



Two new species of *Atlantocuma* (Crustacea: Cumacea), and a new genus and species from Japan, Northwest Pacific, with observations on the degeneration of mouthparts in ovigerous females

TADASHI AKIYAMA

Ushimado Marine Laboratory, Okayama University, Ushimado, Okayama 701-4303, Japan. E-mail: akiyama@uml.okayama-u.ac.jp

Abstract

Two species of the cumacean genus *Atlantocuma* from the southern coast of Honshu, Japan, 781–861 m depth, *A. gamoi* **sp. nov.** and *A. ojii* **sp. nov.**, and *Pseudopicrocuma japonicum* **gen et sp. nov.** from Nansei Islands, 566–1769 m depth, are described. *Atlantocuma gamoi* is characterized by (1) carapace elevated in preparatory and ovigerous female, (2) antero-lateral angle of carapace with 3 teeth in females, and (3) pseudorostrum of carapace of adult males truncate, anterolateral angle without teeth. *Atlantocuma ojii* is characterized by (1) carapace not elevated in preparatory females, but elevated in ovigerous females, (2) inferior margin of carapace in ovigerous female serrated for entire length, (3) pseudorostrum of carapace in adult males truncate, (4) uropod exopod with 1–2 spiniform setae on inner margin, except for subterminal one. The new genus *Pseudopicrocuma*, which is similar to *Picrocuma* from shallow waters of eastern Australia, is characterized by (1) well-developed exopods present on maxilliped 3 and pereopods 1–3 in both sexes, (2) antenna 1 of adult males with many aesthetascs-like sensory setae on peduncle articles 2 and 3, (3) male antenna 2 of clasping form, and (4) uropod slender, peduncle shorter than rami. *Pseudopicrocuma* shows affinity to *Atlantocuma* except for (1) arrangement of well-developed exopods on pereopods, (2) male antenna 2 flagellum of clasping form, and (3) uropod peduncle shorter than rami. In addition, *P. japonicum* and the new Japanese *Atlantocuma* species are characterized by a similar trend in degeneration of mouthparts (mandibles – maxillipeds 2) in ovigerous females, suggesting a rather close relationship of these genera with quite different arrangements of exopods on pereopods. These 2 genera are currently placed in Nannastacidae. Other possible relatives of *Pseudopicrocuma* are *Spilocuma* (Bodotriidae) and *Claudicum* (Nannastacidae).

Key words: Crustacea, Cumacea, *Atlantocuma*, *Pseudopicrocuma*, new genus, new species, deep-sea, Northwest Pacific

Introduction

A few cumacean genera with pleotelsons are problematic in their family placement. One of these genera is *Atlantocuma*, consisting of 5 known species, from bathyal and abyssal waters of the Atlantic, Antarctic, the western Indian Ocean and the southeastern Pacific (Băcescu and Muradian 1974; Băcescu 1988, Jones 1984; Ledoyer 1988, 1993; Petrescu 1995; Mühlenhardt-Siegel 2005; Corbera 2006). This genus is characterized by (1) mandibles navicular, (2) pleopods absent in both sexes (3) well developed exopod present on maxilliped 3 and pereopods 1–4 in males, on maxilliped 3 and pereopod 1 in females. Băcescu and Muradian (1974) did not note anything with regard to the family placement of their newly established genus. Jones (1984) placed the genus in Nannastacidae with considerable doubt, noting that it could be an "aberrant member of Bodotriidae", based on overall appearance of the body and mouthparts. Băcescu (1988) placed *Atlantocuma* in Bodotriidae (subfamily Bodotriinae), which was followed by Petrescu (1995) and Mühlenhardt-Siegel (2005). However, Ledoyer (1988, 1993) placed the genus in Nannastacidae. Haye (2007) also placed the genus outside of Bodotriidae in her phylogenetic analysis of the family, based on morphological characters.

Another genus with similar problems is *Picrocuma* Hale, 1936, from shores along the eastern coast of Australia. This genus is characterized by (1) pleopods absent in males and females, (2) well-developed exopods present on maxilliped 3 and pereopods 1–3 in both sexes, and (3) antenna 2 of adult males with short, clasping form of fla-

gellum. Hale (1945) assigned *P. poecilotum* Hale, 1936 to the family Nannastacidae, based on the morphology of the males. However, Băcescu (1988) recognized this genus as a member of the family Bodotriidae (subfamily Vaunthompsoniinae). Thereafter, an additional 2 congeners were placed in Bodotriidae (Taffe & Greenwood 1996; Mühlenhardt-Siegel 2003). However, Haye (2007) placed the genus outside of Bodotriidae based on the phylogenetic analysis as was the case for *Atlantocuma*. Corbera et al. (2008) provisionally placed this genus (and *Atlantocuma*) in Nannastacidae for comparison of the new hydrothermal vent nannastacid genus *Thalycrocuma*, from the Mid Atlantic, with other genera of the family including *Picrocuma*.

The present study reports two new species of the genus *Atlantocuma* and a new genus and species which is similar to *Picrocuma*, from bathyal waters of southern Japan, Northwest Pacific. Morphological characters of these 2 genera are compared.

Material and methods

The specimens were collected during a survey of benthic fauna of southern Japan by R/V *Tansei-maru* of the Japan Agency for Marine-Earth Science and Technology (JAMSTEC) (cruises KT-08-3 and KT-10-16) and T/S *Nagasaki-maru* of Nagasaki University (Cruise N295), in 2008–2010. Gear used for collection was an ORE beam trawl of 3 m span. Small ring nets (30 cm in diameter, 130 cm in length) equipped with 0.5 mm nylon mesh were attached to the beams of the trawl. The collected sediment samples were sieved through iron mesh of 4 mm opening and nylon mesh of 0.5 mm opening to remove muddy or sandy particles and large animals. The processed sediment samples were preserved in 5–10 % borate buffered formalin sea water. Cumacean specimens were sorted out of the sediment samples under a stereo microscope (Leica MZ6 and MZ125) in the laboratory and preserved in 5 % borate buffered formalin sea water or 70 % ethanol.

The specimens were examined under a stereo microscope (Leica MZ125) and a light microscope (Nikon E600) equipped with drawing tubes. After observation, the specimens were preserved in 70 % ethanol. The specimens examined are deposited in the National Museum of Nature and Science, Tokyo (NSMT).

Taxonomy

Genus *Atlantocuma* Băcescu and Muradian, 1974

Diagnosis. Carapace without ridges or carina, dorsal surface arched; pseudorostrum pointed in females, truncate or weakly pointed in males. Pleon slender, with no pleopods in both sexes, with pleotelson. Antenna 1 main flagellum 3-articulate in female, 4-articulate in male; accessory flagellum uni-articulate, minute in both sexes. Female antenna 2 bi- or tri-articulate, strongly bent at median portion. Male antenna 2 not clasping form; flagellum short, of about 10 articles. Mandibles navicular. Well-developed exopods present on maxilliped 3 and pereopod 1 in females, on maxilliped 3 and pereopods 1–4 in males. Uropod peduncle much longer than rami; endopod uni-articulate.

Atlantocuma gamoi sp. nov.

(Figs. 1–4)

Diagnosis. Carapace elevated in preparatory and ovigerous females; pseudorostrum 0.16–0.18 times carapace in females; anterolateral angle with 3–4 teeth; inferior margin not serrated. Pereopod 1 carpus 1.5–1.8 times propodus. Uropod peduncle 2.1–2.3, 2.6–2.8 times pleonite 6, 1.9–2.0, 2.2–2.4 times endopod in preparatory and ovigerous females, respectively; exopod without spiniform setae on inner margin except for subterminal one. Pseudorostrum in adult male truncate; anterolateral angle without teeth. Uropod peduncle 2.8–3.0 times pleonite 6, 1.7–1.8 times endopod in adult male

Material examined. Holotype. Preparatory female, 4.24 mm (NSMT-Cr 22180), Shima Spur, southern coast of Honshu Island, 34°00.72'N, 136°53.28'E – 34°01.55'N, 136°52.98'E, 781–789 m (KT-08-3, St. SM-01-2), 4

March 2008. Paratypes, 6 preparatory females, 5 specimens dissected, 4.07–4.29 mm, 6 ovigerous females, 4.20–4.42 mm, 5 specimens dissected, 4 adult males (1 specimen damaged), 3.76–3.95 mm, 3 specimens dissected (NSMT-Cr 22181), same locality and date as holotype specimen (KT-08-3, St. M-01-2).

