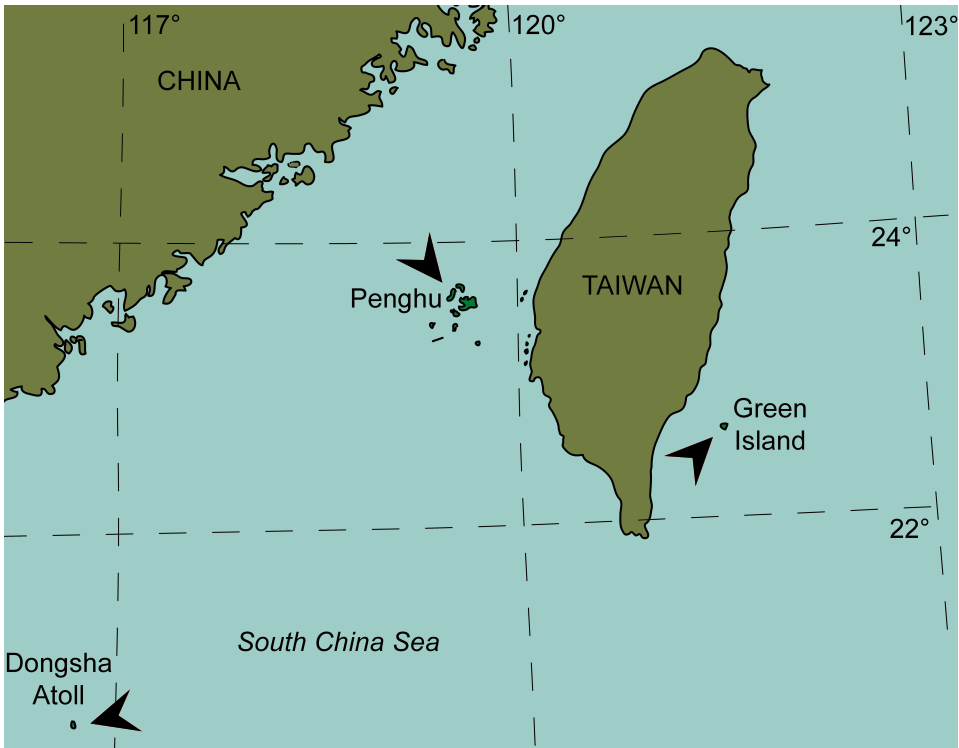


Fig. 1. Map showing the study area (arrows pointed).

Table 1. List of leucothoid species previously reported from the South China and Philippine Seas.

Species	Location	Host	Depth
<i>Anamixis dentatus</i> Ren, 2006	Nansha Islands	Sea weed	unknown
<i>Anamixis vestigium</i> (Ren, 2006)	Hainan Province, China	Coral reef	intertidal
<i>Leucothoe alcyone</i> Imbach, 1967	Vietnam	Mud	15 m
<i>Leucothoe eltoni</i> Thomas, 2015	Philippines	Ascidians	2-20 m
<i>Leucothoe furina</i> (Savigny, 1816)	Vietnam (reported by Imbach, 1967)	Sand	8 m

Material examined: 1 male, 1 female; KNW-Dongsha-2017-8b, Dongsha Atoll, northwest fore reef, 20°46'23.75"N, 116°45'58.78"E, 17.4 m; 24 May 2017; K.N. White, collector.

Ecology: This species occurs among coral rubble in Taiwanese waters and the Ryukyu Archipelago (present study; White and Reimer 2012c).

Distribution: South China Sea: Dongsha Atoll, Taiwan (present study); East China Sea: Ishigaki Island, Iriomote Island, Okinawa Island (all Okinawa), Tokunoshima Island, Yakushima Island (both Kagoshima), Japan (White and Reimer 2012c).

***Leucothoe alani* White and Krapp-Schickel, 2017**
(Fig. 2B)

Leucothoe alani White and Krapp-Schickel, 2017: 10-11, no figs.

?*Leucothoella bannwarthi* Barnard, 1965: 492, fig. 7-Myers, 1985: 94, figs. 74-75.

?*Leucothoe bannwarthi* [sic] - Myers, 2013: 307.

Material examined: 1 male; KNW-Dongsha-2017-1e Dongsha Atoll north beach, 20°42'18.26"N, 116°43'43.29"E, 1.5 m; 29 May 2017; K.N. White, collector. 1 male, 1 female; KNW-Dongsha-2017-3b, Dongsha Atoll lagoon, 20°42'14.76"N, 116°48'17.2074"E, 11 m; 21 May 2017; K.N. White, collector. 1 male, 1 female; KNW-Dongsha-2017-11f, Dongsha Atoll southwest lagoon, 20°39'32.00"N, 116°45'14.68"E, 5 m; 26 May 2017; K.N. White, collector. 1 male; KNW-Dongsha-2017-12e, Dongsha Atoll south beach, 20°47'57.48"N, 116°43'24.07"E, 1.7 m; 27 May 2017; K.N. White, collector.

Ecology: This species occurs among coral rubble (present study) and among *Halimeda* and sponges, including *Melophlus sarasinorum* Thiele, 1899, and coral rubble (Myers 1985; White and Krapp-Schickel 2017).

Distribution: South China Sea: Dongsha Atoll, Taiwan (present study); Pacific Ocean: Fiji (Myers 1985); Western Pacific Ocean: Micronesia: Ifaluk Atoll (Barnard 1965); Palau (Myers 2013).

***Leucothoe bise* White and Reimer, 2012b**
(Fig. 2C)

Leucothoe bise White and Reimer, 2012b: 7-11, figs. 3-4, 24B.

Material examined: 1 female; KNW-Peng-4A, Penghu, Go Sha Zai, 23°22'70.2"N, 119°31'98.4"E,

7 m; 31 July 2013; K.N. White, collector. 1 male, 3 female; KNW-Green-2C, Green Island Cshinlang, 22°39'13.19"N, 121°29'37.70"E, 8 m; 4 August 2013; K.N. White, collector. 2 males, 1 female; KNW-Dongsha-2017-3d,g, Dongsha Atoll lagoon, 20°42'14.76"N, 116°48'17.21"E, 11 m; 21 May 2017; K.N. White, collector. 2 males, 6 females; KNW-Dongsha-2017-4b, Dongsha Atoll southeast fore reef, 20°38'11.4"N, 116°54'25.85"E, 17 m; 22 May 2017; K.N. White, collector. 3 males, 1 female; KNW-Dongsha-2017-5b,e, Dongsha Atoll southeast fore reef, 20°36'58.57"N, 116°53'14.78"E, 15 m; 22 May 2017; K.N. White, collector. 4 males, 11 females; KNW-Dongsha-2017-6c, Dongsha Atoll east fore reef, 20°40'38.18"N, 116°55'31.30"E, 17.4 m; 23 May 2017; K.N. White, collector. 1 male; KNW-Dongsha-2017-7c, Dongsha Atoll, northeast fore reef, 20°46'52.26"N, 116°45'51.50"E, 17.8 m; 23 May 2017; K.N. White, collector. 2 males, 3 females; KNW-Dongsha-2017-8a, Dongsha Atoll, northwest fore reef, 20°46'23.75"N, 116°45'58.78"E, 17.4 m; 24 May 2017; K.N. White, collector. 1 male, 1 female; KNW-Dongsha-2017-9c, Dongsha Atoll, northeast fore reef, 20°46'52.11"N, 116°48'10.81"E, 17.7 m; 24 May 2017; K.N. White, collector. 1 male, 1 female, 1 juvenile; KNW-Dongsha-2017-11c, Dongsha Atoll, southwest lagoon, 20°39'32.00"N, 116°45'14.68"E, 5 m; 26 May 2017; K.N. White, collector. 3 females; KNW-Dongsha-2017-13a, Dongsha Atoll, south fore reef, 20°35'08.62"N, 116°47'28.67"E, 20 m; 30 May 2017; K.N. White, collector.

Ecology: This species lives inside sponges of the genus *Haliclona* Grant, 1836 and among coral rubble in Taiwanese waters (present study) and inside sponges of the genus *Tedania* Gray, 1867 and among coral rubble in the Ryukyu Archipelago (White and Reimer 2012b).

Distribution: South China Sea: Penghu, Dongsha Atoll, Taiwan; Philippine Sea: Green Island, Taiwan (present study); East China Sea: Okinawa Island, Iriomote Island (both Okinawa), Japan (White and Reimer 2012b).

***Leucothoe enko* White and Reimer, 2012c**
(Fig. 2D)

Leucothoe enko White and Reimer, 2012c: 30-34, figs. 9-10, 15C.

Material examined: 1 male, 1 female; KNW-Green-3D, Green Island Mushroom Coral, 22°39'24.35"N, 121°28'18.04"E, 20 m; 4 August

2013; K.N. White, collector. 4 males, 6 females; KNW-Green-4E, Green Island Turtle Bay 22°38'31.04"N, 121°28'50.98"E, 20 m; 5 August 2013; K.N. White, collector. 1 female; KNW-Dongsha-2017-6g, Dongsha Atoll east fore reef, 20°40'38.18"N, 116°55'31.30"E, 17.4 m; 23 May 2017; K.N. White, collector. 1 male, 1 female; KNW-Dongsha-2017-7e, Dongsha Atoll, northeast fore reef, 20°46'52.26"N, 116°45'51.50"E, 17.8 m; 23 May 2017; K.N. White, collector. 1 male; KNW-Dongsha-2017-9f, Dongsha Atoll, northeast fore reef, 20°46'52.11"N, 116°48'10.81"E, 17.7 m; 24 May 2017; K.N. White, collector.

Ecology: This species lives inside gray mucous-filled, red, and red-orange sponges and among coral rubble in Taiwanese waters (present study) and among coral rubble in the Ryukyus Archipelago (White and Reimer 2012c).

Distribution: South China Sea: Dongsha Atoll, Taiwan; Philippine Sea: Green Island, Taiwan (present study); East China Sea: Okinawa Island (Okinawa), Okinoerabu Island and Tokunoshima Island (both Kagoshima), Japan (White and Reimer 2012c).

***Leucothoe furina* (Savigny, 1816)**
(Fig. 2E)

Lycesta furina (Savigny, 1816): 109-110, pl. 4/fig. 2.1.2b. -Audouin, 1826: 92, pl. 11/fig. 2.

Leucothoe furina Guérin-Ménéville, 1829-1844: 23, pl. 26/fig. 8. -Milne Edwards, 1830: no text, pl. 37/fig. 7. -Milne Edwards, 1840: 57, 58, pl. 29/fig. 14. -Lucas, 1840: 230. -White, 1857: 189. -Carus, 1885, 409. -Bonnier, 1887: 328. -Stebbing, 1906: 165. -Schellenberg, 1928: 635-637. -Cecchini, 1929: 771-773. -K.H. Barnard, 1931: 120. -Pirlot, 1936: 294. -K.H. Barnard, 1937: 152. -Sheard, 1937: 20. -Ruffo, 1938: 156. -Nayar, 1966, p. 142, fig. 5d. -Sivaprakasam, 1969: 387, 388, fig. 3. -Imbach, 1967: 79, pl. 21. -Ruffo, 1969: 10, 11. -Ledoyer, 1979: 166-168, fig. 14. -Vader and Beehler, 1983: 59, 60. -Bussarawich et al., 1984a: none. -Lowry and Stoddart, 2003: 155.

