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Three New Deep-sea Species and a new Genus of Cumacean Family Nannastacidae from Southern Japan, Northwest Pacific

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Abstract Three new species and a new genus of the deep-sea species of cumacean family Nannastacid (Crustacea) were collected from southern Japan, Northwest Pacific. *Cumella ohtai* **sp. nov.** is similar to the shallow water species *C. arguta*, but corneal lenses of the eye lobe are degenerate, showing this species has been adapted to the deep-sea dark environment. The new genus *Paracumella* is characterized by (1) females closely similar to the genus *Cumella*, (2) well-developed exopods on maxilliped 3–pereopod 2 in both sexes, (3) male antenna 2 flagellum short, with long sensory setae on each article.
Key words: Crustacea, Cumacea, new genus, new species, deep-sea, Japan, Northwest Pacific.

Introduction

Deep-sea species of *Cumella* have been mainly reported from the Atlantic Ocean and eastern Pacific (Jones, 1984; Petrescu, 1995). Previous records from Japanese, Korean and Alaskan waters are all shallow waters (Gamô, 1962, 1963, 1964, 1965, 1967; Lee and Lee, 2012). Recently, a *Cumella* species from 198–250 m in the Sea of Japan, was described (Akiyama, 2014). The present study reports a new species of the genus from bathyal waters around Okinawa and Amami-Oshima Islands, southern Japan. This study also describes a new genus and two new deep-sea species of *Paracumella*, female specimens of which are very similar to the genus *Cumella*.

Materials and Methods

The cumacean specimens were collected during a survey of benthic fauna by R/V *Hakuho-maru* of Japan Agency for Marine-Earth Science and Technology (JAMSTEC, cruise KH-05-1) and T/S *Nagasaki-maru* of Nagasaki University (cruises N282, N295, N365). Gear used for the collections were ORE beam trawls of 3 m and 4 m span. Two ring nets, 130 cm in length and 30 cm in diameter, equipped with nylon mesh of 0.5 mm opening, were attached to the trawls to collect small epibenthic organisms. Detailed procedure of the collections is described elsewhere (Akiyama and Gerken, 2012). Cumacean specimens were sorted out of the sediment samples under a stereo microscopes (Leica MZ6), and were preserved in 5–10% formalin sea water or 70–80% ethanol. Observations were made under a stereo microscopes (Leica MZ125) and a light microscope (Nikon E600). After observation, the specimens were preserved in 80% ethanol. The type specimens are deposited in National Museum of Nature and Science, Tokyo (NSMT).

Taxonomy

Family Nannastacidae Bate, 1866

Genus *Cumella* Sars, 1865

Cumella ohtai sp. nov.

(Figs. 1–3)

Material examined. Holotype ovigerous female, 2.4 mm (NSMT-Cr 26040), west of

Amami-Oshima Island, Okinawa Trough, 28°32.2′N, 127°01.8′E–28°31.05′N, 127°01.49′E, 574–596 m (KH-05-1, St, OT-6), 13 May 2005. Paratypes; many females and males including dissected 4 ovigerous females, 2.3–2.5 mm; 4 adult males, 2.4–2.5 mm, (NSMT-Cr 26041), same locality and date as holotype female (KH-05-1, St. OT-6); 45 females and 50 males including 2 ovigerous females, 2.4–2.5 mm and 2 adult males, 2.5 mm (NSMT-Cr 26042), west of Amami-Oshima Island, 28°32.7′N, 127°02.1′E, 616 m (N282, St. R-2), 1 December, 2008; 14 females and 2 males (NSMT-Cr 26043), east of Hiraji-sone, 32°14.58′N, 129°28.73′E–32°14.83′N, 129°30.44′E, 414–429 m (N295, St. B).

Description. Holotype ovigerous female 2.4 mm, NSMT-Cr 26040 (Figs. 1A–C, 2G). Carapace (Fig. 1A–C) smooth, 0.31 times total body length, elevated posteriorly, compressed laterally; median dorsal ridge dull, with 2 spines anteriorly directed; pseudrostrum 0.09 times carapace length; antennal notch well marked; anterolateral angle with a prominent tooth directed anteriorly, with small teeth on anterior portion of inferior margin; eye lobe 0.15 times carapace width, corneal lenses absent; branchial chamber slightly swollen. Pereon (Fig. 1A) 0.55 times carapace length. Pleon (Fig. 1A) 0.51 times total body length.

Paratype ovigerous females, 2.4–2.5 mm, NSMT-Cr 26041. Carapace similar to holotype female, 0.30–0.32 times total body length; pseudrostrum 0.079–0.089 times carapace length; width of eye lobe 0.15–0.17 times carapace width, without corneal lenses. Pereon 0.47–0.57 times carapace length. Pleon 0.51–0.52 times total body length; pleonite 6 (Fig. 2F) with 4 minute setae on dorsal surface, 1.30–1.41 times as long as wide.

Antenna 1 (Fig. 1D) peduncle basal article 0.5 times combined length of articles 2 and 3; article 3 0.8–0.9 times article 2; tri-articulate main flagellum 0.6–0.7 times peduncle article 3; basal article 0.8–1.0 times combined length of articles 2 and 3; accessory flagellum 0.6–0.7 times basal article of main flagellum. Antenna 2 (Fig. 1E) small, uni-articulate, with 2 plumose setae on distal margin. Left and right mandibles (Fig. 1F) navicular form, with 5 and 6 ciliated setae on inner margin, respectively; lacinia mobilis tridentate; right and left incisor processes bi- and quadri-dentate, respectively. Upper distal end of labium (Fig. 1H) narrow, with 2 setae. Maxilla 1 (Fig. 1H) with 2 filaments on palp; outer endite with 11 spiniform setae on outer margin; inner endite with 3 stiff and 1 minute setae on outer margin. Maxilla 2 (Fig. 1I) with a row of 8 or 9 simple setae on inferior outer margin. Maxilliped 1 (Fig. 1J, K) with 3–4 small branchial lobules; basis much shorter than remaining articles combined, with brush of thin setae on ventral surface and 1 short simple seta on basal region; carpus with a row of 7 broad tridentate setae on inner margin and 7 simple or plumose setae on ventral surface. Maxilliped 2 (Fig. 1 L) basis shorter than combined length of next 4 articles, with 2 stiff plumose setae on inner distal corner; carpus 1.5 times propodus, with 3 plumose setae on inner margin; propodus with 2 plumose and 2 simple setae on inner margin. Maxilliped 3 (Fig. 1M) with well-developed exopod; basis 1.2–1.5 times distal articles together, with 3 plumose setae on inner margin and 3 spines on ventral surface; outer distal corner extending beyond ischium, with 2 long plumose setae; merus and carpus with a spine and plumose seta on outer distal corner; carpus with 3 plumose setae distally.

Pereopod 1 (Fig. 2A) with well-developed exopod; basis 0.5–0.6 times distal articles together, with robust spiniform seta on inner margin distally; carpus 1.3–1.5 times propodus, with 3 plumose setae on outer margin; propodus 1.5–2.0 times dactylus, with 3 plumose setae on outer margin; dactylus with 3 terminal setae. Pereopod 2 (Fig. 2B) with well-developed exopod; basis 0.7 times distal articles together, with a plumose seta on inner distal corner; dactylus 2.2–2.6 times propodus and 1.3–1.5 times carpus. Pereopods 3–5 (Fig. 2C–E) without exopods; terminal seta fused to dactylus. Pereopod 3 (Fig. 2C) basis 1.1–1.3 times remaining distal articles; carpus 1.2–1.4 times propodus and 1.1–