Description. Preparatory females. 4.07–4.29 mm (Figs. 1, 2). Body moderately calcified, with few hairs. Carapace smooth, with no ridges or carina, 0.30–0.31 times total body length, 1.86–1.95 times width and 1.64–1.74 times depth. Integument with small scale-like sculpture. Pseudorostrum, 0.16–0.18 times carapace length. Width of triangular eye lobe 0.12–0.15 times carapace width; antennal notch well defined; anterolateral angle with 3–4 teeth directing forward (Fig. 1C, D); inferior margin smooth, without teeth. Pereon 0.57–0.60 times carapace length; pereonite 1, narrow tightly jointed to carapace; pereonite 3 well developed; pereonite 3–5 small. Pleon slender, 0.51–0.52 times total length; combined length of carapace and pereon longer than pereonites 1–5 together; posterior end of pleonite 6 slightly exceeding opening of anus (Fig. 2E).

Antenna 1 (Fig. 1E) peduncle article 1 thick and curved, 0.7–0.9 times combined length of articles 2 and 3, with rows of fine hairs on ventral surface; article 3 0.96–1.13 times article 2. Main flagellum tri-articulate; article 1 0.8–0.9 times combined length of articles 2 and 3; article 3 minute, with 2 aesthetascs and 2 long setae; uni-articulate accessory flagellum 0.4–0.5 times article 1 of main flagellum. Antenna 2 (Fig. 1F) tri-articulate; basal article with a plumose seta on distal margin; distal article with simple seta on lateral margin and a few setae on apical end. Mandibles (Fig. 1G) with 4 setae, respectively; lacinia mobilis slender, bi-dentate; incisor process directing inward. Labium (Fig. 1H) pointed distally, with 1 bi-dentate seta and 1 simple seta on tip. Maxilla 1 (Fig. 1I) outer endite with 12 spiniform setae; inner endite with 1 tri-dentate, 1 bi-dentate and 1 simple seta; palp with 2 filaments. Maxilla 2 (Fig. 1J) with 5 setae on 2 narrow endites, respectively; broad endite with a row of about 15 thin simple setae on inferior margin.

Maxilliped 1 (Fig. 1K, L) with 5 rudimental branchial lobules; basis longer than combined length of distal articles; carpus with a row of 6 broad, serrated setae and 3–4 simple setae on inner margin, with plumose seta on outer margin; propodus with 4 setae on inner distal corner; dactylus with 2 minute terminal setae. Maxilliped 2 (Fig. 1M) basis as long as succeeding 4 articles together, with 2 plumose seta on inner margin; carpus shorter than merus, with 1 simple and 1 plumose setae on inner margin; propodus with 2 simple setae on inner margin; dactylus minute, with 2 terminal setae. Maxilliped 3 (Fig. 1N) basis 1.6–1.7 times remaining distal articles, with 2 long plumose seta on outer distal corner, with fine hairs on inner margin; carpus 1.3–1.4 times propodus, with 3 simple and 0–1 plumose setae on inner margin; propodus with 2 simple setae on inner margin distally. Pereopod 1 (Fig. 1O) basis 1.2–1.3 times distal articles together, with 1 robust seta on inner distal corner, carpus 1.5–1.8 times propodus; propodus 1.8–2.0 times dactylus; dactylus with 1 stiff, simple terminal seta. Pereopod 2 (Fig. 2A) basis 0.8–0.85 times remaining distal articles, with a couple of simple setae on lateral margin; carpus 1.1–1.5 times merus; dactylus 1.1–1.2 times carpus, with 5 robust setae on lateral margin and distal end. Pereopod 3 (Fig. 2B) basis 1.0–1.2 times distal articles together, with a couple of simple setae on lateral margin; carpus 1.7–2.2 times propodus; terminal seta fused with dactylus. Pereopod 4 (Fig. 2C) basis 0.7–0.8 times distal articles together, with a couple of seta on lateral margin; carpus 1.9–2.1 times propodus. Pereonite 5 (Fig. 2D) basis 0.6 times distal articles together; carpus 1.9–2.2 times propodus; terminal seta defined at base.

Uropod (Fig. 2E) peduncle 2.1–2.3 times pleonite 6, 1.83–1.97 times exopod and 1.88–2.03 times endopod, with 1 minute spiniform seta on inner distal corner; exopod 1.01–1.05 times endopod, with robust simple seta terminally and with 2 simple setae subterminally; endopod uni-articulate, with 5–7 spiniform setae on inner margin; terminal seta robust.

Ovigerous females, 4.20–4.22 mm (Fig. 3). Carapace 0.29–0.31 times total body length, 1.5–1.7 times carapace width and 1.4–1.1.6 times depth; dorsal surface markedly elevatè posteriorly; pseudorostrum 0.16–0.18 times carapace length; width of eye lobe 0.10–0.12 times carapace width; antennal notch and anterolateral angle similar to preparatory females; inferior margin smooth. Pereon 0.60–0.69 times carapace; 1st segment well developed. Pleon slender, 0.50–0.51 times total body length. No food residue present.

Antenna 1 (Fig. 3D) peduncle article 1 0.6–0.7 times combined length of articles 2 and 3; article 3 1.05–1.12 times article 2; main flagellum 1.0 times article 3 of peduncle; main flagellum article 1 0.9–1.0 times combined length of articles 2 and 3; accessory flagellum 0.4 times article 1 of main flagellum. Antenna 2 similar to preparatory females. Mandibles (Fig. 3F) wholly decalcified and flattened; setae on inner margin and lacinia mobilis reduced. Maxilla 1 (Fig. 3G) with minute setae on both outer and inner endites. Maxilla 2 (Fig. 3H) broad and narrow endites with minute setae.

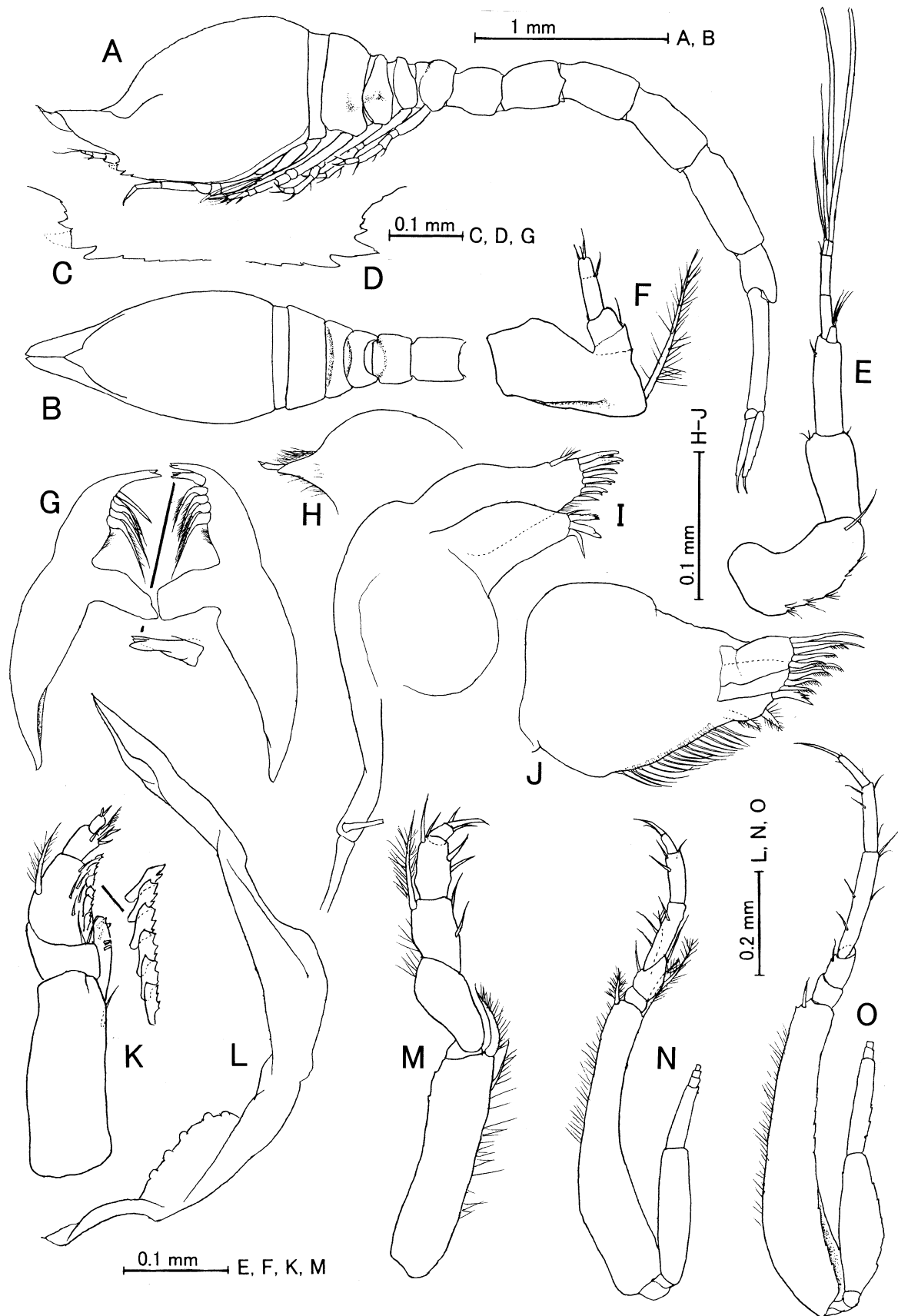


FIGURE 1. *Atlantocuma gamoi* sp. nov., preparatory female. A, lateral view; B, anterior portion of body, from above; C, D, anterolateral angle E, antenna 1; F, antenna 2; G, right and left mandibles; H, labium; I, maxilla 1; J, maxilla 2; K, L, maxillipeds 1; M, N, maxilliped 2 and 3; O, pereopod 1.