Leucothoe hornelli Walker, 1904: 258, 259, pl. 3, fig. 17. -Walker, 1905: 925. -Stebbing, 1906: 724. -Chevreux, 1908: 470. -Walker, 1909: 331.

Leucothoe spinicarpa Rudwick, 1951: 151, fig. 2 (non Abildgaard, 1789).

Material examined: 1 male, 1 female; KNW-Dongsha-2017-4h, Dongsha Atoll southeast fore reef, 20°38'11.4"N, 116°54'25.85"E, 17 m; 22 May 2017; K.N. White, collector. 1 male, 2 female; KNW-Dongsha-2017-6a, Dongsha Atoll east fore reef, 20°40'38.18"N, 116°55'31.30"E, 17.4 m; 23 May 2017; K.N. White, collector.

Ecology: This species lives in the branchial chambers of ascidians in the genus *Pyura* (Molina,

1782) in Taiwanese waters (present study); in *Phallusia nigra* (Savigny, 1816) in Mediterranean waters (Savigny, 1816) and *Polycarpa aurata* (Quoy and Gaimard, 1834) on the Great Barrier Reef (K.H. Barnard, 1937).

Distribution: South China Sea: Dongsha Atoll, Taiwan (present study), Vietnam (Imbach 1967); Mediterranean Sea: Egypt (Savigny 1816; Stebbing 1906), Suez (Schellenberg 1928; K.H. Barnard 1931); North Sea: Banff (Stebbing 1906). Atlantic Ocean: Bay de Quiberon (Bonnier 1887); Indian Ocean: Minikoi, India (Walker 1905), Ceylon (Stebbing 1906; K.H. Barnard 1931; Nayar 1966), Maldives (K.H. Barnard 1937), Puket (Ledoyer 1979); Red Sea (K.H. Barnard 1931; Ruffo 1938); Atlantic Ocean: Dakhla Archipelago (Ruffo 1969).

***Leucothoe hashi* White and Reimer, 2012b**
(Fig. 2F)

Leucothoe hashi White and Reimer, 2012b: 16-20, figs 7-8, 24A.

Material examined: 1 male, 1 female; KNW-Peng-1A, Penghu, Chin Wan Inner Bay, 23°31'75.1"N, 119°33'59.3"E, 1 m; 30 July 2013; K.N. White, collector. 1 male, 3 females; KNW-Peng-2A, Penghu, Chin Wan Inner Bay, 23°31'75.1"N, 119°33'59.3"E, 1 m; 30 July 2013; K.N. White, collector. 2 male, 4 females; KNW-Peng-3C, Penghu, Dong Gee, 23°15'21.8"N, 119°39'95.9"E, 10 m; 31 July 2013; K.N. White, collector. 6 males, 11 females; KNW-Green-3A, Green Island Mushroom Coral, 22°39'24.35"N, 121°28'18.04"E, 20 m; 4 August 2013; K.N. White, collector. 2 females; KNW-Green-3B, Green Island Mushroom Coral, 22°39'24.35"N, 121°28'18.04"E, 20 m; 4 August 2013; K.N. White, collector. 3 females; KNW-Green-4A, Green Island Turtle Bay 22°38'31.04"N, 121°28'50.98"E, 20 m; 5 August 2013; K.N. White, collector. 2 males, 5 females; KNW-Green-4D, Green Island Turtle Bay 22°38'31.04"N, 121°28'50.98"E, 20 m; 5 August 2013; K.N. White, collector. 1 female; KNW-Dongsha-2017-4d, Dongsha Atoll southeast fore reef, 20°38'11.4"N, 116°54'25.85"E, 17 m; 22 May 2017; K.N. White, collector. 1 male; KNW-Dongsha-2017-5d, Dongsha Atoll southeast fore reef, 20°36'58.57"N, 116°53'14.78"E, 15 m; 22 May 2017; K.N. White, collector. 1 male, 1 female, 1 juvenile; KNW-Dongsha-2017-7b, Dongsha Atoll, northeast fore reef, 20°46'52.26"N, 116°45'51.50"E, 17.8 m; 23 May 2017; K.N. White,

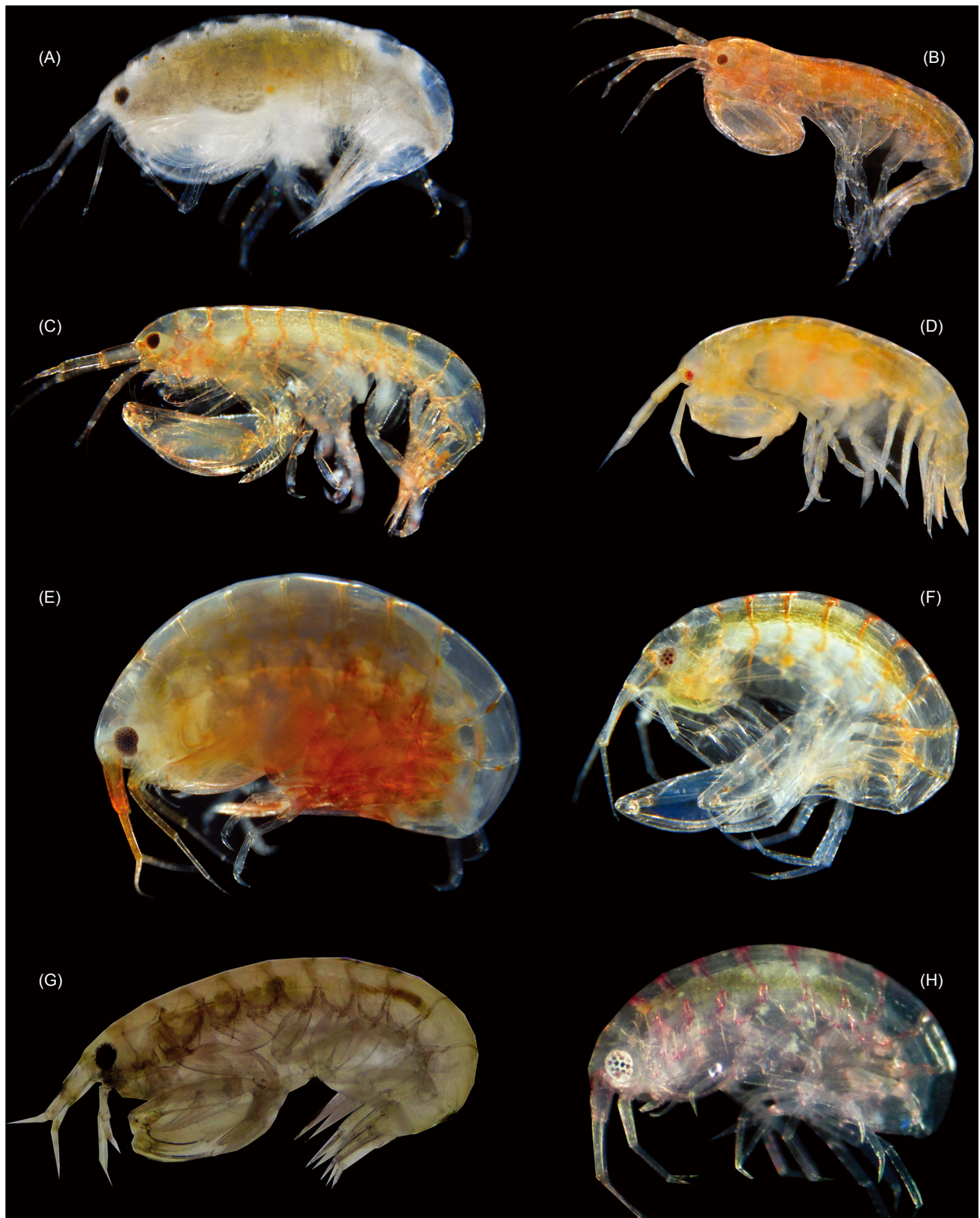


Fig. 2. (A) *Leucothoe akaisen* White and Reimer, 2012c, female, KNW-Dongsha-2017-8b; (B) *Leucothoe alani* White and Krapp-Schickel, 2017, male, KNW-Dongsha-2017-1e; (C) *Leucothoe bise* White and Reimer, 2012b, male, KNW-Dongsha-2017-6c; (D) *Leucothoe enko* White and Reimer, 2012c, female, KNW-Dongsha-2017-9f; (E) *Leucothoe furina* (Savigny, 1816), male, KNW-Dongsha-2017-4h; (F) *Leucothoe hashi* White and Reimer, 2012b, male, KNW-Dongsha-2017-9h; (G) *Leucothoe kebukai* White and Reimer, 2012c, male, KNW-Green-4B; (H) *Leucothoe lecrovayae* White and Reimer, 2012b, male, KNW-Peng-2A.

collector. 3 males, 3 females; KNW-Dongsha-2017-8d, Dongsha Atoll, northwest fore reef, 20°46'23.75"N, 116°45'58.78"E, 17.4 m; 24 May 2017; K.N. White, collector. 1 male, 1 female; KNW-Dongsha-2017-9d,h, Dongsha Atoll, northeast fore reef, 20°46'52.11"N, 116°48'10.81"E, 17.7 m; 24 May 2017; K.N. White, collector. 2 males; KNW-Dongsha-2017-11d, Dongsha Atoll, southwest lagoon, 20°39'32.00"N, 116°45'14.68"E, 5 m; 26 May 2017; K.N. White, collector. 2 males, 2 females; KNW-Dongsha-2017-13b,e, Dongsha Atoll, south fore reef, 20°35'08.62"N, 116°47'28.67"E, 20 m; 30 May 2017; K.N. White, collector.

Ecology: This species lives inside *Callyspongia* Duchassaing and Michelotti, 1864, red orange, and yellow sponges and among coral rubble in Taiwanese waters (present study); and inside *Callyspongia*, ?*Clathria* (*Thalysias*) *reinwardti* Vosmaer, 1880, and sponges in the genera *Haliclona* and *Tedania*, and among coral rubble in the Ryukyus Archipelago (White and Reimer 2012b).

Distribution: South China Sea: Penghu, and Dongsha Atoll, Taiwan; Philippine Sea: Green Island, Taiwan (present study); East China Sea: Iriomote Island, Okinawa Island (both Okinawa), Tokunoshima Island, Amami-oshima Island, Yakushima Island (all Kagoshima), Japan (White and Reimer 2012b).

***Leucothoe kebukai* White and Reimer, 2012c**
(Fig. 2G)

Leucothoe kebukai White and Reimer, 2012c: 34-38, figs. 11-12, 15E.

Material examined: 1 male, 1 female, 1 juvenile; KNW-Green-4B, Green Island Turtle Bay 22°38'31.04"N, 121°28'50.98"E, 20 m; 5 August 2013; K.N. White, collector. 1 male, 1 female; KNW-Dongsha-2017-4f, Dongsha Atoll southeast fore reef, 20°38'11.4"N, 116°54'25.85"E, 17 m; 22 May 2017; K.N. White, collector.