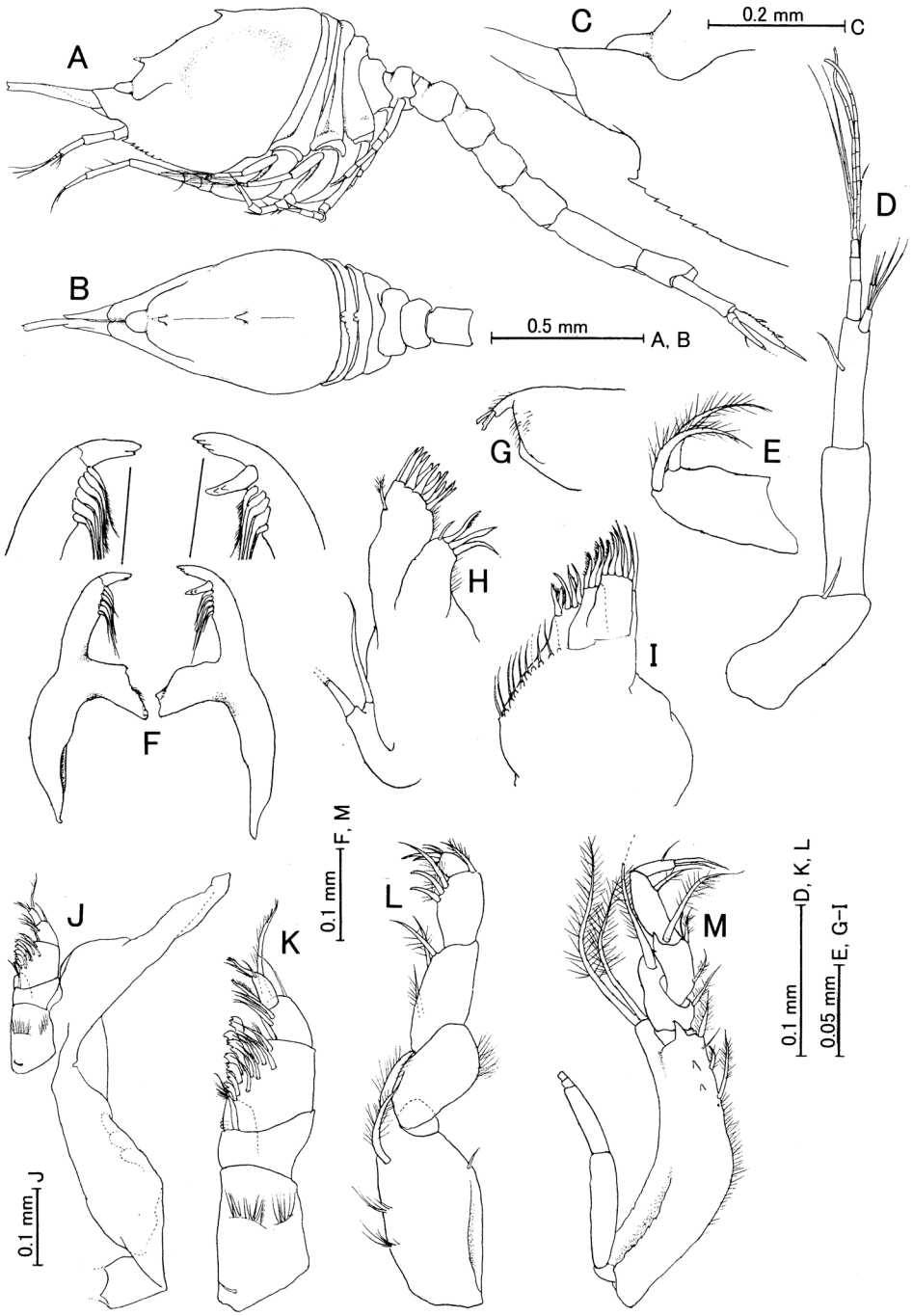


Fig. 1. *Cumella ohtai* sp. nov., A–C, holotype ovigerous female (NSMT-Cr 26040), D–K, paratype ovigerous female (NSMT-Cr 26041). A, lateral view; B, anterior portion of body, from above; C, anterior portion of carapace, lateral view; D, antenna 1; E, antenna 2; F, right and left mandibles; G, labium; H, maxilla 1; I, maxilla 2; J, K, maxilliped 2; L, maxilliped 2; M, maxilliped 3.

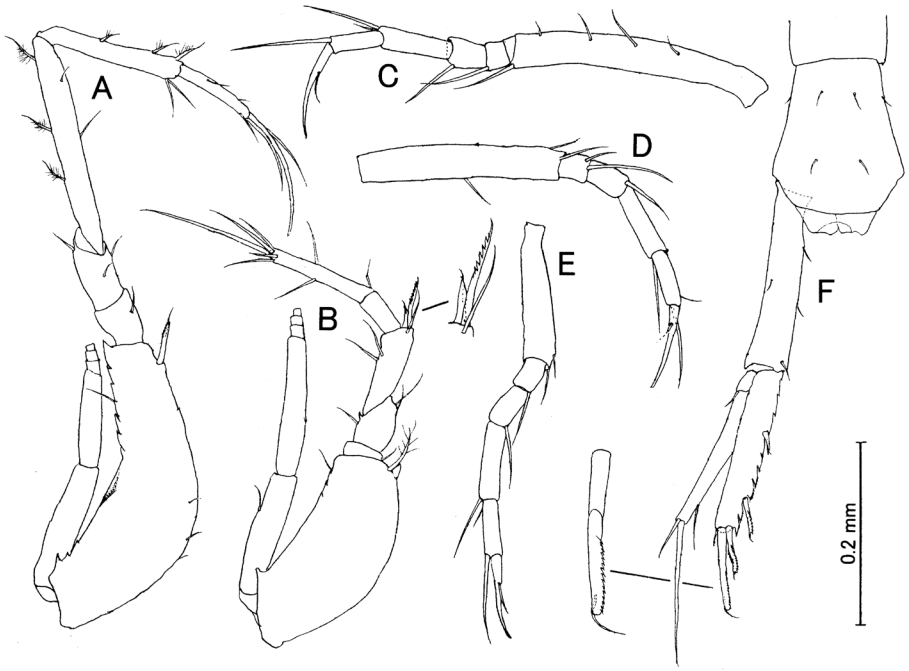


Fig. 2. *Cumella ohtai* sp. nov., paratype ovigerous female. A–E, pereopods 1–5; F, uropod with pleonite 6.

1.4 times combined length of ischium and merus. Pereopod 4 (Fig, 2D) basis 0.9–1.0 times distal articles together; carpus 1.3–1.5 times propodus and 1.0–1.3 times combined length of ischium and merus. Pereopod 5 (Fig. 2E) basis 0.5–0.6 times distal articles together; carpus 1.3–1.5 times propodus and 1.2–1.3 times combined length of ischium and merus.

Uropod (Fig. 2F) peduncle 1.1–1.2 times pleonite 6, 1.1–1.2 times exopod and 1.00–1.23 times endopod, with 3 short simple setae on inner margin; exopod 0.9–1.1 times endopod, with long terminal seta along with 2 short terminal and subterminal setae; endopod uni-articulate, with 2–3 spiniform setae on serrated inner margin; terminal seta robust and long.

Paratype adult males 2.4–2.5 mm, NSMT-Cr 26041 (Fig. 3). Carapace (Fig. 3A, B) 0.33–0.34 times total body length, surface of integument smooth; mid dorsal ridge absent, frontal lobe with anteriorly directed spin. Pseudrostrum short, 0.59–0.68 times carapace length; siphon longer than pseudorostral lobe; antennal notch distinct; anterolateral angle round, inferior margin smooth. Eye lobe 0.20–0.22 times carapace width, without corneal lenses. Pereon (Fig. 3A) 0.52–0.59 times carapace length, pereonites 1 and 2 with transverse ridges anteriorly. Pleon (Fig. 3A) 0.44–0.49 times total body length; pleonites 1–5 with lateral grooves for flagellum of antenna 2; pleonites 1 and 2 with pair of serrated dorsal ridges (Fig. 3K); pleonite 6, 1.2–1.5 times as long as wide, not extending past anal opening, with 4 simple setae on dorsa surface and 2 simple setae on lateral surface. Pleopods absent.

Antenna 1 (Fig. 3C), peduncle basal article slightly curved, 0.6 times combined length of articles 2 and 3; article 3 0.7–0.8 times article 2; main flagellum tri-articulate, 0.6–0.7 times peduncle article 3; article 1 0.8–1.0 times combined length of articles 2 and 3, accessory flagellum uni-articulate, 0.6–0.7 times basal article of main flagellum. Antenna 2 (Fig. 3D) peduncle article 2 with 2 plumose setae on lateral margin; articles 4 and 5 with numerous short setae; article 5 much longer than article 4; flagellum of 18–19 articles, reaching near posterior end of pleonite 6. setae on peduncle article 2. Maxilliped 3 (Fig.