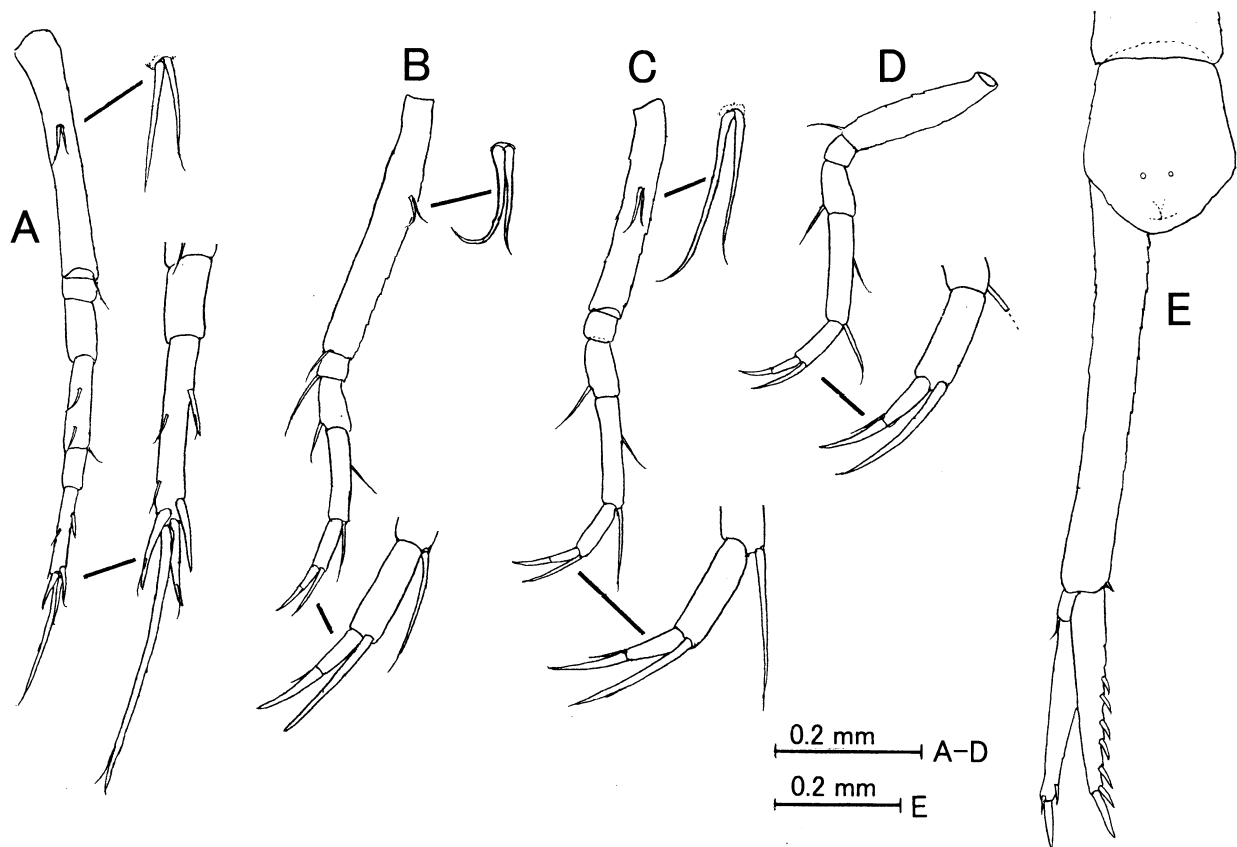


FIGURE 2. *Atlantocuma gamoi* sp. nov., preparatory female. A–D, pereopods 2–5; E, uropod with pleonite 6.

Maxilliped 1 (Fig. 3I) slender; serrated setae on inner margin of carpus thinner than preparatory females. Maxilliped 2 (Fig. 3J) slender; stiff plumose seta on inner distal corner of basis absent. Maxilliped 3 (Fig. 3K) basis 1.7–1.9 times distal articles together, with 7–9 stiff plumose setae on inner margin; merus with 1 plumose seta on inner distal corner. Pereopods 1–5 (Fig. 3L–P) similar to preparatory females. Uropod (Fig. 3Q) peduncle elongate, 2.6–2.87 times pleonite 6, 2.12–2.35 times exopod, 2.22–2.37 times endopod; exopod 1.01–1.05 times endopod; endopod with 5–7 spiniform setae on inner margin.

Adult males, 3.76–3.95 mm (Fig. 4). Body slender, weakly calcified. Integument of carapace covered with scale-like sculptures (Fig. 4D). Carapace length 0.29–0.30 times total body length, 2.1–2.2 times greatest width and 1.9–2.0 times depth. Dorsal surface of carapace weakly arched; pseudorostrum truncate, 0.068–0.079 times carapace length; antennal notch shallow; anterolateral angle (Fig. 4C) and inferior margin smooth, with no teeth; width of eye lobe 0.17–0.20 times carapace width.

Antenna 1 (Fig. 4E) peduncle article 1 0.5–0.6 times combined length of articles 2 and 3; article 3 1.2–1.3 times article 2. Main flagellum 4-articulate, 0.8–0.9 times article 3 of peduncle; articles 1, 3 and 4 with 2 aesthetascs, respectively; accessory flagellum uni-articulate, 0.9–1.0 times article 1 of main flagellum. Antenna 2 (Fig. 4F) peduncle article 4 and 5 subequal in length, with numerous long sensory setae; flagellum of 10 articles of normal size and 1 minute terminal one, 0.7–0.9 times peduncle.

Maxilliped 3 (Fig. 4G) basis 1.7 times distal articles together. Pereopods 1–4 basis massive, with well-developed exopods. Pereopod 1 (Fig. 4H) basis 1.3 times distal articles together; carpus 1.6–1.7 times propodus, carpus with 5–6 simple setae on lateral margin and distal corner. Pereopod 2 (Fig. 4I) basis 1.0–1.1 times remaining distal articles; carpus with 3–4 setae. Pereopod 3 (Fig. 4J) basis 1.3–1.4 times distal articles together; carpus with 2–3 simple setae. Pereopod 4 (Fig. 4K) basis 1.0–1.1 times distal articles together; carpus with 2–3 simple setae. Pereopod 5 (Fig. 4L) basis 0.7–0.8 times distal articles together.

Uropod (Fig. 4M) elongate, peduncle 2.8–3.0 times pleonite 6, 1.70–1.72 times exopod, 1.70–1.75 times endopod; exopod 0.99–1.03 times endopod, with subterminal spiniform seta on inner margin; endopod with 13–15 spiniform setae on inner margin.