Ecology: This species lives inside a red sponge and among *Halimeda* and coral rubble in Taiwanese waters (present study); and among coral rubble in the Ryukyus Archipelago (White and Reimer 2012c).

Distribution: South China Sea: Dongsha Atoll, Taiwan; Philippine Sea: Green Island, Taiwan (present study); East China Sea: Okinawa Island (Okinawa), Tokunoshima Island, Yakushima Island (both Kagoshima), Japan (White and Reimer

2012c).

***Leucothoe lecrovae* White and Reimer, 2012b**
(Fig. 2H)

Leucothoe lecrovae White and Reimer, 2012b: 20-24, figs. 9-10, 23C.

Material examined: 2 males, 4 females; KNW-Peng-2A, Penghu, Chin Wan Inner Bay, 23°31'75.1"N, 119°33'59.3"E, 1 m; 30 July 2013; K.N. White, collector. 1 male, 5 females; KNW-Green-2A, Green Island Cshin-lang, 22°39'13.19"N, 121°29'37.70"E, 8 m; 4 August 2013; K.N. White, collector.

Ecology: This species lives among coral rubble in Taiwanese waters (present study) and in sponges of the genus *Rhadastrella* sp. and family Axinellidae (dark red chimney and orange lumpy), and among coral rubble in the Ryukyus Archipelago (White and Reimer 2012b).

Distribution: Philippine Sea: Green Island, Taiwan (present study); East China Sea: Okinawa Island (Okinawa), Amami-oshima Island, Yakushima Island (both Kagoshima), Japan (White and Reimer 2012b).

***Leucothoe obuchii* White and Reimer, 2012a**
(Fig. 3A)

Leucothoe obuchii White and Reimer, 2012a: 31-34, figs. 9-10, 17E.

Material examined: 1 male, 1 female; KNW-Green-1A, Green Island Chiakou, 22°40'34.72"N, 121°28'59.91"E, 10 m; 4 August 2013; K.N. White, collector. 2 males, 2 females; KNW-Green-2B, Green Island Cshin-lang, 22°39'13.19"N, 121°29'37.70"E, 8 m; 4 August 2013; K.N. White, collector.

Ecology: This species lives in the branchial chamber of *Pyura* sp. ascidians and among coral rubble in Taiwanese waters (present study) and in the branchial chamber of *Rhopalaea circula* and *Rhopalaea* sp. ascidians and among coral rubble in the Ryukyus Archipelago (White and Reimer 2012a).

Distribution: Philippine Sea: Green Island, Taiwan (present study); East China Sea: Okinawa Island (Okinawa), Tokunoshima Island, Amami-oshima Island, and Yakushima Island (all Kagoshima), Japan (White and Reimer 2012a).

***Leucothoe ouraensis* White and Reimer, 2012b**
(Fig. 3B)

Leucothoe ouraensis White and Reimer, 2012b: 32-26, figs. 15-16, 23E.

Material examined: 2 females; KNW-Green-4C, Green Island Turtle Bay, 22°38'31.04"N, 121°28'50.98"E, 20 m; 5 August 2013; K.N. White, collector. 1 female; KNW-Dongsha-2017-9i, Dongsha Atoll, northeast fore reef, 20°46'52.11"N, 116°48'10.81"E, 17.7 m; 24 May 2017; K.N. White, collector. 4 males, 8 females; KNW-Dongsha-2017-10c, Dongsha Atoll southwest fore reef, 20°35'58.45"N, 116°45'05.55"E, 12 m; 26 May 2017; K.N. White, collector. 1 male; KNW-Dongsha-2017-11e, Dongsha Atoll, southwest lagoon, 20°39'32.00"N, 116°45'14.68"E, 5 m; 26 May 2017; K.N. White, collector. 1 female; KNW-Dongsha-2017-13c, Dongsha Atoll, south fore reef, 20°35'08.62"N, 116°47'28.67"E, 20 m; 30 May 2017; K.N. White, collector.

Ecology: This species lives inside soft red and red orange sponges and among coral rubble in Taiwanese waters (present study) and inside sponges of the genus *Mycale* (brown-red chimney and bivalve-encrusting) and *Mycale* (*Zygomycale*) *parishii* (Bowerbank, 1875), and among coral rubble in the Ryukyus Archipelago (White and Reimer 2012b).

Distribution: South China Sea: Dongsha Atoll, Taiwan; Philippine Sea: Green Island, Taiwan (present study); East China Sea: Okinawa-jima Island, Okinawa, Japan (White and Reimer 2012b).

***Leucothoe togatta* White and Reimer, 2012b**
(Fig. 3C)

Leucothoe togatta White and Reimer, 2012b: 36-40, figs. 17-18, 23G.

Material examined: 1 female; KNW-Peng-3A, Penghu, Dong Gee, 23°15'21.8"N, 119°39'95.9"E, 10 m; 31 July 2013; K.N. White, collector. 1 female; KNW-Peng-3D, Penghu, Dong Gee, 23°15'21.8"N, 119°39'95.9"E, 10 m; 31 July 2013; K.N. White, collector. 1 female; KNW-Peng-4B, Penghu, Go Sha Zai, 23°22'70.2"N, 119°31'98.4"E, 7 m; 31 July 2013; K.N. White, collector. 1 male; KNW-Green-1D, Green Island Chiakou, 22°40'34.72"N, 121°28'59.91"E, 10 m; 4 August 2013; K.N. White, collector. 1 male; KNW-Dongsha-2017-7d, Dongsha Atoll, northeast fore reef, 20°46'52.26"N, 116°45'51.50"E, 17.8 m; 23 May 2017; K.N. White, collector. 1 male, 2 females; KNW-Dongsha-

2017-8e, Dongsha Atoll, northwest fore reef, 20°46'23.75"N, 116°45'58.78"E, 17.4 m; 24 May 2017; K.N. White, collector.

Ecology: In hard brown bumpy sponges and among coral rubble (present study); In hard brown sponges of the genus *Jaspis*, and among coral rubble (White and Reimer 2012b).

Distribution: South China Sea: Penghu and Dongsha Atoll, Taiwan; Philippine Sea: Green Island, Taiwan (present study); East China Sea: Okinawa Island (Okinawa), Yakushima Island (Kagoshima), Japan. (White and Reimer 2012b).

***Leucothoe toribe* White and Reimer, 2012b**
(Fig. 3D)

Leucothoe toribe White and Reimer, 2012b: 41-44, figs. 19-20, 23H.

Material examined: 3 males, 3 females, 2 juveniles; KNW-Green-2F, Green Island Cshinlang, 22°39'13.19"N, 121°29'37.70"E, 8 m; 4 August 2013; K.N. White, collector. 1 male, 1 female; KNW-Dongsha-2017-5f, Dongsha Atoll southeast fore reef, 20°36'58.57"N, 116°53'14.78"E, 15 m; 22 May 2017; K.N. White, collector. 2 males, 4 females, 2 juveniles; KNW-Dongsha-2017-6b,d,e, Dongsha Atoll east fore reef, 20°40'38.18"N, 116°55'31.30"E, 17.4 m; 23 May 2017; K.N. White, collector. 1 male; KNW-Dongsha-2017-8h, Dongsha Atoll, northwest fore reef, 20°46'23.75"N, 116°45'58.78"E, 17.4 m; 24 May 2017; K.N. White, collector.

Ecology: This species lives inside red sponges and among coral rubble in Taiwanese waters (present study) and inside *Clathria* (*Thalysias*) *reinwardti* sponges and among coral rubble in the Ryukyus Archipelago (White and Reimer 2012b).

Distribution: South China Sea: Dongsha Atoll, Taiwan; Philippine Sea: Green Island, Taiwan (present study); East China Sea: Okinawa Island (Okinawa), Yakushima Island (Kagoshima), Japan (White and Reimer 2012b).

***Leucothoe trulla* White and Reimer, 2012a**
(Fig. 3E)

Leucothoe trulla White and Reimer, 2012a: 34-38, figs. 11-12, 17F.

Material examined: 3 males, 6 females; KNW-Dongsha-2017-1a,c, Dongsha Atoll north beach, 20°42'18.26"N, 116°43'43.29"E, 1.5 m; 29 May 2017; K.N. White, collector. 1 male, 5