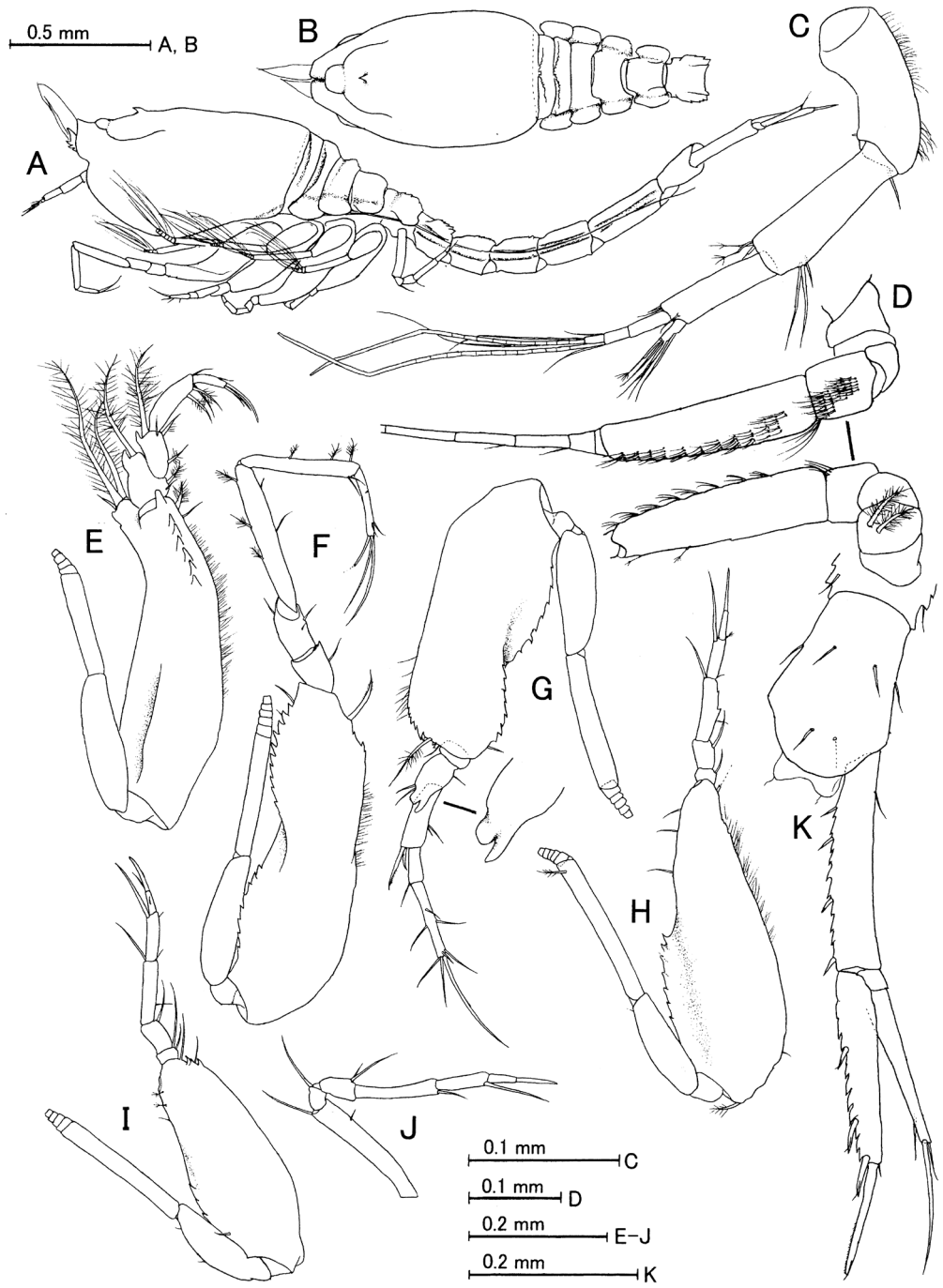


Fig. 3. *Cumella ohtai* sp. nov., paratype adult male (NSMT-Cr 26041). A, lateral view; B, anterior portion of body, from above; C, antenna 1; D, antenna 2; E, maxilliped 3; F–J, pereopods 1–5; K, uropod with pleonite 6.

3E) with well-developed exopod; basis 1.8–2.0 times distal articles together; outer distal corner extending past ischium, with 2 long plumose setae; distal portion of ventral surface with a row of spines; merus and carpus with long plumose seta on outer distal corner and plumose seta on

inner margin; carpus with 3 plumose setae inner margin distally.

Pereopod 1 (Fig. 3F) with well-developed exopod, basis 0.8–0.9 times distal articles together, outer margin serrated distally and proximally; carpus 1.3–1.4 times propodus, with 2–3 plumose setae on outer margin; propodus 1.6–1.9 times dactylus, with 2–4 plumose or simple setae; dactylus with 3 terminal setae. Pereopod 2 (Fig. 3G) with well-developed exopod, basis 1.3 times distal articles together, outer margin serrated; merus with a spine and a tubercle on distal end; dactylus 2.0–2.4 times propodus and 1.2–1.5 times carpus. Pereopod 3 with well-developed exopod, (Fig. 3H) basis 1.8–2.0 times distal articles together; proximal portion thick, outer margin serrated; carpus 1.3–1.4 times propodus and much longer than combined length of ischium and merus; terminal seta occasionally fused with dactylus. Pereopod 4 (Fig, 3I) with well-developed exopod, basis 1.3–1.4 times distal articles together; carpus 1.3 times propodus and longer than combined length of ischium and merus; terminal seta occasionally fused with dactylus. Pereopod 5 (Fig. 3J) basis 0.6 times distal articles together; carpus 1.5–1.8 times propodus and much longer than combined length of ischium and merus.

Uropod (Fig. 3K) peduncle 1.2–1.5 times pleonite 6, 1.2–1.3 times exopod and 1.1–1.3 times endopod, with 3–4 spiniform setae on inner margin; exopod 0.9 times endopod, with long and short terminal setae and subterminal setae, endopod uniarticulate, with 2–3 spiniform setae on serrated inner margin; robust terminal seta long.

Etymology. The species name is dedicated to Dr. Suguru Ohta of the University of Tokyo, director of R/V *Hakuho-maru* cruise (KH05-1) during which many specimens examined for the present study were collected.

Remarks. The new species is most similar to *Cumella arguta* Gamô, 1962 from Tanabe Bay, Kii Peninsula, southern coast of Honshu, 0 m, in having a similar greatly elevated carapace with a few spines on the dorsal crest. *Cumella ohtai* can be distinguished from *C. arguta* by (1) dorsal crest of female carapace with 2 spine (3 spines in *C. arguta*), (2) corneal lenses degenerate (present in *C. arguta*), (3) antenna 1 peduncle article 3 shorter than article 2 (subequal in *C. arguta*), (4) pereopod 1 carpus longer than combined length of ischium and merus (subequal to combined length of ischium and merus in *C. arguta*).

Cumella ohtai also resembles *C. quadrispinosa* Gamô, 1965 from Akkeshi, eastern Hokkaido, 3 m depth, in having spines on the dorsomedian carina. *Cumella ohtai* is distinguished from *C. quadrispinosa* by (1) dorsal crest with 2 spines in females (4 spines in *C. quadrispinosa*), (2) transverse ridge on each side of carapace absent (present in *C. qudrispinosa*), (3) corneal lenses degenerate (present in *C. quadrispinosa*), (4) carpus of pereopods 3–5 elongate, much longer than propodus (subequal in length to propodus in *C. qudrispinosa*).

The merus of the pereopod 2 of the adult male is characterized by an unusual morphology, with a spine and a tubercle distally. In another nannastacid, *Campylaspis brevirostoris* Akiyama 2014, adult males are characterized by the propodus of maxilliped 3 with a finger-like tubercle distally. The spines and tubercles in these species may be used during their mating.