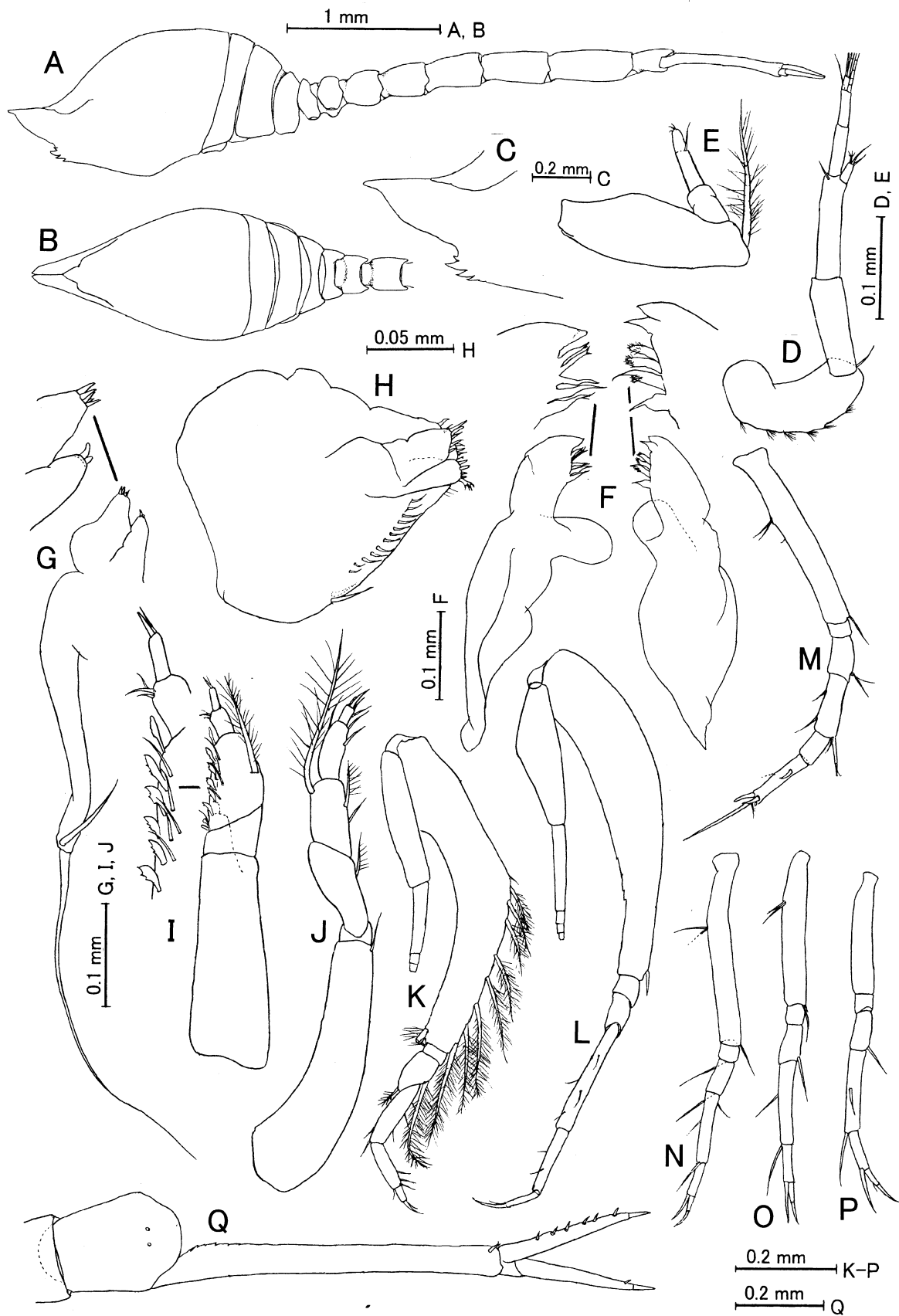


FIGURE 3. *Atlantocuma gamoi* sp. nov., ovigerous female. A, lateral view; B, anterior portion of body, from above; C, anterior portion of carapace, lateral view; D, antenna 1; E, antenna 2; F, right and left mandibles; G, maxilla 1; H, maxilla 2; I-K, maxillipeds 1-3; L-P, pereopods 1-5; Q, uropod with pleonite 6.

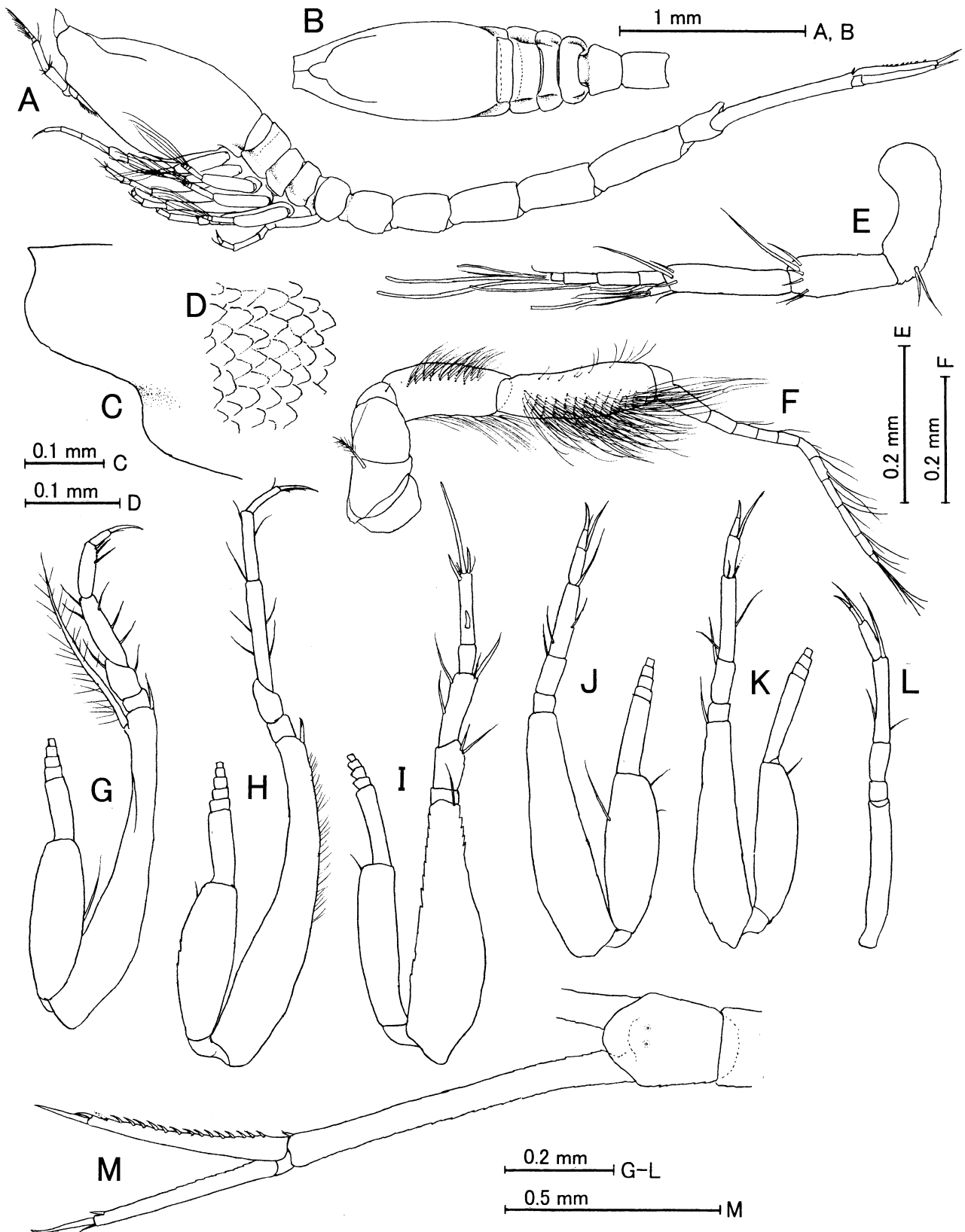


FIGURE 4. *Atlantocuma gamoi* sp. nov., adult male. A, lateral view; B, anterior portion of body, from above; C, anterior portion of carapace, lateral view; D, sculpture of integument of carapace; E, antenna 1; F, antenna 2; G, maxilliped 3; H-L, pereopods 1-5; Q, uropod with pleonite 6.

Etymology. The species name is dedicated to Dr. Sigeo Gamô, in his honor of contribution to cumacean taxonomy.

Remarks. The present new species resembles *A. tenue* Jones, 1984 from the deep Atlantic in which carapace of the ovigerous female is elevated, however, it can be distinguished from the latter by (1) carapace of preparatory females also elevated, (2) maxilliped 3 basis less than 2 times remaining articles (3 times in *A. tenue*), (3) uropod endopod with 5–7 spiniform setae (12–13 in *A. tenue*), and (4) male pseudorostrum truncate (pointed in *A. tenue*).

Atlantocuma gamoi is also similar to *A. ramses*, Miuhlenhardt-Siegel, 2005 from the deep Atlantic, 5415 m, but is distinguished from the latter by (1) uropod peduncle length less than 3 times pleonite 6 (3.25 times in *A. ramses*), (2) uropod endopod of females with 5–7 spiniform setae (9 setae in *A. ramses*) (3) maxilliped 2 merus longer than carpus (subequal in length in *A. ramses*), (4) maxilliped 2 merus without long setae (with 1 long plumose seta in *A. ramses*), (5) carapace of adult males without tooth on anterolateral angle (with a tooth in *A. ramses*).

The ovigerous females are characterized by a degeneration of the mouthparts (1) wholly decalcified mandibles, (2) reduced number and size of setae on inner margin of mandibles, maxilla 1 and 2, and maxilliped 2, and (3) maxilliped 1 and 2 slender. Other noteworthy characters of the ovigerous females are elevation of carapace, and maxilliped 3 with stiff plumose setae on inner margin.

Distribution. Southern coast of Honshu, Northwest Pacific, 781–789 m.

Atlantocuma ojii sp. nov.