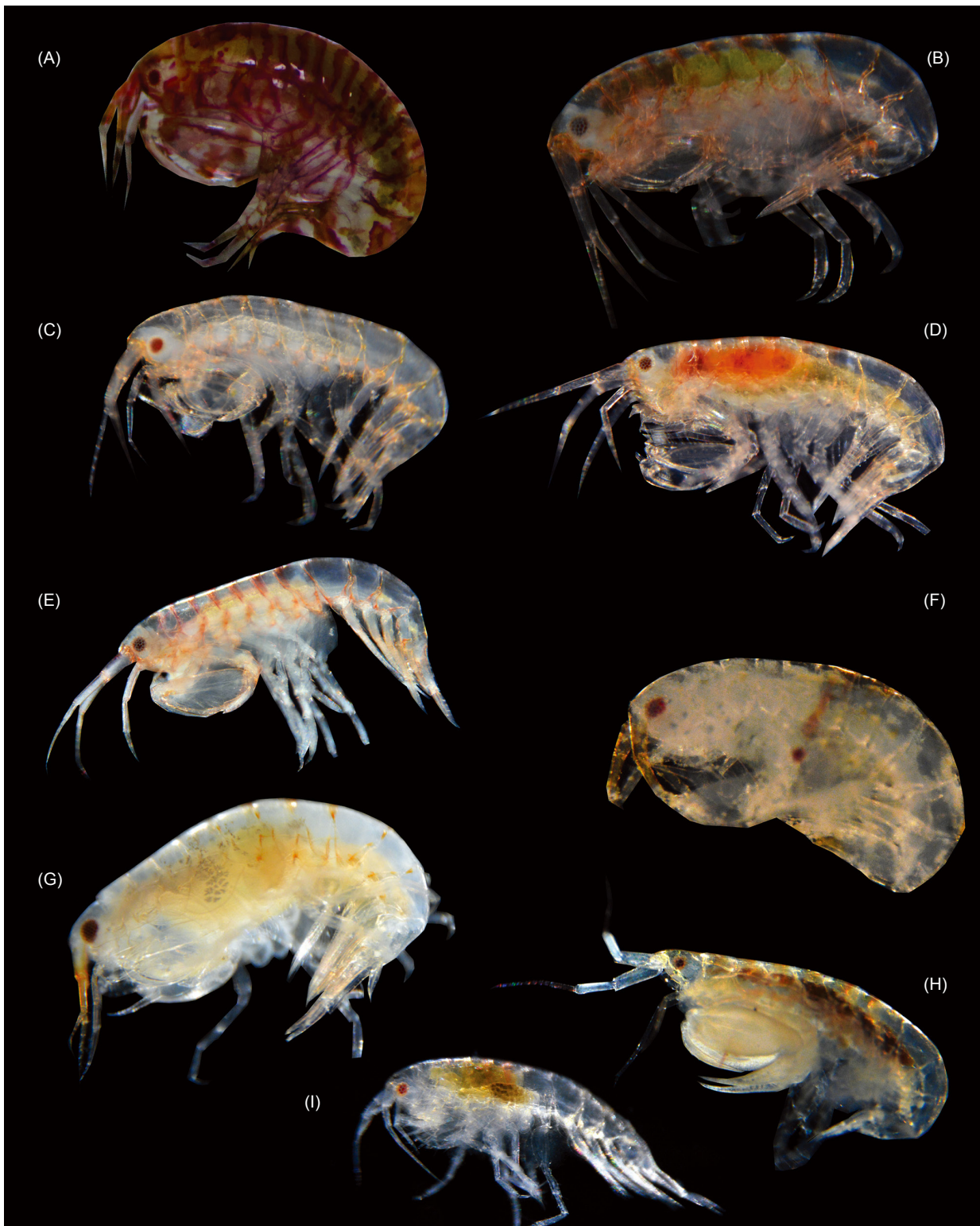


Fig. 3. (A) *Leucothoe obuchii* White and Reimer, 2012a, male, KNW-Green-2B; (B) *Leucothoe ouraensis* White and Reimer, 2012b, female, KNW-Dongsha-2017-10c; (C) *Leucothoe togatta* White and Reimer, 2012b, male, KNW-Dongsha-2017-7d; (D) *Leucothoe toribe* White and Reimer, 2012b, female, KNW-Dongsha-2017-6b; (E) *Leucothoe trulla* White and Reimer, 2012a, male, KNW-Dongsha-2017-8a; (F) *Leucothoe batillum* sp. nov., male, KNW-Dongsha-2017-3f; (G) *Leucothoe cracentis* sp. nov., female, KNW-Dongsha-2017-4b; (H) *Paranamixis lunata* sp. nov., male anamorph, KNW-Dongsha-2017-7a; (I) *Paranamixis lunata* sp. nov., female leucomorph, KNW-Dongsha-2017-9a.

females, 1 juvenile; KNW-Dongsha-2017-2a,b,e,i, Dongsha Atoll northwest beach, 20°42'18.26"N, 116°43'43.29"E, 1.5 m; 19 May 2017; K.N. White, collector. 1 male, 2 females; KNW-Dongsha-2017-8c, Dongsha Atoll, northwest fore reef, 20°46'23.75"N, 116°45'58.78"E, 17.4 m; 24 May 2017; K.N. White, collector. 7 females; KNW-Dongsha-2017-12c, Dongsha Atoll south beach, 20°47'57.48"N, 116°43'24.07"E, 1.7 m; 27 May 2017; K.N. White, collector.

Ecology: This species lives inside *Haliclona simmiformes* sponges, sponges of the genera *Cinachyrella* and *Cladocroca*, and among *Halimeda* and coral rubble in Taiwanese waters (present study) and in the branchial chamber of *Herdmania* ascidians and among coral rubble in the Ryukyu Archipelago (White and Reimer 2012a).

Distribution: South China Sea: Dongsha Atoll, Taiwan (present study); East China Sea: Ishigaki Island and Iriomote Island, Okinawa, Japan (White and Reimer 2012a).

***Leucothoe batillum* sp. nov.**

(Figs. 3F, 4-5)

urn:lsid:zoobank.org:act:4884D455-66F6-4FDE-84E7-A77F1D08D94A

Material Examined: Holotype: male, 4.3 mm, NMMB-CD 5583 KNW-Dongsha-2017-1d, Dongsha Atoll north beach, 20°42'18.26"N, 116°43'43.290"E, 1.5 m, 29 May 2017, K.N. White collector. Paratype: female, 4.1 mm, NMMB-CD 5584, same station data as Holotype.

Other: 1 male, 1 female, 1 juvenile; ASIZCR000421, KNW-Dongsha-2017-3f, Dongsha Atoll lagoon, 20°42'14.76"N, 116°48'17.2074"E, 11 m; 21 May 2017; K.N. White, collector. 4 females, 1 juvenile; KNW-Dongsha-2017-12d, Dongsha Atoll south beach, 20°47'57.48"N, 116°43'24.07"E, 1.7 m; 27 May 2017; K.N. White, collector.

Etymology: From the Latin '*batillum*' meaning 'shovel, fire pan' and referring to the shovel-like gnathopod 2 carpus in males of this species, used as noun in apposition.

Diagnosis: Head anterior margin round. Ventral cephalic keel anterior margin excavate, anteroventral margin quadrate with a simple cusp. Eyes oval (Fig. 4A). Accessory flagellum present, 1-articulate (Fig. 4B). Gnathopod 1 dactylus reaching 0.2 × propodus length (Fig. 4C). Gnathopod 2 carpus distally truncate, resembling a shovel, serrate; propodus with one mediofacial

setal row slightly displaced toward midline (Fig. 4F). Telson apex evenly rounded (Fig. 5B).

Description (male holotype): Head: Anterior margin rounded, anterodistal margin evenly rounded; ventral cephalic keel anterior margin excavate, anteroventral margin quadrate with a simple cusp, ventral margin oblique; eyes with more than 10 ommatidia, oval. Antenna 1 0.3 × body length, flagellum 7-articulate, peduncle article 1 width slightly wider than article 2 (Fig. 4A), accessory flagellum present, 1-articulate (Fig. 4B). Antenna 2 0.2 × body length, shorter in length than antenna 1, flagellum 3-articulate (Fig. 4A).

Mandibular palp ratio of articles 1-3 1.0:3.2:2.0, article 2 with 6 marginal setae, article 3 with 2 distal setae, incisors weakly dentate (Fig. 5F); left mandible with 13 raker spines, lacinia mobilis large, weakly toothed (Fig. 5E); right mandible with 13 raker spines, lacinia mobilis small (Fig. 5F). Maxilla 1 palp 2-articulate, with 4 distal slender setae; outer plate with 6 distal robust setae and 3 slender setae (Fig. 4H). Maxilla 2 inner plate with 7 marginal and distal robust setae, outer plate with 3 distal robust setae and several slender marginal setae (Fig. 4G). Maxilliped inner plates distal margin rounded, with short simple robust setae; outer plate inner margin smooth, reaching 0.4 × palp article 1; palp article 4 thick, subequal in length with article 3, distally acute (Fig. 5G).

Pereon: Coxae 1-4 relative widths 1.0: 1.2: 0.8: 1.4 (Fig. 4A).

Gnathopod 1 coxa anterodistal margin produced with notch, distal margin straight, posterior margin concave; basis distally slightly expanded, anterior margin with 3 short setae, posterior margin bare; ischium bare (Fig. 4C); carpus curved, distal length 9 × width, distally very narrow, smooth, anterior margin with small short setae (Fig. 4E); propodus straight, palm dentate with short setae; dactylus smooth, reaching 0.2 × propodus length (Fig. 4D).

Gnathopod 2 coxa subquadrate, wider than coxa 3, smooth, margins slightly rounded; basis slightly distally expanded, anterior margin with 4 short setae, posterior margin with 1 distal seta; ischium with 1 distal seta; carpus 0.4 × propodus length, curved, setose, distally truncate, resembling a shovel, serrate; propodus with one mediofacial setal row slightly displaced to midline, reaching 0.8 × propodus length, submarginal setal row of 6 setae, anterior margin gently curved, smooth, palm with 5 medium tubercles; palmar corner clearly defined as prominent hump, remaining posterior margin straight; dactylus curved, proximal margin

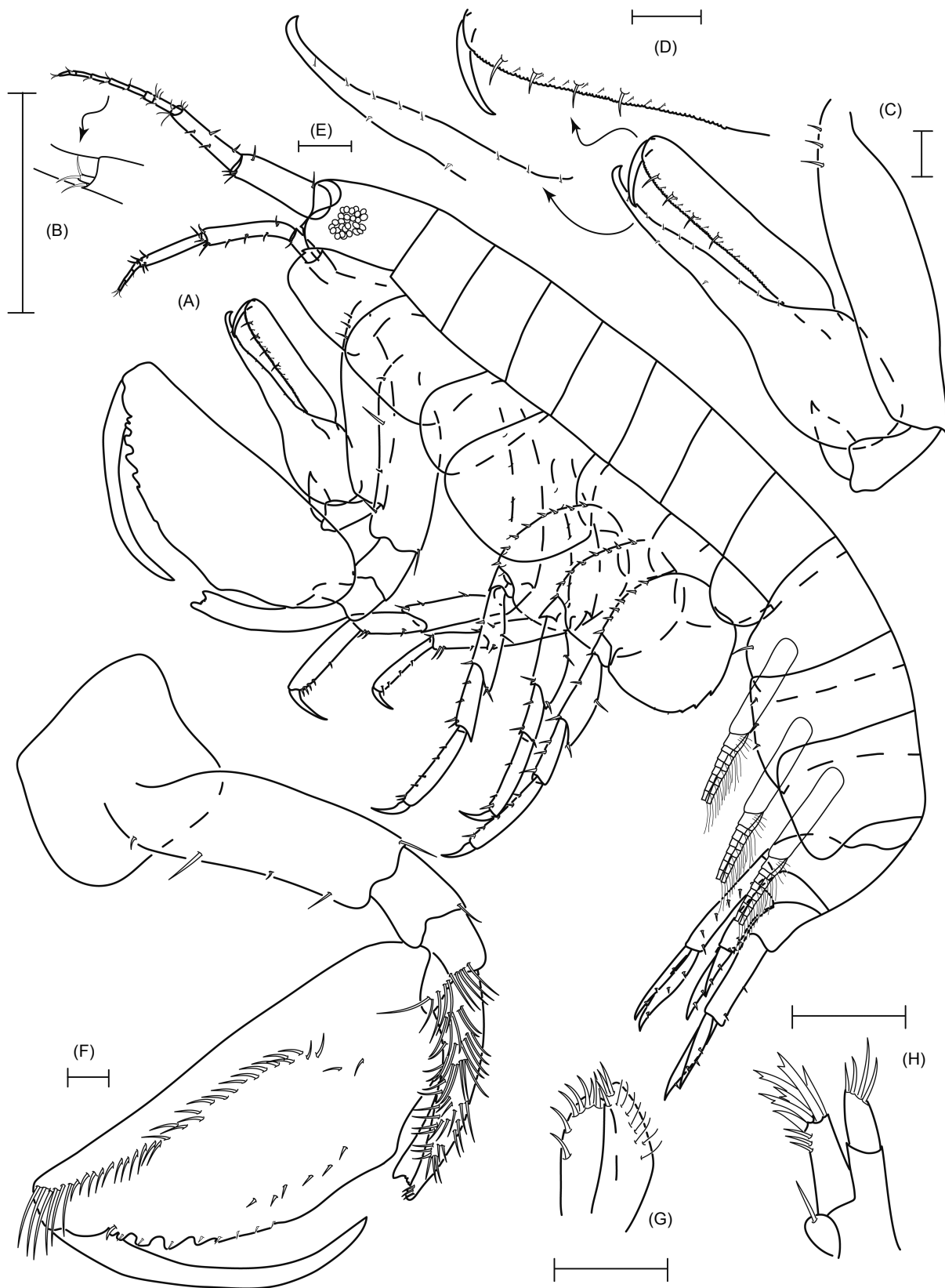


Fig. 4. *Leucothoe batillum* sp. nov. male holotype, scale bars represent 0.1 mm; (A) Habitus; (B) Antenna 1 enlarged; (C) Gnathopod 1 medial; (D) Gnathopod 1 propodus enlarged; (E) Gnathopod 1 carpus enlarged; (F) Gnathopod 2 medial; (G) Maxilla 2; (H) Maxilla 1.