Distribution. West of Amami-Oshima Island, Minami-Ensei Knoll area, Okinawa Trough, 574–616 m, Hiraji-sone, off Kyusyu-Island, 414–429 m .

Paracumella gen. nov.

Diagnosis. Female. Eye lobe large, without corneal lenses. Antenna 1 main flagellum 3-articulate; bi-articulate accessory flagellum small; antenna 2 with 2 plumose setae distally; mandibles navicular, with pointed incisor process and lacinia mobilis; maxilliped 1 carpus with thin dentate setae on inner margin; well-developed exopods present on maxilliped 3–pereopod 2; uropod endopod uniarticulate. Male. Left and right pseudorostrum contact each other; antenna 2; antenna flagellum of 20 articles, strongly bent at mid region, not reaching posterior end of the

pleon, with long sensory setae; well-developed exopods present on maxilliped 3–pereopod 2.

Etymology. The genus name refers to similarity of the females of the new genus to the genus *Cumella*.

Remarks. The new genus is allied to *Almyracuma*, Jones and Burbanck, 1959 and *Thalycrocuma* Corbera *et al.*, 2008, in the combination of the characters; (1) female specimens similar to *Cumella* females, and (2) well-developed exopod present on maxilliped 3 and pereopod 1–2 in both sexes. *Paracumella* is distinguished from the other genera by male characters; (1) antenna 1 normal for the family Nannastacidae (with long sensory setae on the peduncle in *Thalycrocuma*), (2) antenna 2 flagellum of 20 articles (undeveloped, uni-articulate in *Almyracuma*, and with flagellum of less than 10 articles in *Thalycrocuma*), and (3) pseudorostral lobes contact each other in front of the eye lobe (no contact in *Thalycrocuma*).

Paracumella hashimotoi sp. nov.

(Figs. 4–6)

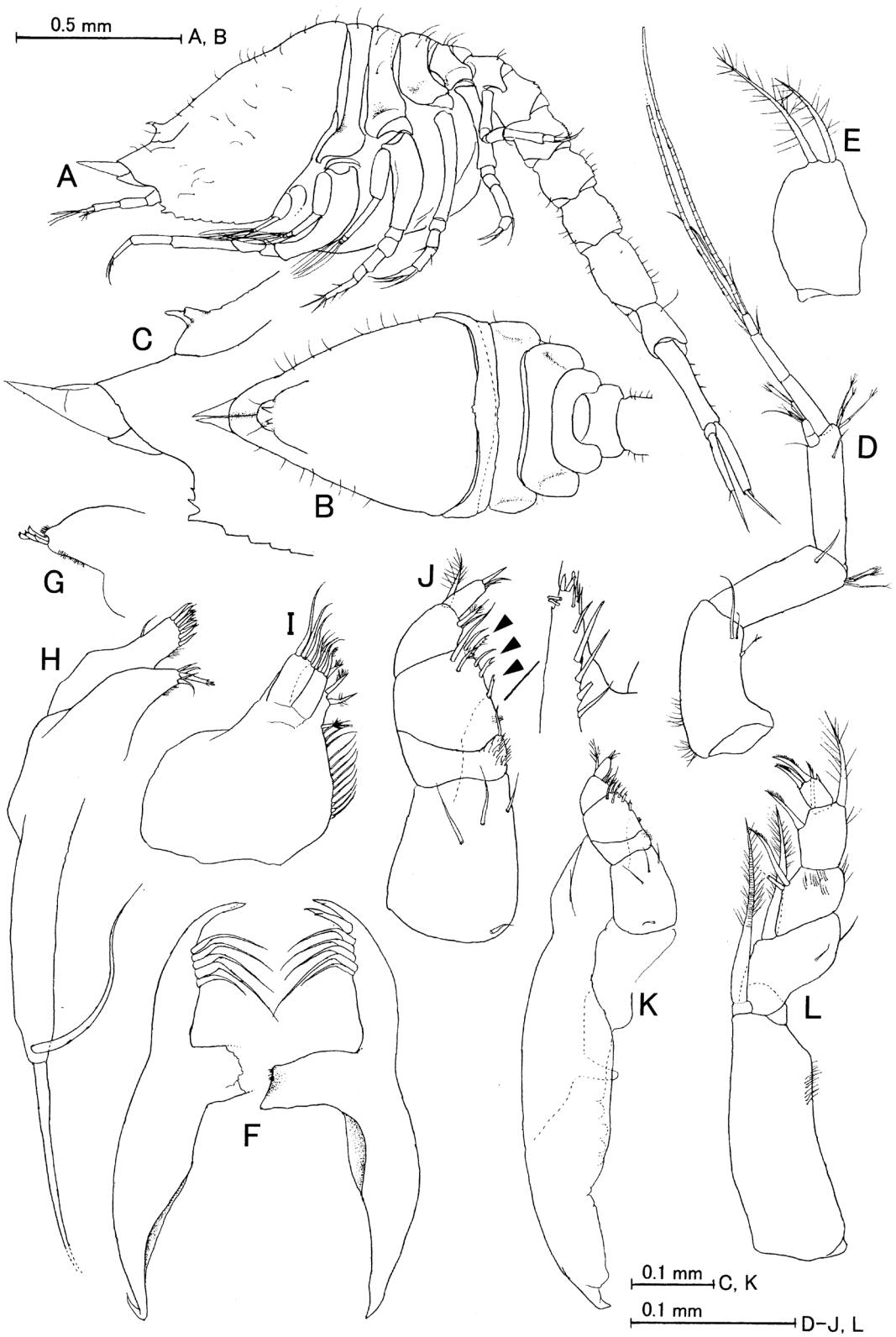
Material examined. Holotype ovigerous female, 2.2 mm (NSMT-Cr 26044), west of Amami-Oshima Island, Okinawa Trough, 28°32.22′N, 127°01.84′E–28°31.05′N, 127°01.49′E, 576–594 m (KH-05-1, St. OT-6), 13 May 2005; Paratypes, 1 preparatory female, 2.0 mm (dissected), 4 adult males, 1.7–1.9 mm, 3 specimens dissected (NSMT-Cr 26045), same locality and date as holotype female (KH-05-1, St. OT-6); 2 ovigerous and 2 preparatory females, 2.03–2.10 mm, dissected, 2 adult males, 1.90 mm, dissected (NSMT-Cr 26046), west of Amami-Oshima Island, Okinawa Trough, 28°32.70′N, 127°02.00′E–28°34.16′N, 127°02.65′E, 606–608 m (N295, St. R2-1), 19 November 2009.

Other material. 3 females (1 ovigerous female damaged), 5 males, west of Amami-Oshima Island, Okinawa Trough, 28°35.7′N, 127°.03′E, 605 m (N282, St. R-2), 9 June 2009; 1 female, 5 males, west of Amami-Oshima Island, Okinawa Trough, 28°33.18 N, 127°02.22 E–28°34.13 N, 127°02.55 E, 604–609 m (N365, St. J6-1), 16 November 2012: 3 females, 1 male, west of Amami-Oshima Island, 28°32.27 N, 127°02.28 E–28°34.15 N, 127°02.53 E, 604–621 m (N365, St. J6-4) 16 November 2012.

Description. Holotype ovigerous female, 2.2 mm, NSMT-Cr 26044 (Fig. 4A–C). Carapace, 0.32 times total body length, 1.17 times width, 1.65 times depth, covered with hairs; dorsal surface without median ridge; pseudrostrum 0.12 times carapace length; siphon (seen from above, Fig. 4B) longer than pseudrostrum; antennal notch shallow; anterolateral angle (Fig. 4A, C) and anterior portion of inferior margin with 9–10 teeth; eye lobe (Fig. 4C) 0.16 times carapace width, with two spines; corneal lenses absent. Pereon (Fig. 4A) 0.77 times carapace length. Pleon (Fig. 4A) 0.44 times total body length; width of pleon (based on lateral view) 0.77 times total body length .