(Figs. 5–8)

Diagnosis. Carapace elevated only in ovigerous female; pseudorostrum length 0.16–0.20 times carapace in preparatory females; anterolateral angle with about 3 teeth; inferior margin not serrated in preparatory female, serrated for entire length in ovigerous female. Pereopod 1 carpus 1.7–2.0 times propodus. Uropod peduncle 2.6–2.9, 2.9–3.3 times pleonite 6, 2.2–2.4, 2.5–2.8 times endopod, in preparatory and ovigerous females, respectively; exopod with 1–2 spiniform setae on inner margin, except for subterminal one. Pseudorostrum in adult male truncate, anterolateral angle without teeth. Uropod peduncle 3.7 times pleonite 6, 2.0 times endopod in adult male.

Material examined. Holotype preparatory female, 4.70 mm (NSMT-Cr 22182), Shima Spur, southern coast Honshu, 34°00.72'N, 136°53.28'E – 34°01.55'N, 136°52.98'E, 781–789 m (KT-08-3, St. SM-1-2), 4 March 2008. Paratypes; 7 preparatory female, 5 specimens dissected, 4.48–4.78 mm, 5 ovigerous females, dissected, 4.50–4.77 mm, (NSMT-Cr 22183), same locality as holotype female (KT-08-3, St. SM-1-2); 3 adult males (1 specimen damaged), dissected, 3.85–4.16 mm (NSMT-Cr 22184), Shima Spur, 34°00.53'N, 136°52.49'E–34°00.02'N, 136°52.32'E, 810–861 m (KT-10-16, St. SK2), 14 August, 2010.

Description. Preparatory females, 4.48–4.78 mm (Figs. 5, 6). Body moderately calcified, with few hairs. Carapace (Fig. 5C) slender, 0.27–0.29 times total body length, 1.97–2.13 times carapace width and 1.80–1.97 times carapace depth; pseudorostrum pointed, 0.18–0.20 times carapace length; width of triangular eye lobe (Fig. 5B) 0.12–0.14 times carapace width; antennal notch shallow; anterolateral angle with 3 teeth; inferior margin smooth (Fig. 5C). Pereon 0.51–0.60 times carapace length (Fig. 5A); posterior portion of pereonite 1 covered by pereonite 2. Pleon 0.52–0.56 times total animal length (Fig. 5A); combined length of carapace and pereon shorter than pereonites 1–5 together.

Antenna 1 (Fig. 5D) peduncle article 1 thick and curved, 0.6–0.8 times combined length of articles 2 and 3, with fine hairs on ventral surface; article 3 0.9–1.1 times article 2. Main flagellum 3-articulate, 1.0–1.1 times article 3 of peduncle, with 2 aesthetascs and 2 long setae on tip; article 1 0.8–0.9 times combined length of articles 2 and 3; article 3 minute; accessory flagellum uni-articulate, 0.4–0.5 times article 1 of main flagellum. Antenna 2 (Fig. 5E) tri-articulate; basal article with a plumose seta on distal end; median and distal articles with simple seta. Right and left mandibles (Fig. 5F) with 4 setae; lacinia mobilis long and slender; incisor process directed inward. Arrangement of setae on maxilla 1 and 2 (Fig. 5G, H) normal for the genus.

Maxilliped 1 (Fig. 5I) basis longer than distal articles together, with 4–5 rudimentary branchial lobules; basis longer than combined length of distal articles; carpus with 6 broad, serrated setae and 5 simple setae on inner margin, with 1 plumose seta on outer margin; propodus with 4 setae on inner distal corner; dactylus with 2 thin terminal setae. Maxilliped 2 (Fig. 5J) basis 0.9–1.0 times combined length of succeeding 4 articles, with 1 plumose seta on inner margin and 1 plumose seta on inner distal corner; carpus shorter than merus, with 1 simple and 1 plumose

setae on inner margin; dactylus with 2 minute terminal setae. Maxilliped 3 (Fig. 5K) basis 1.6–1.8 times remaining distal articles, with 2 long plumose setae on outer distal corner and fine hairs on inner margin; carpus with 3 simple setae on inner margin. Pereopod 1 (Fig. 6A) basis 1.1–1.2 times length of distal articles together, with 1 robust spiniform seta and 1 minute spine on inner distal corner, carpus 1.7–2.0 times propodus, propodus 1.7–2.0 times dactylus; dactylus with stiff terminal seta. Pereopod 2 (Fig. 6B) basis 0.7–0.9 times remaining distal articles, with a couple of simple setae on lateral margin; carpus 1.2–1.4 times merus; dactylus 1.1–1.3 times carpus. Pereopod 3 (Fig. 6C) basis 1.1 times distal articles together, with a couple of simple setae on lateral margin; carpus 2.0–2.1 times propodus. Pereopod 4 (Fig. 6D) basis 0.8 times distal articles together, with a couple of simple setae on lateral margin; carpus 2.1–2.4 times propodus. Pereonite 5 (Fig. 6E) basis 0.6 times distal articles together; carpus 2.3–2.5 times propodus.

Uropod (Fig. 6F) peduncle 2.6–2.9 times pleonite 6, 2.16–2.36 times exopod and 2.17–2.41 times endopod, with minute spiniform setae on inner distal corner; exopod 1.00–1.07 times endopod, with spiniform setae on inner margin except for subterminal one; endopod uni-articulate, with 8–10 spiniform setae on inner margin.

Ovigerous females, 4.50–4.77 mm (Fig. 7). Carapace markedly elevate (Fig. 7C); Carapace length 0.27–0.29 times total body length, 1.5–1.7 times carapace width and 1.6–1.7 times depth; pseudorostrum 0.16–0.19 times carapace length; width of eye lobe 0.09–0.10 times carapace width; antennal notch shallow; anterolateral angle and inferior margin serrated with 25–27 teeth (Fig. 7C). Pereon 0.56–0.68 times carapace (Fig. 7A). Pleon 0.54 times total body length. No food residue present.

Antenna 1 (Fig. 7D) peduncle article 1 0.6–0.7 times combined length of articles 2 and 3; article 3 0.9–1.1 times article 2; main flagellum 1.0–1.1 times article 3 of peduncle. Main flagellum article 1 0.8–0.9 times combined length of articles 2 and 3; accessory flagellum uni-articulate, 0.4–0.5 times article 1 of main flagellum. Mandibles (Fig. 7E) decalcified and flattened, setae on inner margin reduced; lacinia mobilis not identifiable. Maxilla 1 and 2 with reduced simple setae (Fig. 7F, G). Maxilliped 1 (Fig. 7H) slender; carpus with thin serrated setae on inner margin. Maxilliped 2 (Fig. 7I) slender, basis 1.2–1.3 times combined length of next 4 articles; carpus with 2 thin short simple setae on lateral margin.

Maxilliped 3 (Fig. 7J) basis 1.2–1.3 times distal articles together, with 6–8 plumose setae on inner margin; merus with 1 plumose seta on inner distal corner. Pereopods 1–5 (Fig. 7K–O) similar to preparatory females. Uropod (Fig. 7P) peduncle 2.9–3.3 times pleonite 6, 2.4–2.8 times exopod, 2.5–2.8 times endopod; exopod 0.92–1.07 times endopod, with 1–2 spiniform setae on inner margin except for subterminal one; endopod with 8–11 spiniform setae on inner margin.

Adult males, 3.85–4.16 mm (Fig. 8). Body slender, weakly calcified. Carapace 0.26–0.27 times total body length, 2.3 times greatest width and 2.0–2.1 times depth (fig. 8A, B). Dorsal surface weakly arched; pseudorostrum (Fig. 8B) truncate, 0.07–0.08 times carapace length; antennal notch well marked; anterolateral angle and inferior margin smooth, without teeth; width of eye lobe 0.16–0.18 times carapace width.

Antenna 1 (Fig. 8D) peduncle article 1 0.46–0.57 times combined length of articles 2 and 3; article 3 0.9–1.1 times article 2. Main flagellum 4-articulate, as long as article 3 of peduncle; accessory flagellum uni-articulate, 1.0–1.1 times article 1 of main flagellum. Antenna 2 (Fig. 8E) peduncle article 4 and 5 with numerous thin long setae; flagellum 0.8–0.9 times peduncle, of 11 articles, terminal one minute.

Maxilliped 3 (Fig. 8F) basis 1.7–1.8 times distal articles together, with fine hairs on inner margin. Pereopods 1–4 with well-developed exopods. Pereopod 1 (Fig. 8G) basis 1.2–1.3 times distal articles together; carpus 1.8–1.9 times propodus, with 8–11 simple setae on lateral margin and distal corner. Pereopod 2 (Fig. 8H) basis 1.0–1.2 times remaining distal articles; carpus with 7 simple setae. Pereopod 3 (Fig. 8I) basis 1.3–1.5 times distal articles together; carpus with 6–7 simple setae. Pereopod 4 (Fig. 8J) basis 1.0–1.2 times distal articles together; carpus with 7 simple setae. Pereonite 5 (Fig. 8K) basis 0.7 times distal articles together; carpus with 7–8 simple setae.