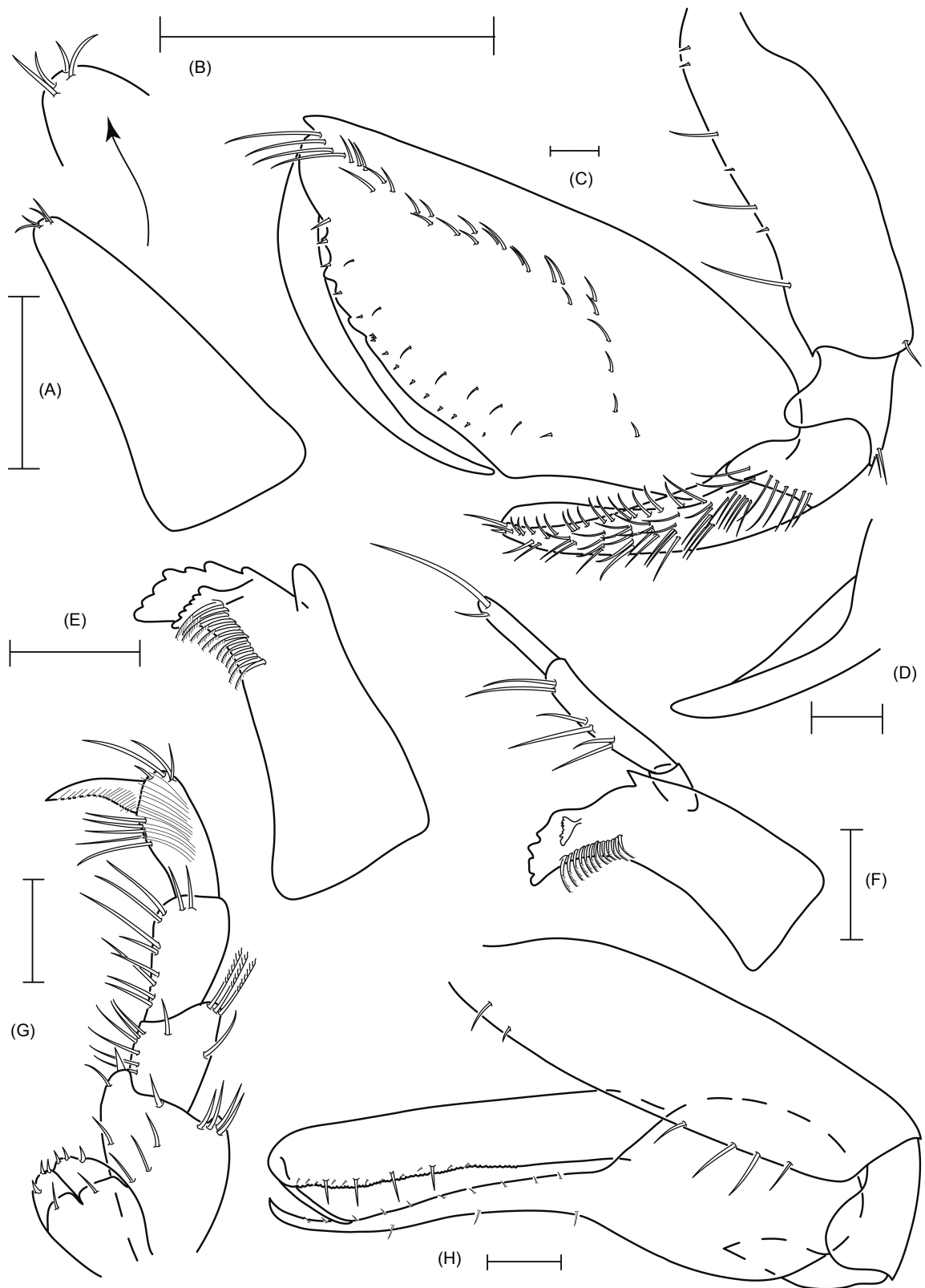


Fig. 5. *Leucothoe batillum* sp. nov. male holotype and female paratype, scale bars represent 0.1 mm; (A) male telson; (B) male telson enlarged; (C) female Gnathopod 2 medial; (D) female Gnathopod 2 carpus lateral; (E) male left Mandible; (F) male right Mandible; (G) male Maxilliped; (H) female Gnathopod 1 medial.

smooth, bare, anterior margin distally acute, reaching $0.6 \times$ propodus length (Fig. 4F).

Pereopod 3 coxa smooth, anterior margin rounded, distal margin rounded, oblique, posterior margin straight. Pereopod 4 coxa smooth, anterior margin expanded, distal margin straight, posterior margin convex. Pereopods 5-7 bases width length ratios 1: 1.1, 1: 1.1, 1:1.0, posterior margins bare; pereopods 5-6 bases posterior margins smooth, pereopod 7 basis posterior margin serrate (Fig. 4A).

Pleon: Epimeron 1 anterodistal margin with 1 seta; Epimeron 2 distal margin with 3 setae; Epimeron 3 bare, posteroventral corner rounded (Fig. 4A). Uropods 1-3 relative lengths 1.0: 0.6: 0.8. Uropod 1 peduncle $1.3 \times$ inner ramus length, outer ramus $0.9 \times$ inner ramus length; inner and outer rami each with 3 robust setae. Uropod 2 peduncle $0.9 \times$ inner ramus length, outer ramus $0.7 \times$ inner ramus length; inner and outer rami each with 2 robust setae. Uropod 3 peduncle subequal in length with inner ramus, outer ramus $0.8 \times$ inner ramus length; inner and outer rami each with 2 robust setae (Fig. 4A). Telson $2.1 \times$ longer than wide (Fig. 5A), apex rounded, beset with four short setae (Fig. 5B).

Female paratype (sexually dimorphic characters): Gnathopod 1 basis anterior margin with six short setae (Fig. 5H). Gnathopod 2 carpus distally tapered, smooth, not spoon-like; propodus palm with 3 small tubercles (Fig. 5C).

Color pattern: When alive this species has yellow antenna 1 peduncle articles 1 and 2, a red-orange striped "saddle" pattern on pereonites 2-5, and a red dot coxa 4 (Fig. 3F).

Ecology: This species was collected among *Halimeda* and coral rubble.

Relationships: *Leucothoe batillum* sp. nov. resembles *Leucothoe assimilis* Barnard, 1974, *Leucothoe epidemos* White and Thomas, 2009, *Leucothoe makromatos* White and Thomas, 2009, *Leucothoe tarte* Barnard, 1974, and *Leucothoe trulla* White and Reimer, 2012a in having a round anterior head margin, a long gnathopod 1 dactylus, and a truncate gnathopod 2 carpus. The shovel-shape of the gnathopod 2 carpus is unique to *L. batillum* sp. nov., with the carpus of all of the other species being more fluted or spoon-like. The displaced mediofacial setal row on gnathopod 2 propodus is shared with *L. makromatos* and *L. trulla*. The other species listed here have a mediofacial setal row above the midline. The rounded telson found in *L. batillum* sp. nov. is not shared by any of these species, with a blunt simple

telson in *L. assimilis* and a tridentate tip found in the other species.

Distribution: Dongscha Atoll, Taiwan (present study).

Leucothoe cracentis sp. nov.

(Figs. 3G, 6-7)

urn:lsid:zoobank.org:act:457D5DF7-464A-46B1-BEE0-315C9AA6930A

Material Examined: Holotype: male, 1.8 mm, NMMB-CD 5585, KNW-Dongscha-2017-4b, Dongscha Atoll southeast fore reef, $20^{\circ}38'11.4''\text{N}$, $116^{\circ}54'25.85''\text{E}$, 17 m; 22 May 2017; K.N. White, collector. Paratype: female, 2.2 mm, NMMB-CD 5586, same station data as Holotype.

Other: 1 male, 2 females, ASIZCR000422, same station data as Holotype. 2 males, 3 females, same station data as Holotype.

Etymology: Derived from the Latin '*cracens*' meaning 'slender, graceful, neat' and referring to the overall appearance of gnathopod 1.

Diagnosis: Head anterior margin oblique, produced, distal margin straight. Eyes round. Accessory flagellum present, 1-articulate. Mandibular palp article 3 short, $0.9 \times$ length of article 1. Gnathopod 1 carpus stout, anterior margin dentate; propodus slightly inflated, palm smooth; dactylus reaching $0.1 \times$ propodus length. Gnathopod 2 carpus distally truncate, serrate. Pereopods 5-6 bases anterior and posterior margins nearly parallel, pereopod 7 basis posteriorly moderately produced.

Description (male holotype): Head: Anterior margin oblique, produced, distal margin straight; ventral cephalic keel anterior margin excavate, anteroventral margin rounded, ventral margin straight; eyes with more than 20 ommatidia, round.

Antenna 1 $0.5 \times$ body length, flagellum 7-articulate, peduncle article 1 width subequal to article 2, accessory flagellum present, 1-articulate. Antenna 2 $0.4 \times$ body length, shorter in length than antenna 1, flagellum 5-articulate.

Mandibular palp ratio of articles 1-3 1.0:2.3:0.9, article 2 with 2 marginal setae, article 3 with 2 distal setae, incisors nearly smooth; left mandible with 12 raker spines, lacinia mobilis large, strongly toothed; right mandible broken. Maxilla 1 palp 2-articulate, with 3 distal slender setae; outer plate with 2 distal robust spines, 4 distal robust setae and 3 slender setae. Maxilla 2 inner plate with 2 marginal and 4 distal slender setae, outer plate with 3 distal slender setae. Lower lip inner lobes with moderate gape (Fig.