Paratype preparatory (3 specimens) and ovigerous (2 specimens) females, 2.03–2.12 mm, NSMT-Cr 26045–26046 (Figs. 4D–L, Fig. 5). Carapace 0.35 times total body length, 1.20–1.40 times width, 1.55–1.82 times depth; pseudrostrum 0.10–0.14 times carapace length; siphon longer than pseudorostrum; antennal notch shallow; anterolateral angle (Fig. 4A, C) and anterior portion of inferior margin with several teeth; width of eye lobe 0.15–0.19 times carapace width, with two spines laterally arranged. Pereon 0.51–0.65 times carapace length. Pleon 0.43–0.48 times total body length; width of pleon 0.074–0.076 times total body length. Pleonite 6 (Fig. 5G) with 4 minute setae on dorsal surface, 0.79–0.98 times as long as wide, posterior end not extending anal opening.

Antenna 1 (Fig. 4D) peduncle basal article 0.5–0.6 times combined length of articles 2 and 3; article 3 1.0–1.2 times article 2; main flagellum tri-articulate, 1.0 times peduncle article 3; basal article 0.8–1.0 times combined length of articles 2 and 3; minute accessory flagellum bi-articulate, 0.4 times article 1 of main flagellum. Antenna 2 (Fig. 4E) uni-articulate, with 2 plu-


0.5 mm
A, B
A
B
C
D
E
F
G
H
I
J
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0.1 mm
C, K
0.1 mm
D–J, L

mose setae on distal margin. Mandibles (Fig. 4F) navicular, with 5 setae on inner margin, respectively; bi-dentate lacinia mobilis slender, pointed; incisor process pointed, bi-dentate; lacinia mobilis pointed, bi-dentate. Labium (Fig. 4G) with 4 setae on tip. Maxilla 1 (Fig. 4H) with 2 filaments on palp; outer endite with 10 spiniform setae; inner endite with 1 marked dentate seta and 4 simple setae. Maxilla 2 (Fig. 4I) narrow endites with 4 setae, respectively; lower distal margin of broad endite with a row of 13 simple setae.

Maxilliped 1 (Fig. 4J, K) with 3–4 very short branchial lobules; basis with 4 simple setae on ventral surface, and basal end; carpus with a few thin dentate setae (arrowheads in Fig. 4J) and 4 simple setae on inner margin. Maxilliped 2 (Fig. 4L) basis subequal in length distal articles together, with stiff plumose seta on inner distal corner; merus with stiff plumose seta on inner distal corner; carpus subequal in length to propodus, with 2 stiff plumose seta on inner distal corner; propodus with plumose setae on outer distal corner and 2 ciliated setae on inner margin. Maxilliped 3 (Fig. 5A) basis 1.4–1.6 times distal articles together, with 2 plumose setae on inner margin; outer distal corner reaching distal end of ischium, with 3 long plumose setae; carpus with 2 short setae on inner distal corner; well-developed exopod with 2 short articles terminally.

Pereopod 1 (Fig. 5B) basis 0.7–0.8 times distal articles together, with 2 robust spiniform setae and plumose seta on inner and outer distal corner, respectively; carpus 1.4–1.7 times propodus; propodus 1.4–1.7 times dactylus; dactylus with 4 terminal setae: well developed exopod with 3 short articles terminally. Pereopod 2 (Fig. 5C) basis 0.8 times distal articles together, with plumose seta on inner distal corner; carpus with 2 robust setae on inner distal corner, 0.9–1.0 times combined length of ischium and merus; dactylus 2.0–2.3 times propodus and 1.3–1.4 times carpus; well-developed exopod with 3 short articles terminally. Pereopod 3 (Fig. 5D) basis 1.1–1.5 times remaining distal articles; carpus 2.1–2.6 times propodus; terminal seta fused with dactylus. Pereopod 4 (Fig, 5E) basis 0.7–0.9 times distal articles together; carpus 2.5–3.2 times propodus; terminal seta fused with dactylus. Pereopod 5 (Fig. 5F) basis 0.5 times distal articles together; carpus 2.6–3.1 times propodus; terminal seta fused with dactylus.

Uropod (Fig. 5G) peduncle 1.5–2.0 times pleonite 6, 1.1–1.3 times exopod and 1.1–1.2 times endopod, with 5–6 spiniform setae on inner margin; exopod 0.9–1.0 times endopod, with 2 terminal setae and 1 short subterminal seta; endopod uni-articulate, with 7 spiniform setae on inner margin and distal end; terminal seta robust, long.

Paratype adult males, 1.74–1.93 mm, NSMT-Cr 26045–26046 (Fig. 6). Carapace (Fig. 6A, B) 0.32–0.33 times total body length, covered with short hairs; dorsal surface slightly arched, without mid dorsal ridge. Pseudrostrum (Fig. 6A, C) 0.09–0.12 times carapace length; pseudorostral lobes meeting in front of eye lobe; siphon longer than females; antennal notch (Fig. 6C) well marked; anterolateral angle (Fig. 6C) with 3–6 teeth; width of eye lobe (Fig. 6B) 0.18–0.23 times carapace width; corneal lenses absent. Pereon (Fig. 6A) 0.61–0.72 times carapace length, Pleon (Fig. 6A) 0.45–0.48 times total body length, without lateral grooves; pleonite 6 0.83–0.87 times as long as wide, not reaching opening of anus. Pleopods absent.

Antenna 1 (Fig. 6D), peduncle basal article slightly curved, 0.5–0.6 times combined length of article 2 and 3; article 3 0.0.9–1.1 times article 2; main flagellum tri-articulate, 0.9–1.0 times peduncle article 3; article 1 0.8–0.9 times combined length of articles 2 and 3; accessory flagellum bi-articulate, 0.4 times article 1 of main flagellum. Antenna 2 (Fig. 6E) peduncle article 2

Fig. 4. *Paracumella hashimotoi* sp. nov., A–C, holotype ovigerous female (NSMT-Cr 26044), D–L, paratype ovigerous female (NSMT-Cr 26046). A, lateral view; B, anteriotr portion of body, from above; C, anterior portion of carapace, lateral view; D, antenna 1; E, antenna 2; F, right and left mandibles; G, labium; H, maxilla 1; I, maxilla 2; J, K, maxilliped 1; L, maxilliped 2.

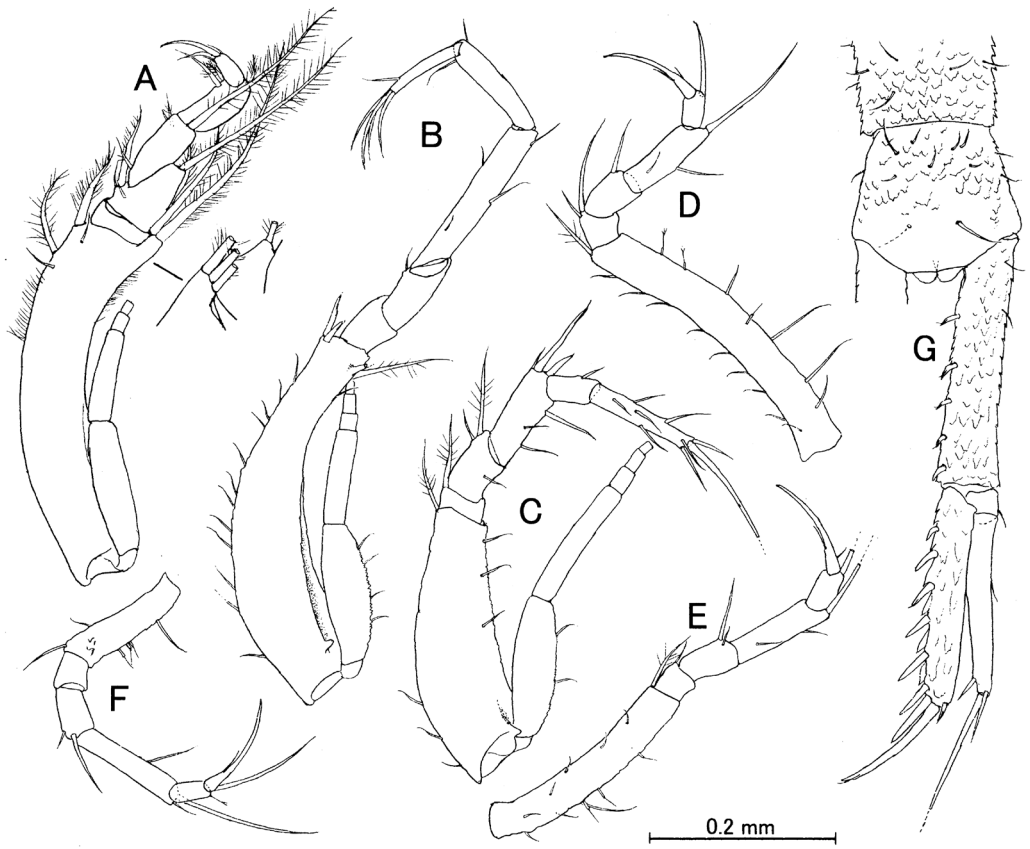

Fig. 5. *Paracumella hashimotoi* sp. nov., paratype ovigerous female (NSMT-Cr 26046). A, maxilliped 3; B–F, pereopods 1–5; G, uropod with pleonite 6.

with plumose seta on lateral margin; articles 4 and 5 with numerous setae; flagellum strongly bent at mid region, 1.8–2.4 times peduncle length, of 20 articles, terminal one minute; each article with 4–6 long sensory setae.