Uropod (Fig. 8L) elongate, peduncle 3.7 times pleonite 6, 1.95–1.98 times exopod, 1.98–2.03 times endopod; exopod 1.02–1.03 times endopod, with 2–3 spiniform setae except for subterminal one; endopod with 15–16 spiniform setae on inner margin.

Etymology. The species name is dedicated to Dr. Tatsuo Oji, director of the R/V *Tansei-maru* cruises during which all *Atlantocuma* specimens examined in the present study were collected.

Remarks. *Atlantocuma oji* sp. nov. resembles *Atlantocuma tenue* Jones, 1984, from deep Atlantic and the Southeast Pacific, 587–5000 m, in the shape of carapace in preparatory and ovigerous females. However, the former species is distinguished from the latter by (1) pereopod 1 carpus 1.7–2.0 times propodus, dactylus less than

2 times dactylus (carpus about 1.5 times propodus, propodus 2 times dactylus in *A. tenue*), (2) uropod peduncle 2.6–3.3 times pleonite 6 (2.4 times pleonite 6 in *A. tenue*), (3) uropod exopods with 1–3 spiniform setae on inner margin except for subterminal one (no setae in *A. tenue*), (4) pseudorostrum of adult males truncate (pointed in *A. tenue*).

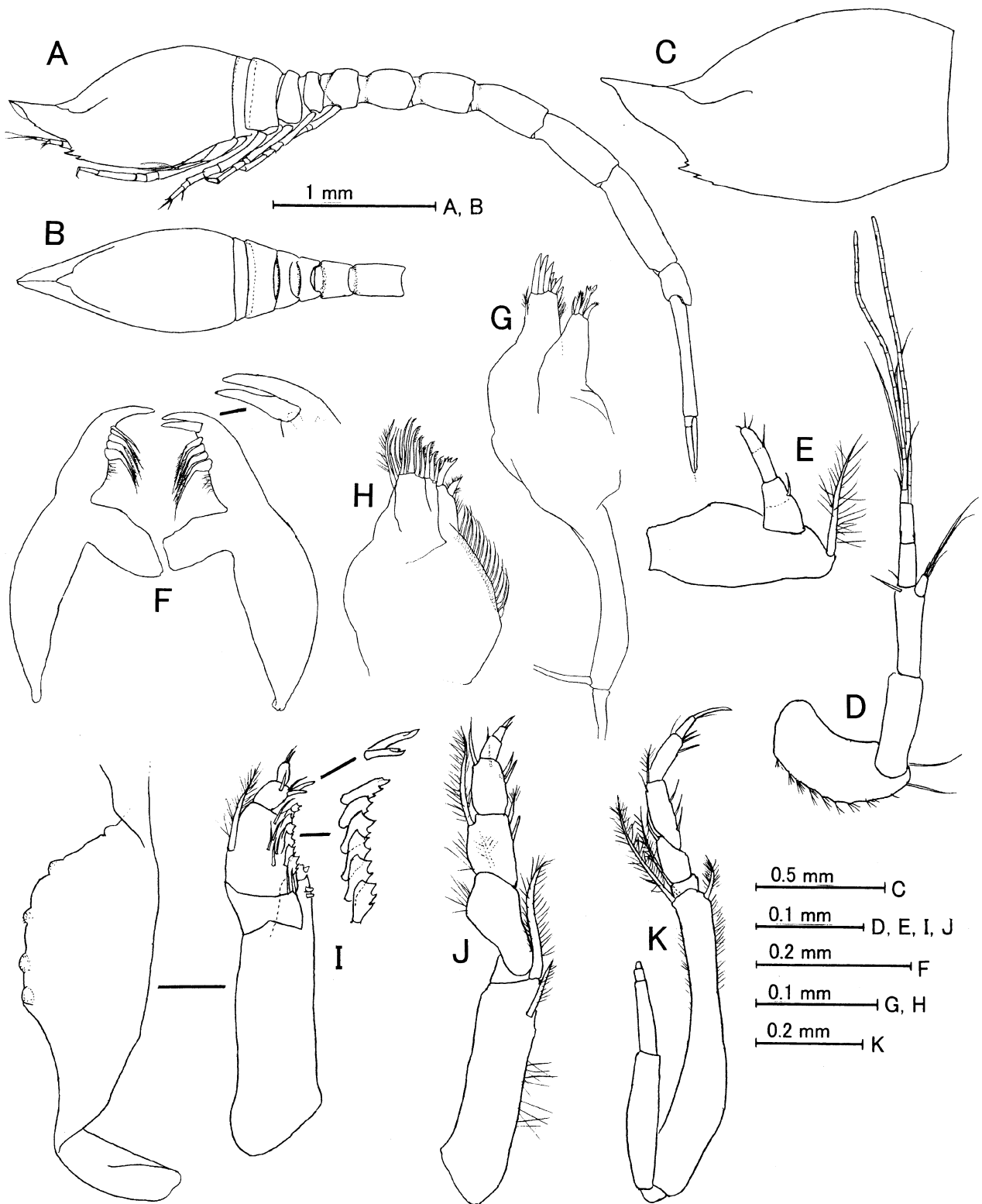


FIGURE 5. *Atlantocuma ojii* sp. nov., preparatory female. A, lateral view; B, anterior portion of body, from above; C, carapace, lateral view; D, antenna 1; E, antenna 2; F, right and left mandibles; G, maxilla 1; H, maxilla 2; I–K, maxillipeds 1–3.

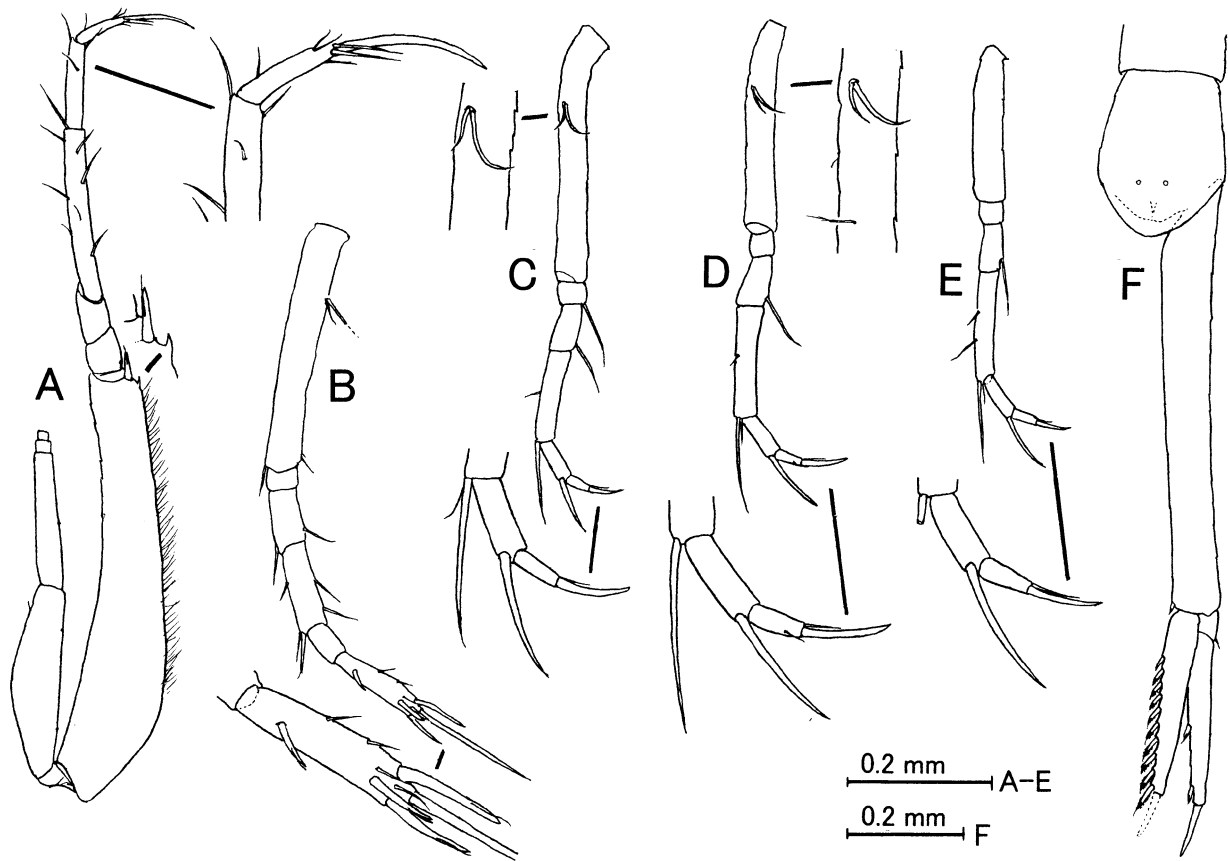


FIGURE 6. *Atlantocuma ojii* sp. nov., preparatory female. A–E, pereopods 2–5; F, uropod with pleonite 6.