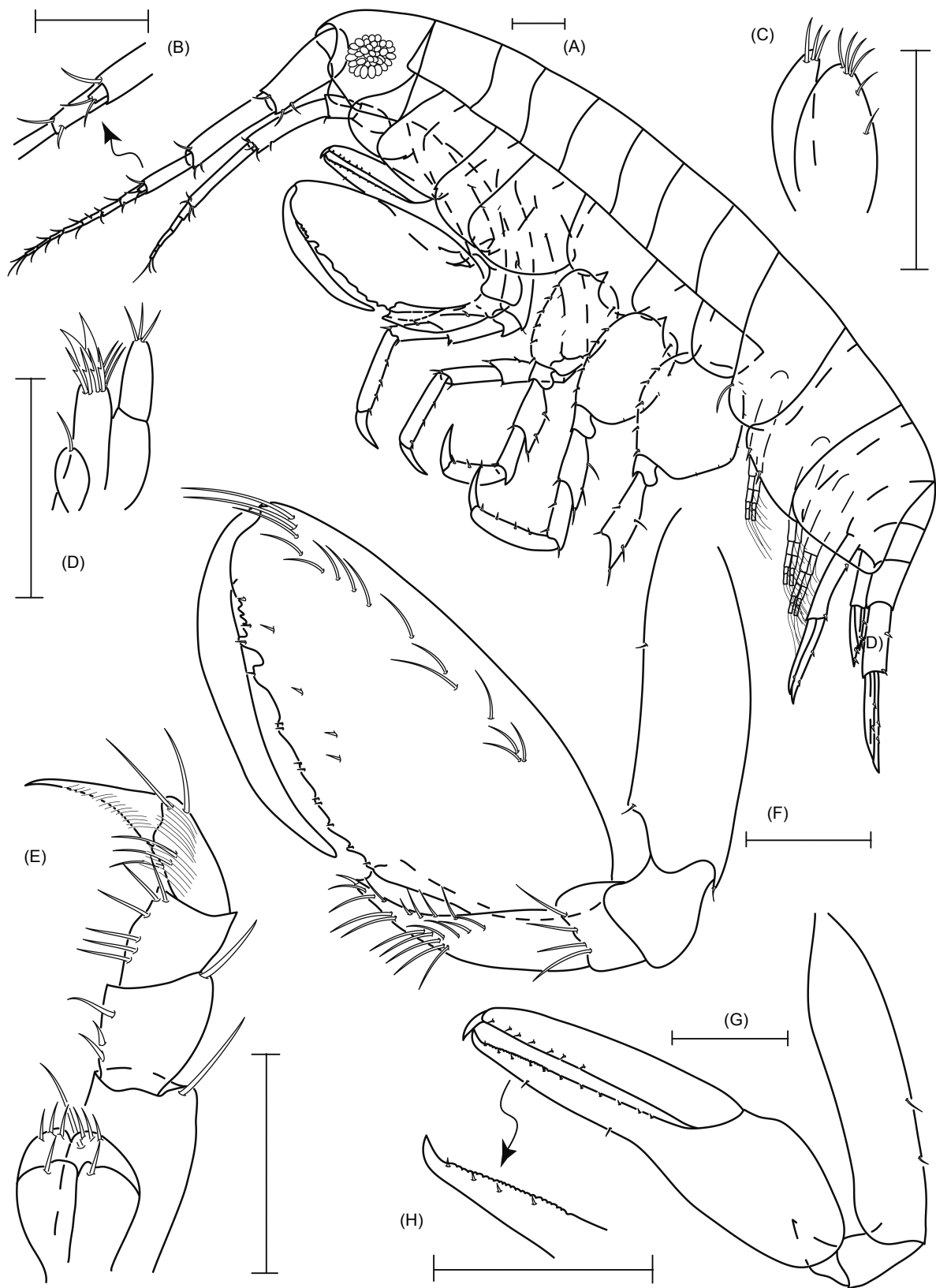


Fig. 6. *Leucothoe cracentis* sp. nov. male holotype, scale bars represent 0.1 mm; (A) Habitus; (B) Antenna 1 enlarged; (C) Maxilla 2; (D) Maxilla 1; (E) Maxilliped; (F) Gnathopod 2 medial; (G) Gnathopod 1 medial; (H) Gnathopod 1 carpus enlarged.

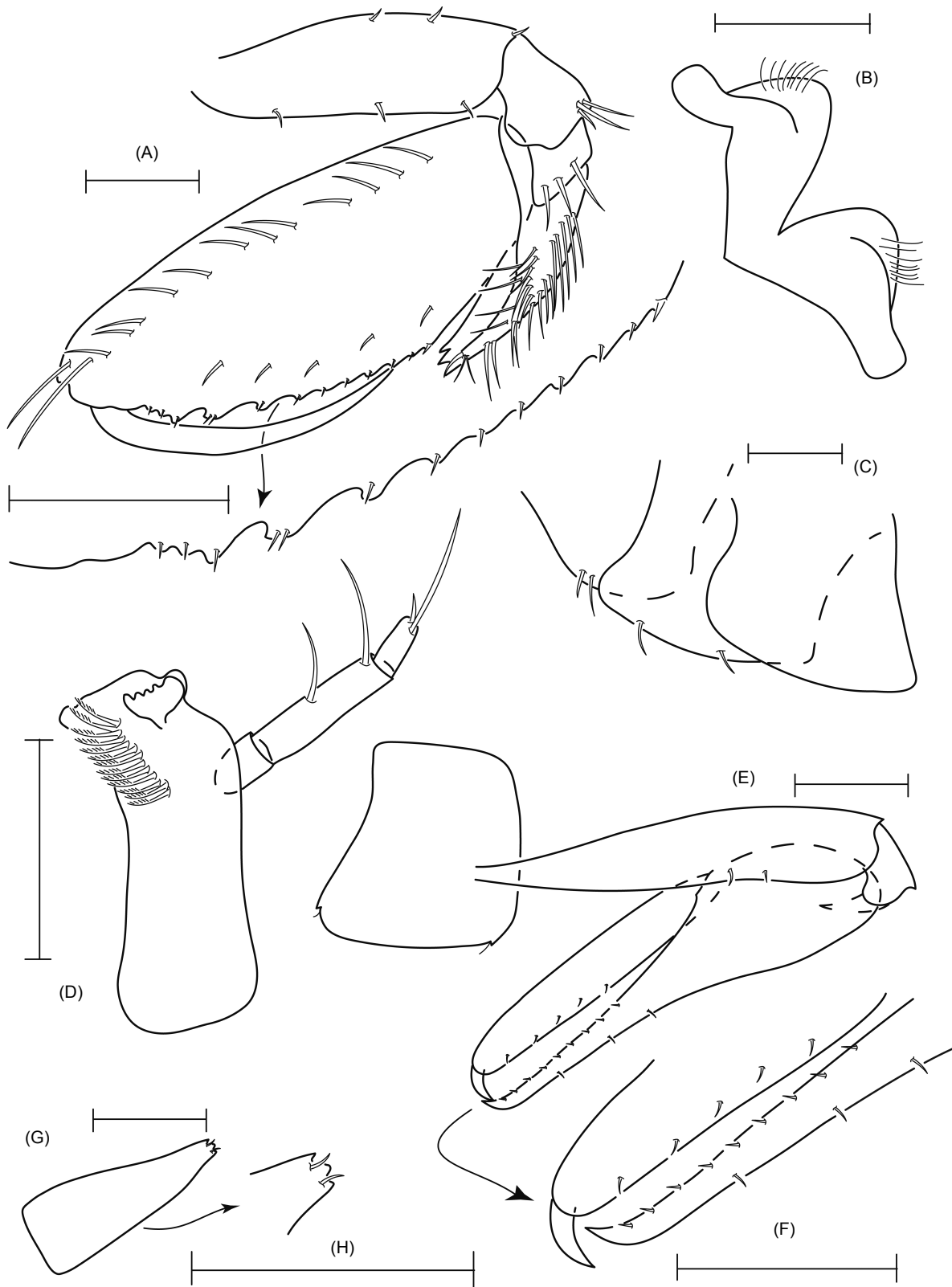


Fig. 7. *Leucothoe cracentis* sp. nov. female paratype, scale bars represent 0.1 mm; (A) Gnathopod 2 medial; (B) Lower lip; (C) Epimeron 1-3; (D) left Mandible; (E) Gnathopod 1 medial; (F) Gnathopod 1 propodus and carpus enlarged; (D); (G) Telson; (H) Telson enlarged.

7B). Maxilliped inner plates distal margin rounded, v-shaped, with short simple robust setae; outer plate inner margin smooth, not extended up toward palp article 1; palp article 4 subequal in length with article 3, distally narrowing and acute.

Pereon: Coxae 1-4 relative widths 1.0: 1.1: 1.1: 1.4. Gnathopod 1 coxa anterodistal margin produced, rounded, distal margin rounded with posterior notch, posterior margin convex; basis slightly distally expanded, anterior margin bare, posterior margin with 2 short setae; ischium bare; carpus distally curved, distal length $9 \times$ width, anterior margin dentate with small short setae; propodus slightly inflated, palm smooth with short setae; dactylus smooth, reaching $0.1 \times$ propodus length.

Gnathopod 2 coxa subquadrate, subequal in width with coxa 3, smooth, margins slightly rounded; basis not expanded, stout, anterior margin with 2 short setae, posterior margin bare; ischium bare; carpus $0.4 \times$ propodus length, curved, setose, distally truncate, serrate; propodus with one high mediofacial setal row reaching $0.7 \times$ propodus length, submarginal setal row with 4 setae, anterior margin gently curved, smooth, palm with 2 large and many small tubercles; posterior margin straight; dactylus curved, proximal margin smooth, bare, anterior margin distally subacute, reaching $0.6 \times$ propodus length.

Pereopod 3 coxa anterior margin straight, distal margin slightly rounded with anterior and posterior notches, posterior margin straight. Pereopod 4 coxa smooth, antero-distally produced, anterior margin straight, distal margin rounded, posterior margin tapered. Pereopods 5-7 bases width length ratios 1: 1.5, 1: 1.3, 1:1.1, posterior margins smooth and setose; pereopods 5-6 bases with anterior and posterior margin nearly parallel, pereopod 7 basis posteriorly moderately produced.

Pleon: Epimeron 1 with 1 long anterodistal seta; epimeron 2 distal margin with 2 short setae; epimeron 3 bare, posteroventral corner subquadrate. Uropods 1-3 relative lengths 1.0: 0.7: 1.0. Uropod 1 peduncle subequal in length with inner ramus, outer ramus $0.9 \times$ inner ramus length; inner ramus with 2 robust setae; outer ramus with 1 robust seta. Uropod 2 peduncle $0.9 \times$ inner ramus length, outer ramus $0.7 \times$ inner ramus length; inner and outer rami each with 2 robust setae. Uropod 3 peduncle $0.7 \times$ inner ramus length, outer ramus $0.9 \times$ inner ramus length; inner and outer rami each with 2 robust setae. Telson $1.9 \times$ longer than wide, apex tridentate, beset with two short setae.

Female (sexually dimorphic characters):

Gnathopod 1 basis distally expanded, anterior margin with 2 short setae, posterior margin bare; carpus anterior margin smooth. Gnathopod 2 mediofacial setal row reaching $0.8 \times$ propodus length. Epimeron 1 with 2 anterodistal setae.

Color pattern: When alive this species has yellow antennae and a white snowflake pattern on coxa 4.

Ecology: This species was collected among coral rubble.

Relationships: *Leucothoe cracentis* sp. nov. resembles *Leucothoe alata* Barnard, 1959, *Leucothoe dentata* Ledoyer, 1973, *Leucothoe lihue* Barnard, 1970, *Leucothoe micronesiae* Barnard, 1965, *Leucothoe rudicula* White and Thomas, 2009, in having round eyes, gnathopod 1 with stout carpus and short dactylus. *L. cracentis* is unique in having a strongly dentate gnathopod 1 carpus anterior margin. The distally truncate gnathopod 2 carpus is also shared with *L. alata*, *L. lihue*, *L. rudicula*, and *Leucothoe venetiarum* Soika, 1949, but it is only serrate in *L. cracentis* sp. nov. The short mandibular palp article 3 is shared with *L. alata*, *L. lihue*, and *L. micronesiae*.