Maxilliped 3 (Fig. 6F) basis 1.5–1.7 times distal articles together; outer distal corner weakly produced, with 2 long plumose setae; merus with long plumose seta on outer distal corner and plumose seta on inner margin; carpus with long plumose seta on outer distal corner and 3 plumose setae on inner margin.

Pereopod 1 (Fig. 6G), basis 0.8–0.9 times distal articles together, with 2 spiniform setae on inner distal corner and 1 spine on outer distal corner; carpus 1.4–1.7 times propodus; propodus 1.6–1.9 times dactylus; well-developed exopod with 5 short articles terminally. Pereopod 2 (Fig. 6H) basis 1.8–0.9 times distal articles together, carpus with 2 spiniform setae on distal corner, 1.0–1.1 times combined length of ischium and merus; dactylus 2.1–2.3 times propodus and 1.1–1.3 times carpus; well-developed exopod with 5 short articles terminally. Pereopod 3 (Fig. 6I) basis 1.2–1.5 times distal articles together; terminal seta fused with dactylus. Pereopod 4 (Fig, 6J) basis 0.8–0.9 times distal articles together; terminal seta fused with dactylus. Pereopod 5 (Fig. 6K) basis 0.5–0.6 times distal articles together; terminal seta fused with dactylus.

Uropod (Fig. 6L) peduncle 1.8–1.9 times pleonite 6, 1.2–1.3 times exopod and 1.1–1.2 times endopod, with 4–5 spiniform setae on inner margin; exopod 0.9–1.0 times endopod, with 2 terminal setae and subterminal seta. Endopod uniarticulate, with 6–7 spiniform setae on inner

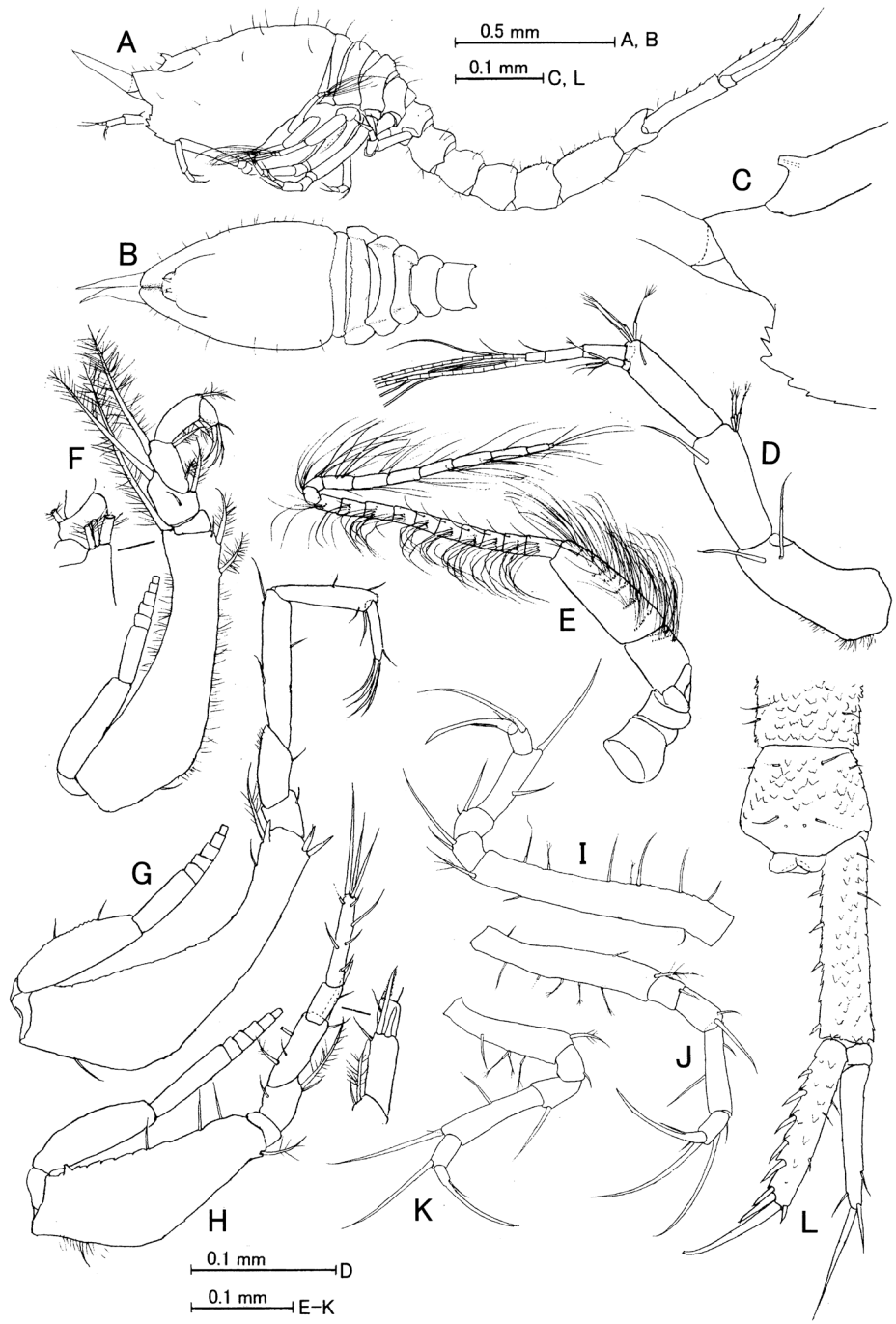

Fig. 6. *Paracumella hashimotoi* sp. nov., paratype adult male (NSMT-Cr 26045). A, lateral view; B, anterior portion of body, from above; C, anterior portion of carapace, lateral view; D, antenna 1; E, antenna 2; F, axilliped 3; G–K, pereopods 1–5; L, uropod with pleonite 6.

margin; terminal seta robust and long.

Etymology. The species name is dedicated to Dr. Jun Hashimoto of Nagasaki University, who has greatly contributed to knowledge of hydrothermal vent and cold seep communities. He was the director of the cruises of the training ship *Nagasaki-maru* of Nagasaki Universitty, Japan, during which many specimens examined in the present study were collected.

Remarks. Large eye lobe without corneal lenses in both sexes, along with two spines on on it, arranged laterally, is unusual in the Nannastacidae . In the Nannastacidae, a similar arrangement of spines on the eye lobe has been observed only in *Styloptcuma*, which is characterized by numerous spins on the carapace, pereon and pleon.

The mandible molar process and incisor processes are rather narrow at the tip (Fig. 4F). Especially, the pointed tip of the lacinia mobilis is rather unusual. In addition, dentate setae on inner margin of carpus of Maxilliped 1are thin (arrow heads in Fig. 4J), whereas those setae in most other nannastacids are broad (for example, see Fig, 1K). These morphological feature of the mouthparts suggests that food of the species is different from that of *Cumella*.