The new species also resembles *Atlantocuma ramses* Muihlenhardt-Siegel, 2005, but can be distinguished by (1) maxilliped 2 merus shorter than carpus (subequal in length in *A. ramses*), (2) long plumose seta absent on merus of maxilliped 2 (present in *A. ramses*), (3) basis of maxilliped 3 in females 1.2–1.8 times distal articles together (1.96 times in *A. ramses*), (4) anterolateral angle of adult male without teeth (with a tooth in *A. ramses*).

Atlantocuma ojii is distinguishable from *A. gamoi*, collected from the same locality, by (1) carapace of preparatory female elevated, (2) inferior margin of carapace in ovigerous females serrated (not serrated in *A. gamoi*), (3) combined length of carapace and pereon shorter than length of pleonite 1–5 together (longer in *A. gamoi*), and (4) uropod exopod with 2–3 spiniform setae on inner margin (1 spiniform seta in *A. gamoi*). Degeneration of mouthparts, and morphology of maxilliped 3 in ovigerous females show the same trends as *A. gamoi*.

Distribution. Southern coast of Honshu, Northwest Pacific, 781–861 m.

Pseudopicrocuma gen. nov.

Diagnosis. Carapace with no ridges or carina; dorsal surface arched; pseudorostrum pointed; eye lobe large, without corneal lenses. Antenna 1 main flagellum tri-articulate in female and 4-articulate in male; accessory flagellum much shorter than main flagellum basal article. Male antenna 1 with many sensory setae on peduncle articles 2 and 3. Female antenna 2 bi- or tri-articulate, strongly bent between basal and distal articles. Male antenna 2 clasping form; distal 2 articles of peduncle fused; flagellum of less than 10 articles. Mandibles navicular. Well-developed exopods present on maxilliped 3 and pereopods 1–3 in both sexes. Pleopods absent in both sexes. Uropod peduncle shorter than rami; endopod uni-articulate.

Etymology. The genus name refers to similarity of the new genus to *Picrocuma* Hale, 1936.

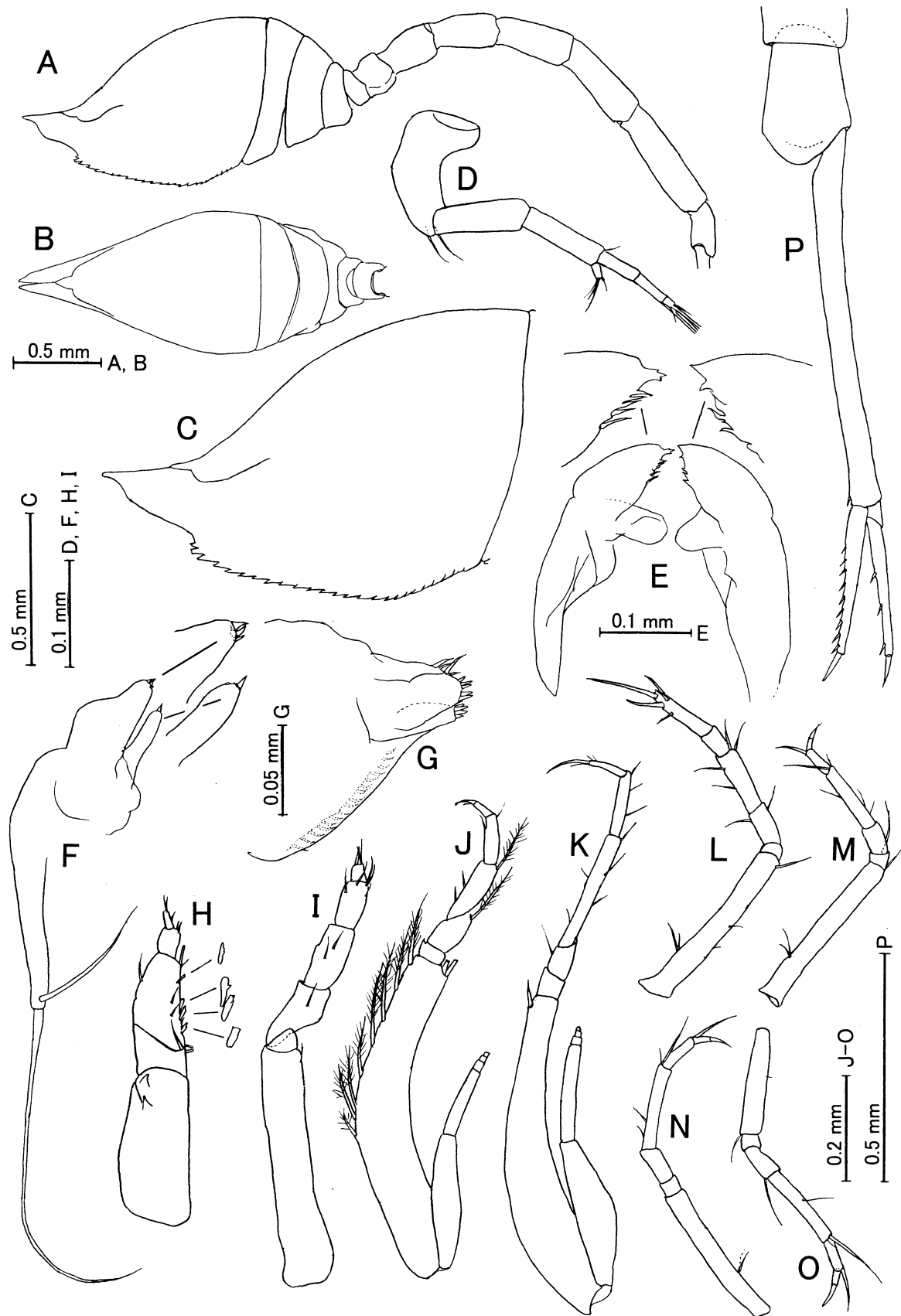


FIGURE 7. *Atlantocuma oji* sp. nov., ovigerous female. A, lateral view; B, anterior portion of body, from above; C, carapace, lateral view; D, antenna 1; E, right and left mandibles; F, maxilla 1; G, maxilla 2; H–J, maxillipeds 1–3; K–O, pereopods 1–5; Q, uropod with pleonite 6.