Distribution: Dongsha Atoll, Taiwan (this study).

Genus *Paranamixis* Schellenberg, 1938

Paranamixis lunata sp. nov.

(Figs. 3H-I, 8-9)

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Material examined: Holotype: male anamorph, 2.6 mm, NMMB-CD 5587, KNW-Dongsha-2017-7a, Dongsha Atoll, northeast fore reef, $20^{\circ}46'52.26''\text{N}$, $116^{\circ}45'51.50''\text{E}$, 17.8 m; 23 May 2017; K.N. White, collector. Paratypes: male leucomorph, 1.9 mm, NMMB-CD 5588, same station data as Holotype; female leucomorph, 2.1 mm, NMMB-CD 5589, KNW-Dongsha-2017-9a, Dongsha Atoll, northeast fore reef, $20^{\circ}46'52.11''\text{N}$, $116^{\circ}48'10.81''\text{E}$, 17.7 m; 24 May 2017; K.N. White, collector.

Other: 5 anamorph males, 2 leucomorph males, 9 leucomorph females; KNW-Dongsha-2017-1b,f Dongsha Atoll north beach, $20^{\circ}42'18.26''\text{N}$, $116^{\circ}43'43.29''\text{E}$, 1.5 m; 29 May 2017; K.N. White, collector. 1 leucomorph female; KNW-Dongsha-2017-3m, Dongsha Atoll lagoon, $20^{\circ}42'14.76''\text{N}$, $116^{\circ}48'17.2074''\text{E}$, 11 m; 21 May 2017; K.N. White, collector. 1 anamorph male, 1 leucomorph female; KNW-Dongsha-2017-10b, Dongsha Atoll southwest fore reef, $20^{\circ}35'58.45''\text{N}$,

116°45'05.55"E, 12 m; 26 May 2017; K.N. White, collector. 1 anamorph male, 1 leucomorph male, 3 leucomorph females, 2 leucomorph juveniles; ASIZCR000423, KNW-Dongsha-2017-11a, Dongsha Atoll southwest lagoon, 20°39'32.00"N, 116°45'14.68"E, 5 m; 26 May 2017; K.N. White, collector. 4 anamorph males, 1 leucomorph male, 9 leucomorph females, 5 leucomorph juveniles; KNW-Dongsha-2017-12a,b, Dongsha Atoll south beach, 20°47'57.48"N, 116°43'24.07"E, 1.7 m; 27 May 2017; K.N. White, collector.

Etymology: From the Latin '*lunatus*' meaning 'shaped like a crescent moon' in reference to the crescent-shaped ventral cephalic keel in male anamorphs of this species.

Diagnosis: Head anterior margin rounded with anterodistal cusp. Ventral cephalic keel concave, crescent-shaped (Fig. 8B). Gnathopod 2 coxa with midventral notch (Fig. 8A); basis with anteroproximal and mediodistal serrate ridges; propodus palm convex (Fig. 8G).

Description (male anamorph holotype): Head: Anterior margin rounded, anterodistal margin with cusp, distal margin slightly rounded; ventral cephalic keel anterior margin concave, anteroventral margin with sharp point, ventral margin oblique; eyes present with more than 10 ommatidia, round (Fig. 8B).

Antenna 1 $0.4 \times$ body length, flagellum 8-articulate, peduncle article 1 width less than $2 \times$ article 2, accessory flagellum absent. Antenna 2 $0.3 \times$ body length, shorter than antenna 1, flagellum 3-articulate (Fig. 8A). Mouthparts reduced. Maxilliped inner and outer plates smooth, lacking inner lobes; palp 4-articulate, palp article 4 elongate, slender, strongly recurved (Fig. 8H).

Pereon: Coxae 1-4 relative widths 1.0: 1.7: 1.6: 1.9 (Fig. 8A).

Gnathopod 1 coxa reduced, smooth, bare. Gnathopod 1 absent. Gnathopod 2 coxa longer than broad, subequal in width with coxa 3, smooth, bare, anterior margin rounded, distal margin rounded with midventral notch (Fig. 8A); basis with anteroproximal and mediodistal serrate ridges, anterior margin with two short setae, posterior margin bare; carpus $0.8 \times$ propodus length, curved, distally tapered, anterior margin smooth; propodus with 1 mediofacial setal row reaching $0.6 \times$ propodus length, 1 submarginal setal row of five setae, posterior margin smooth, palm convex, with one large and several small triangular protrusions and small setae; dactylus curved, reaching $0.5 \times$ propodus length, proximal margin with excavation and two long setae, anterior margin distally

tapered, sub-acute (Fig. 8G).

Pereopod 3 coxa length $1.3 \times$ width, anterodistal corner overriding distal face of coxa 2, with postero-distal notch, anterior and posterior margins straight, distal margin rounded. Pereopod 4 coxa smooth, anterior margin rounded, distal margin rounded, posterior margin convex. Pereopods 5-7 coxae, facial setae absent. Pereopods 5-7 bases width: length ratios 1: 1.1, 1: 1.2, 1: 1.2, pereopods 5-6 posterior margins smooth, bare; pereopod 7 posterior margin serrate, setose (Fig. 8A).

Pleon: Epimera 1-3 bare, epimeron 2 posteroventral corner with notch, epimeron 3 posteroventral corner quadrate with slight projection. Uropods 1-3 relative lengths 1.0: 0.8: 0.9. Uropod 1 peduncle $0.9 \times$ inner ramus length, outer ramus $0.5 \times$ inner ramus length; inner ramus with 3 robust setae; outer ramus with 2 robust setae (Fig. 8E). Uropod 2 peduncle $0.7 \times$ inner ramus length, outer ramus $0.7 \times$ inner ramus length; inner ramus with 4 robust setae; outer ramus with 2 robust setae (Fig. 8D). Uropod 3 peduncle subequal in length with inner ramus, outer ramus $0.8 \times$ inner ramus length; inner ramus with 2 robust setae; outer ramus with 3 robust setae (Fig. 8C). Telson $1.4 \times$ longer than wide, apex rounded, beset with 2 small setae (Fig. 8F).

Description (female and male leucomorph): Head: Anterior margin truncate, anterodistal margin subquadrate, distal margin straight; eyes present with about 20 ommatidia, round. Antenna 1 $0.3 \times$ body length, flagellum 7-articulate, peduncle article 1 less than $2 \times$ width of article 2, accessory flagellum absent. Antenna 2 $0.2 \times$ body length, shorter than antenna 1, flagellum 3-articulate (Fig. 9A). Mandibles lost. Maxilla 1 palp 2-articulate, with 3 distal slender setae (Fig. 9C); outer plate lost. Maxilla 2 inner and outer plates each with 2-3 distal slender setae. Maxilliped outer plate vanishing; palp 4-articulate, article 4 subequal in length with article 3, distally acute (Fig. 9I).

Pereon: Coxae 1-4 relative widths 1.0: 0.8: 0.7: 1.0 (Fig. 9A).

Gnathopod 1 coxa smooth, distally expanded, anterior and distal margins rounded, posterior margin straight (Fig. 9A); basis long and smooth, anterior and posterior margins bare; ischium bare; carpus straight, distally thin, length $11 \times$ width (Fig. 9E), proximal margin serrate (Fig. 9F); propodus narrowing distally, palm irregularly serrate with 4 large 4 small marginal setae; dactylus minute (Fig. 9G). Gnathopod 2 coxa longer than broad, wider than coxa 3, smooth, anterior margin straight,

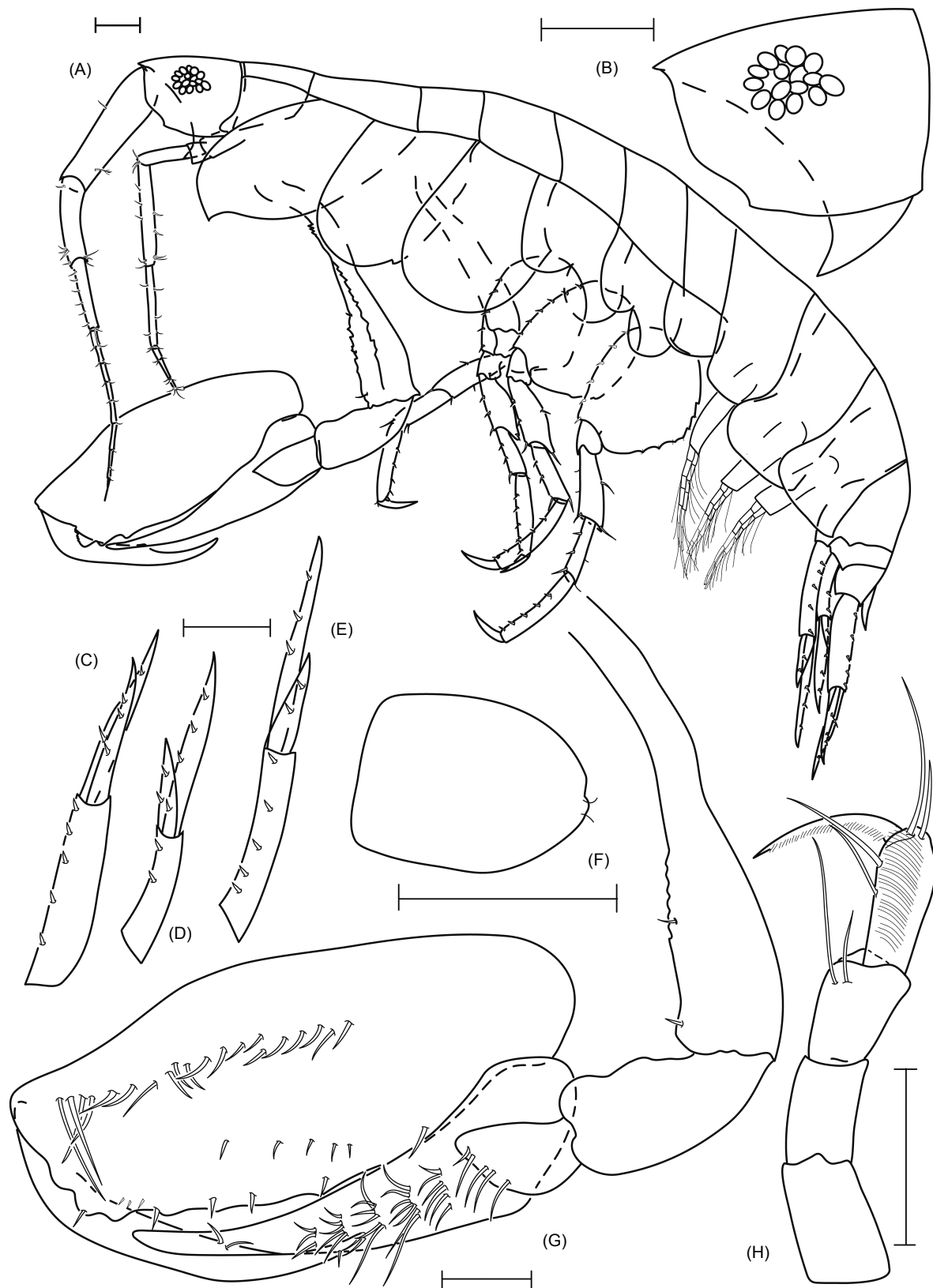


Fig. 8. *Paranamixis lunata* sp. nov. male anamorph holotype, scale bars represent 0.1 mm; (A) Habitus; (B) Head; (C) Uropod 3; (D) Uropod 2; (E) Uropod 1; (F) Telson; (G) Gnathopod 2 medial; (H) Maxilliped.