The strongly bent male antenna 2 is wholly hidden under the carapace in all specimens. The ventral surface of the basal article of the maxilliped 1 in both sexes is with 3 simple setae (Fig. 4J), whereas the ventral surface is characterized by one or more groups of setae arranged like combs in *Cumella* (Fig. 1K).

Along with antenna 2, sexual characteristics of adult males were observed in the exopod flagella on maxilliped 3–pereopod 2, which each have 5 small terminal articles vs. 2–3 articles in females. These articles are furnished with long plumose setae in both sexes, which suggests that the exopods of the males can be more effective swimming apparatus than female, as is usual in most other cumaceans.

Distribution. West of Amami-Oshima Island, Okinawa Trough, 576–621 m.

Paracumella longicauda sp. nov.

(Figs. 7, 8)

Materials examined. Holotype preparatory female, 3.5 mm (NSMT-Cr 26047), Northern slope of Ryukyu Trench, 24°33.16′N, 127°02.92′E–24°31.92′N, 127°01.50′E, 3817–3924 m (KH-05-1, St. RT-3).

Description. Holotype preparatory female, 3.5 mm, NSMT-Cr 26047 (Figs. 7, 8). Carapace (Fig. 7A) 0.33 times total body length, 1.42 times width, 1.55 times depth, dorsal surface without median ridge; pseudrostrum 0.10 times carapace length; siphon much longer than pseudorostrum; antennal notch shallow; anterior portion of inferior margin with 6 teeth; eye lobe large, with two spines laterally arranged; corneal lenses absent (Fig. 7B). Pereon (Fig. 7A, B) 0.68 times carapace length. Pleon (Fig. 7B) slender, 0.44 times total body length, pleonite 6 (Fig. 8G) 0.86 times as long as wide, posterior end with minute triangular projection; width of pleon (based on lateral view) 0.058 times total body length.

Antenna 1 (Fig. 7D) peduncle basal article 0.5 times combined length of articles 2 and 3; article 3 0.9 times article 2; main flagellum 3-articulate, 0.7 times peduncle article 3; basal article 0.9 times combined length of articles 2 and 3; minute accessory flagellum bi-articulate, 0.5 times article 1 of main flagellum. Antenna 2 (Fig. 7E) with 2 plumose setae on distal margin. Mandibles (Fig. 7F) navicular, with 5 setae on inner margin, respectively; lacinia mobilis and incisor process pointed. Labium (Fig. 7G) with 4 setae on tip. Maxilla 1 (Fig. 7H) with 2 filaments on palp; outer endite with 11 spiniform setae; inner endite with 1 marked dentate seta, 3 simple setae and 1 seta ciliated distally. Maxilla 2 (Fig. 7I) narrow endites with 4 and 3 setae, respectively; lower distal margin of broad endite with a row of 13 simple setae.

Maxilliped 1 (Fig. 7J) with 3 very short branchial lobules; basis with comb-like arrangement of 10 simple setae and 1 short simple setae on ventral surface; carpus with 3 thin dentate setae (arrowheads in Fig. 7J) and a simple seta on inner mar-

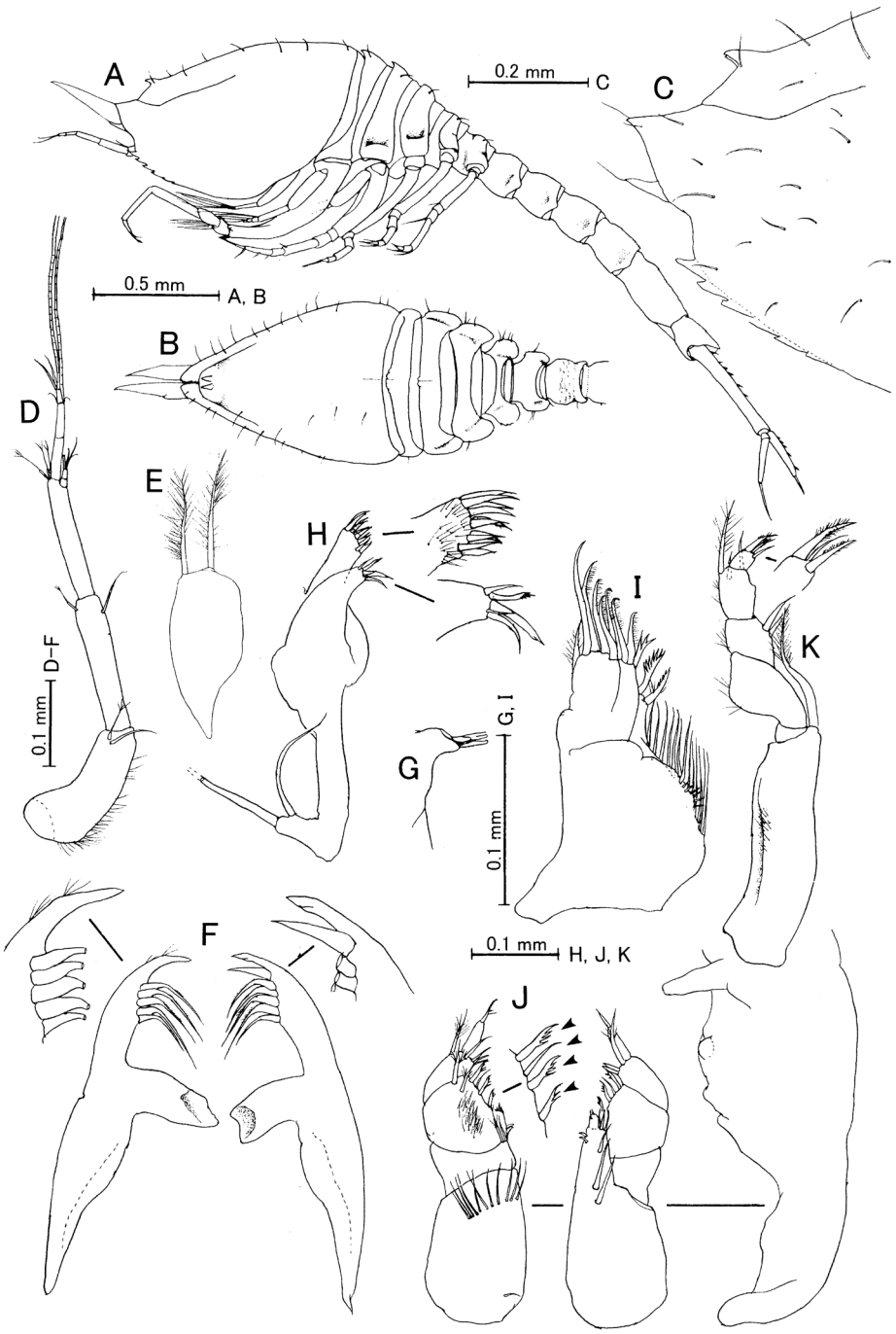

Fig. 7. *Paracumella longicauda* sp. nov., holotype preparatory female (NSMT-Cr 26047). A, lateral view; B, anterior portion of body, from above; C, anterior portion of carapace, lateral view; D, antenna 1; E, antenna 2; F, right and left mandibles; G, labium; H, maxilla 1; I, maxilla 2; J, maxilliped 1; K, maxilliped 2.

gin, 2 plumose setae on ventral surface. Maxilliped 2 (Fig. 7K) basis slightly longer than distal articles together, with stiff plumose seta on inner distal corner; merus with stiff plumose seta on inner distal corner; carpus subequal in length to propodus, with 1 simple and 1 plumose setae on