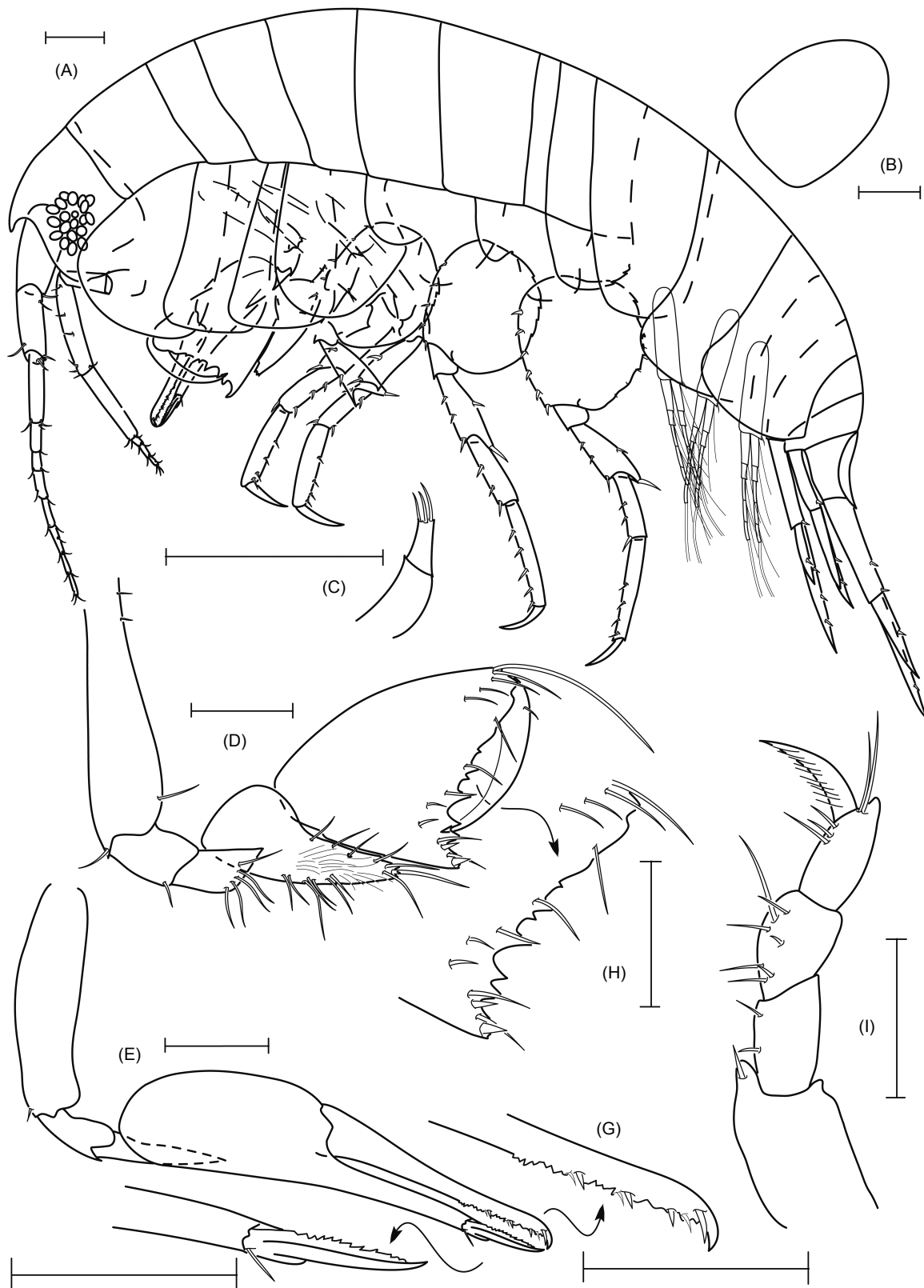


Fig. 9. *Paramixis lunata* sp. nov. female leucomorph paratype, scale bars represent 0.1 mm; (A) Habitus; (B) Telson; (C) Maxilla 1 palp; (D) Gnathopod 2 medial; (E) Gnathopod 1 medial; (F) Gnathopod 1 carpus enlarged; (G) Gnathopod 1 propodus enlarged; (H) Gnathopod 2 propodus enlarged; (I) Maxilliped.

anterodistal margin rounded, distal margin nearly straight, posterior margin straight (Fig. 9A); basis expanded distally, anterior margin with few short setae, posterior margin with 1 seta; ischium with one postero-distal seta; carpus $0.3 \times$ propodus length, straight, distally tapered, distal margin serrate, setose; propodus with 1 short mediofacial setal row, with row of submarginal setae, posterior margin smooth, posterior margin triangular (Fig. 9D), palm with triangular tubercles (Fig. 9H); dactylus strongly curved, distally acute, margins smooth, bare (Fig. 9D).

Pereopod 3 coxa length $1.8 \times$ width, anterodistal corner overriding distal face of coxa 2, smooth, anterior margin straight, distal margin slightly rounded, posterior margin straight. Pereopod 4 coxa smooth, anterior margin rounded, distal margin rounded, posterior margin tapered. Pereopods 5-7 bases width length ratios 1: 1.2, 1: 1.1, 1: 1, posterior margins rounded, serrate, pereopods 5-6 posterior margins bare; pereopod 7 posterior margin setose (Fig. 9A).

Pleon: Epimera 1-3 bare, epimeron 3 posteroventral corner quadrate, with slight projection.

Uropods 1-3 relative lengths 1.0: 0.8: 1.1. Uropod 1 peduncle $0.7 \times$ inner ramus length, outer ramus $0.4 \times$ inner ramus length; inner ramus with 3 robust setae; outer ramus with 1 robust seta. Uropod 2 peduncle $0.6 \times$ inner ramus length, outer ramus $0.8 \times$ inner ramus length; inner ramus with 2 robust setae; outer ramus bare. Uropod 3 peduncle $0.8 \times$ inner ramus length, outer ramus $0.7 \times$ inner ramus length; inner and outer rami each with 1 robust seta (Fig. 9A). Telson $1.4 \times$ longer than wide, bare, apex rounded (Fig. 9B).

Color pattern: When alive male anamorphs of this species are translucent with brown coloration on pereon segments 2-7, brown eyes, and an opaque ivory gnathopod (Fig. 3H); male and female leucomorphs are translucent with faint pink stripes on pereonite segments 2-5 and a red eye (Fig. 3I).

Ecology: This species was collected among *Halimeda* and coral rubble.

Relationships: Male anamorphs of *Paranamixis lunata* sp. nov. resemble *P. bocki* Schellenberg, 1938, *P. clarkae* Thomas, 1997, *P. fijiensis* Thomas, 1997, and *P. ledoyeri* Ortiz and Lalana, 1997 in having an anteroventral cusp on the head and an excavate ventral cephalic keel. *Paranamixis lunata* sp. nov. differs in the unique crescent shape of the keel. Except for *L. ledoyeri*, all of these species have a serrate ridge

on the anterior margin of gnathopod 2 basis, with the new species having both anteroproximal and mediiodistal serrate ridges. Leucomorphs are unknown for all of the similar species.

Distribution: Dongsha Atoll, Taiwan (this study).

DISCUSSION

This study increases the number of leucothoid species reported from the South China and Philippine Sea from five (see Table 1) to 16, all from Taiwanese waters. Three new species are described as endemic to Dongsha Atoll. The known ranges are extended for 13 species previously described from the East China Sea and Pacific Ocean basin. The range extensions suggest genetic- or geographic-driven connectivity between the South and East China Seas and the Philippine Sea. Given the direct development of amphipods and the geologic history of the area, the latter is more likely than genetic connectivity. The Asia Pacific region is an area of convergence and subduction zones, with the Pacific plate being subducted under the Philippine Sea Plate (PSP), the PSP being subducted under the Eurasian Plate, and the PSP converging with the Sunda Plate (Smoczyk et al. 2013).

The occurrence of the apparently wide-ranging *Leucothoe furina* in Taiwan is questionable since the species was originally described from the Mediterranean or Red Sea (White 2011). Specimens of *L. furina* examined in this study agree with the description of Vietnamese specimens attributed to *L. furina* by Imbach (1967). *Leucothoe furina*, as currently understood, most likely represents a species complex, which has been recently documented in the family Leucothoidae (Thomas and Klebba 2006 2007; Krapp-Schickel and De Broyer 2014; Thomas 2015; White and Krapp-Schickel 2017). Examination of all reports of *L. furina* is necessary to determine how many species are actually represented, a problem compounded by the loss of the type specimens (White 2011). It is likely that specimens from the South China Sea are one species, and specimens from the Mediterranean Sea, North Sea, Indian Ocean, Red Sea, and Atlantic Ocean represent multiple species. The occurrence of *L. alani*, described from the Red Sea, in Taiwan also raises concern, although the specimens agree morphologically with the description of Myers

(1985). Careful morphological examination and molecular analyses will help to recognize species complexes in the Leucothoidae.

Acknowledgments: This work and the three new species names have been registered with ZooBank under urn:lsid:zoobank.org:pub:F347BCBB-F9D5-4A2B-8A01-8CB1183889A9. This research was supported by a 2016-2017 Dongsha Atoll Research Award and Academia Sinica. The following people are thanked for logistical support: Ya-Ying Lin from The Biodiversity Research Center, Academia Sinica; Hernyi Justin Hsieh from the Fisheries Research Institute, Penghu Marine Biology Research Center, Council Agriculture, Magong 880, Penghu, Taiwan; Hsiu-Chin Lin, Keryea Soong, and Yalan Chou from the Department of Oceanography, National Sun Yat-sen University, Kaohsiung, Taiwan; Ming-hong Chen, Arthur (Chern-siang Chang), and Oscar (Kan-min Ng) from the Dongsha Research Atoll; and Wayne Price from The University of Tampa.

Author contributions: KNW and RJM participated in field collections. KNW performed the morphological description and drafted the manuscript. KNW and RJM contributed to drafting and revising the manuscript and approved the final manuscript.

Competing interests: KNW and RJM declare that they have no conflict of interest.

Availability of data and materials: Type specimens for new species have been deposited in the National Marine Biology Museum and Aquarium of Taiwan (accession numbers in "Material examined"). Additional material examined has been deposited in the Biodiversity Research Museum Academia Sinica of Taiwan (accession numbers in "Material examined"). All other specimens are maintained in the laboratory of KNW for molecular analyses.

Consent for publication: Not applicable.

Ethics approval consent to participate: Not applicable.

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