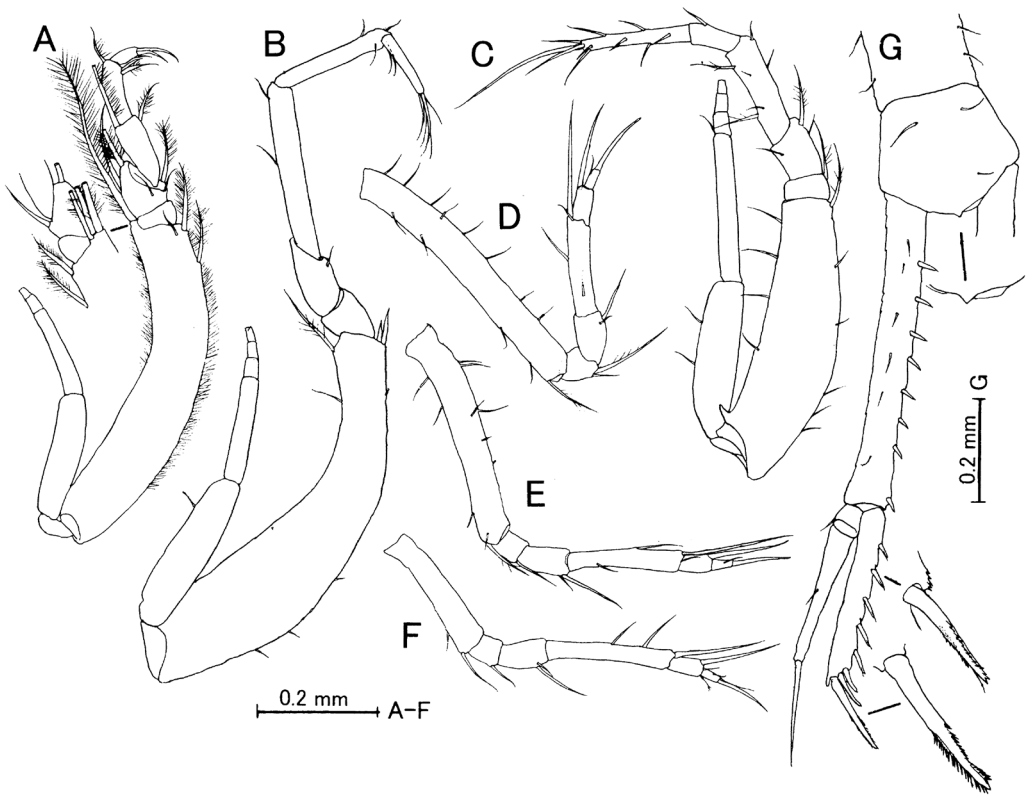

Fig. 8. *Paracumella longicauda* sp. nov., holotype preparatory female (NSMT-Cr 26047). A, maxilliped 3; B–F, pereopods 1–5; G, uropod with pleonite 6.

inner margin; propodus with 2 plumose and 1 simple setae on distal corner; dactylus with 2 ciliated setae and 1 simple seta on distal end. Maxilliped 3 (Fig. 8A) basis 1.8 times distal articles together, with 2 plumose setae on inner margin; outer distal corner reaching distal end of ischium, with 3 long plumose setae; carpus with 1 plumose seta on inner distal corner and distal end, respectively; well-developed exopod with 2 short distal articles.

Pereopod 1 (Fig. 8B) basis as long as distal articles together, with 2 spiniform setae and plumose seta on inner and outer distal corner, respectively; carpus 1.4 times propodus; propodus 1.9 times dactylus; dactylus with 4 terminal setae: well-developed exopod with 3 short distal articles. Pereopod 2 (Fig. 8C) basis 0.9 times distal articles together, with plumose seta on inner distal corner; carpus with 2 robust setae on inner distal corner, 1.2 times combined length of ischium and merus; dactylus 2.3 times propodus and 1.2 times carpus; well-developed exopod with 3 short articles terminally. Pereopod 3 (Fig. 8D) basis 1.3 times remaining distal articles; carpus 2.8 times propodus; terminal seta not fused with dactylus. Pereopod 4 (Fig, 8E) basis 0.9 times distal articles together; carpus 3.5 times propodus; terminal seta not fused with dactylus. Pereopod 5 (Fig. 8F) basis 0.5 times distal articles together; carpus 3.6 times propodus; terminal seta not fused with dactylus.

Uropod (Fig. 8G) peduncle 2.6 times pleonite 6, 1.9 times exopod and 1.8 times endopod, with 8 spiniform setae on inner margin; exopod 0.9 times endopod, with simple terminal seta; endopod uni-articulate, with 7 spiniform, ciliated setae on inner margin and distal end.

Etymology. The species name refers to the long uropods.

Remarks. Although morphology of the males is unknown, the new species is assigned to the genus *Paracumella* based on (1) large eye lobe without lenses, (2) mandible incisor process pointed, (3) maxilliped 1 carpus with thin dentate setae on inner margin, along with overall similarity of trunk and appendages of the specimen to *P. hashimotoi*. The present new species is distinguished from *P. hashimotoi* by (1) width of pleon 0.06 times total body length (0.07–0.08 in *P. hashimotoi*), (2) pleonite 6 with minute projection at the posterior end (without projection in *P. hashimotoi*), (3) main flagellum of the antenna 0.7 times peduncle article 3 length (1.0 times in *P. hashimotoi*), (4) maxilliped 1 bases ventral surface with comb-like arranged 11 simple setae on the ventral surface (3 simple setae in *P. hashimotoi*) (5) uropod peduncle 2.6 times pleonite 6 length, 1.8 times endopod (1.5–2.0 times and 1.1–1.2 times in *P. hashimotoi*), (6) Terminal setae on pereopods 3–5 are not fused to dactylus (fused in *P. hashimotoi*).

Distribution. East of Okinawa Island, 3817–3924 m.

Discussion

The new species *Cumella ohtai* is similar to the shallow water species *C. arguta* from southern Japan, which suggest that the Japanese shallow water *Cumella* species, probably *C. arguta* or related species, have possibly expanded their habitat to the deep-sea. Another deep-sea *Cumella* from Japan, *C. tanseiae*, Akiyama, 2014 from 198–250 m depth at the Sea of Japan has the eye lobe without lenses (Akiyama, 2014). Several deep-sea *Cumella* species from the Atlantic Ocean do not have lenses on the eye lobes (Jones, 1984; Petrescu, 1995), whereas most shallow water species of the genus have lenses on the eye lobes, which suggest their ancestor was shallow water species. However, further investigation on the lenses on eye lobe of *Cumella* would be necessary, because a shallow water species *C. biformis* Micca and Roccatagliata, 2002 from the Argentine shore, 3–62 m depth, has no lenses in females and "incipient lenses" (or clear areas) in adult males (Micca and Roccatagliata, 2002), whereas two deep-sea *Cumella* species from off the Argentine coast, *C. argentina* Jones, 1984 from 256–293 m and *C. jonesi* Petrescu, 1995 from 5239 m depth, are characterized by having lenses on the eye lobes.

Secondary sexual characters of adult male cumaceans, including *Cumella* species, are usually observed in the carapace, second antenna, exopods on maxilliped 3–pereopod 4 and uropods (occasionally this appendage does not show sexual dimorphism in *Cumella* as shown in *C. ohtai*). In addition to these characters, pereopod 2 of the males of *Cumella ohtai* has a tubercle and a dull spine on distal end of the merus. This novel character has not been reported in shallow water *Cumella* before.

Habitats of two related genera to *Paracumella*, *Almyracuma* and *Thalycrocuma*, are rather unusual in cumaceans. *Almyracuma* from the eastern coast of North America and the Gulf of Mexco, lives in fresh and brackish waters (Jones and Burbanck 1959; Petrescu and Heard 2004). *Thalycrocuma* from mid and eastern Atlantic, lives in hydrothermal vent fields (Corbera *et al.* 2008; Muhlenhardt-Siegel 2012). Another nannastacid cumacean *Styloptocuma darwini* was reported (Corbera and Segonzac, 2010) from hydrothermal vent fields.

The samples of the *Paracumella hashimotoi* were collected near Minami-Ensei Knoll (Okutani *et al.*, 1992), where a few chemosynthetic molluscan species, *Caryptogena kawamurai*, *Elliptiolucina ingens*, *Lepidozona alba* were reported (Okutani, 2011; Saito, 2013; Kuhara *et al.*, 2014), which suggest that *P. hashimotoi* may be a member of the chemosynthetic community. However, further investigations will be necessary because the beam-trawl samples examined in the present study include benthic animals from a very wide sea area of sea bottom. *Cumella ohtai* specimens were also collected near Minami-Ensei Knoll, except for a specimen collected off Hiraji-sone, rather distant from Minami-Ensei Knoll.

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