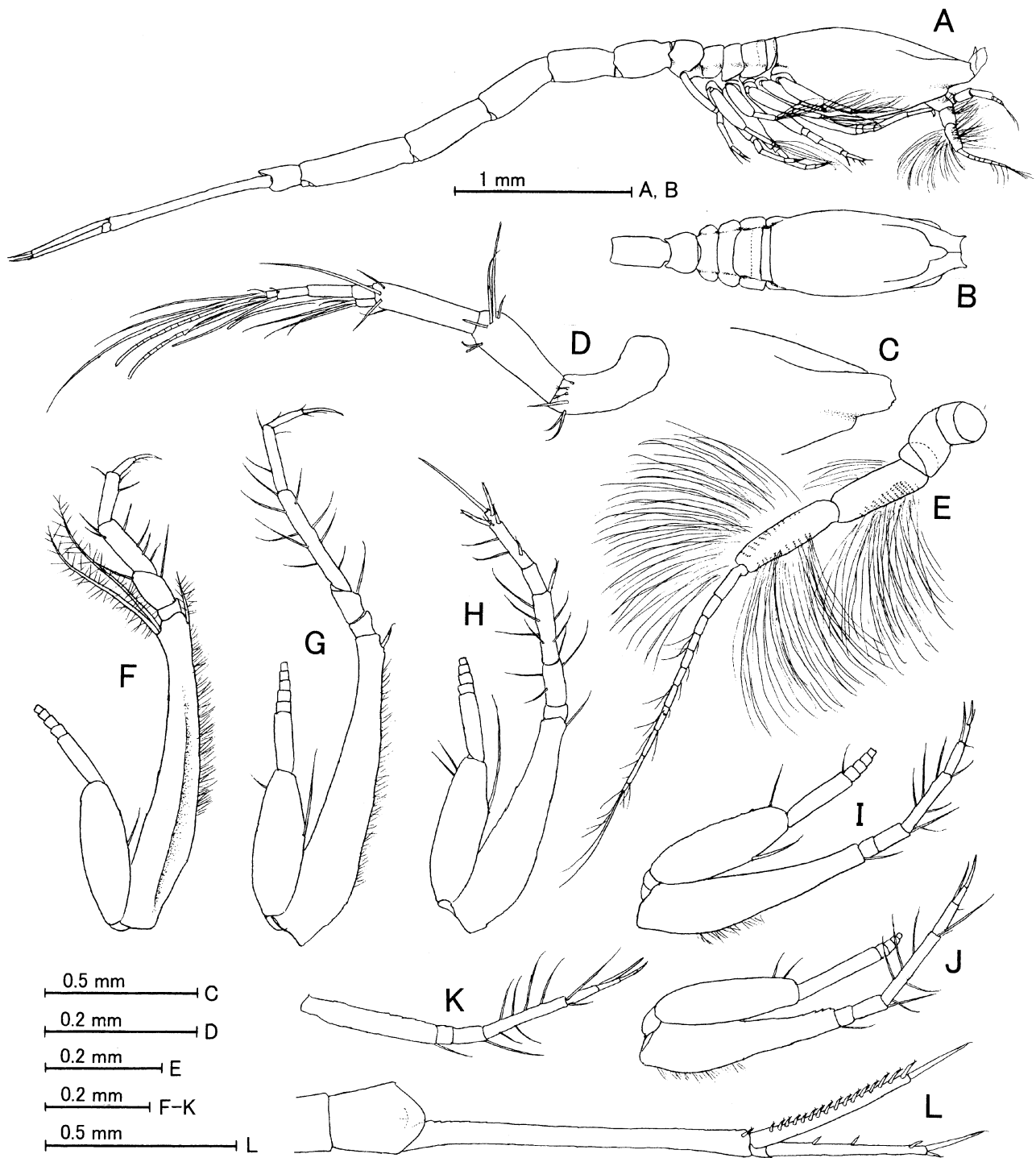


FIGURE 8. *Atlantocuma ojii* sp. nov., adult male. A, lateral view; B, anterior portion of body, from above; C, anterior portion of carapace, lateral view; D, antenna 1; E, antenna 2; F maxilliped 3; G–K, pereopods 1–5; Q, uropod with pleonite 6.

***Pseudopicrocuma japonicum* sp. nov.**
(Figs. 9–13)

Material examined. Holotype preparatory female, 3.23 mm (NSMT-Cr 22185), off Yakushima-Tanegashima, 29°51.42'N, 130°55.69'E – 29°49.82'N, 130°54.46'E, 1678–1769 m (KT-07-1, St. YT-3), 24 February, 2007. Paratypes; 2 adult males (1 specimen dissected), 2.92 mm, 3.08 mm, (NSMT-Cr 22186), same locality as holotype preparatory female (KT-07-1, St. YT-3); 1 preparatory female, 3.04 mm, 2 adult males, 2.86 mm, 2.88 mm, dissected

(NSMT-Cr 22187), off Yakushima-Tanegashima, 30°04.40'N, 130°59.95'E – 30°04.54'N, 130°57.89'E, 566–724 m (KT-07-1, St. YT-1), 24 February, 2007; 1 ovigerous female, 3.43 mm (damaged), 1 preparatory female, 3.20 mm, 2 adult males, 2.93 mm, 3.03 mm, dissected (NSMT-Cr 22188), north of Minami-Ensei Knoll, Okinawa Trough, 29°19.35'N, 127°37.37'E – 29°20.52'N, 127°37.96'E, 1018–1042 m (N295, St. Q-1), 21 November, 2009.

Description. Preparatory females, 2.92–3.23 mm (Figs 9, 10). Body moderately calcified, with few hairs. Carapace smooth, with no ridges, 0.33 times total body length, 1.8–1.9 times carapace width and 1.4–1.8 times carapace depth; dorsal surface arched; pseudorostrum acute, 0.19–0.21 times carapace length. Width of large eye lobe 0.20–0.25 times carapace width, corneal lens not observable, separated from frontal lobe by slight depressions on each side. Antennal notch very shallow; anterolateral angle (Fig. 9C) with 2 teeth directing forward, succeeded by minute teeth; inferior margin smooth. Pereon 0.55–0.76 times carapace length; posterior portion of pereonite 1 covered with well-developed pereonite 2. Pleon slender, 0.44–0.48 times total body length; pleonite 6 slightly exceeding opening of anus, with 2 minute setae on dorsal surface and a pair of perianal setae (Fig. 10G).

Antenna 1 (Fig. 9D) peduncle article 1 curved, 0.4 times combined length of articles 2 and 3; article 3 1.6–1.7 times article 2. Main flagellum tri-articulate, 0.5–0.6 times article 3 of peduncle; article 1 2.1–2.9 times combined length of articles 2 and 3; accessory flagellum 0.4 times article 1 of main flagellum. Antenna 2 (Fig. 9E) bi-articulate, strongly bent between basal and distal articles; basal article broad, with plumose seta near distal end; distal article slender, with simple seta on proximal region. Right and left mandibles (Fig. 9F) with 5 and 3 curved setae, respectively; lacinia mobilis tri-dentate; incisor process very weakly curved inward. Labium (Fig. 9G) round, without process or seta on distal margin. Maxilla 1 (Fig. 9H) outer endite with 12 spiniform setae; inner endite with 1 tridentate and 2 minute setae; palp with 2 filaments. Maxilla 2 (Fig. 9I) 2 narrow endites with 3 and 4 setae respectively, broad endite with a row of 12 simple setae on distal portion of inferior margin.

Maxilliped 1 (Fig. 9J) branchial lobules absent; basis subequal in length to distal articles together; carpus with 4 broad, serrated setae and 3 simple setae on inner margin, plumose seta on outer margin; propodus with 4 setae on inner distal corner; dactylus with 2 weakly curved simple setae on tip. Maxilliped 2 (Fig. 9K) basis 0.8–0.9 times combined length of succeeding 4 articles, with long plumose seta on inner distal corner; merus longer than carpus and subequal in length to propodus, with plumose seta on inner distal corner; carpus with 2 simple setae on inner margin and plumose seta on outer distal corner; propodus with simple seta on inner margin; dactylus minute with robust forked and serrated terminal seta. Maxilliped 3 (Fig. 10A) basis 1.0 times remaining distal articles, with plumose seta on inner distal corner and fine hairs on inner margin; outer distal corner of basis not protruding, with 2 long plumose setae; carpus 1.4 times propodus, slightly curved inward, with 2 simple setae on inner margin; propodus 4.9 times dactylus, slightly curved inward, with simple seta on inner and outer margins, respectively; dactylus with simple seta on inner distal corner and 2 simple setae on outer margin; 2 hooked terminal setae, one also robust and serrated. Pereopods 1–3 with well-developed exopods (Fig. 10B–D). Pereopod 1 (Fig. 10B) basis 0.8–0.9 times distal articles together, with 3 simple setae on inner margin and 1 robust seta and 1 long plumose seta on outer distal corner; carpus 1.7–1.8 times propodus, with 4 simple setae on inner and outer margins, respectively; propodus 2.0–2.3 times dactylus; dactylus with 2 simple terminal setae. Pereopod 2 (Fig. 10C) basis 0.6–0.7 times remaining distal articles, with 2 simple setae on inner distal corner; merus subequal in length to carpus; dactylus 2.2–2.3 times carpus. Pereopod 3 (Fig. 10D) basis 1.1 times distal articles together, with simple seta on distal corner; carpus 2.1–2.2 times merus and 1.6–1.8 times propodus, with 2 stiff simple setae distally; dactylus with 2 short terminal setae. Pereopod 4 (Fig. 10E) basis 0.8 times distal articles together, with a couple of simple setae on lateral margin and 1 simple seta on distal corner; merus 1.2–1.4 times ischium; carpus 1.8–2.3 times merus and 1.9–2.1 times propodus, with 2 long and 1 short simple setae on distal margin. Pereopod 5 (Fig. 10F) basis 0.6 times distal articles together; merus 1.2 times ischium; carpus 2.3 times merus and 1.9 times propodus.

Uropod (Fig. 10G) peduncle 1.9–2.1 times pleonite 6, 0.56–0.66 times exopod and 0.60–0.66 times endopod, with minute spiniform seta on inner distal corner; exopod 1.00–1.07 times endopod, with 2 terminal setae and 1 subterminal seta on inner margin; endopod uni-articulate, with 7–8 spiniform setae on inner margin and bi-dentate terminal and subterminal setae.

Ovigerous female carrying 10 larvae at 2nd nauplius stage, 3.43 mm (Figs. 11, 12). Carapace damaged, 0.31 times total body length; dorsal surface markedly elevate posteriorly; eye lobe (Fig. 11B) smaller than preparatory females. Pereon 0.76 times carapace length (Fig. 11A); pereonite 1 and 2 well developed. Pleon 0.44 times total body length (Fig. 11A); pleonite 6 with 4 minute setae on dorsal surface (Fig. 12G). No food residue present.

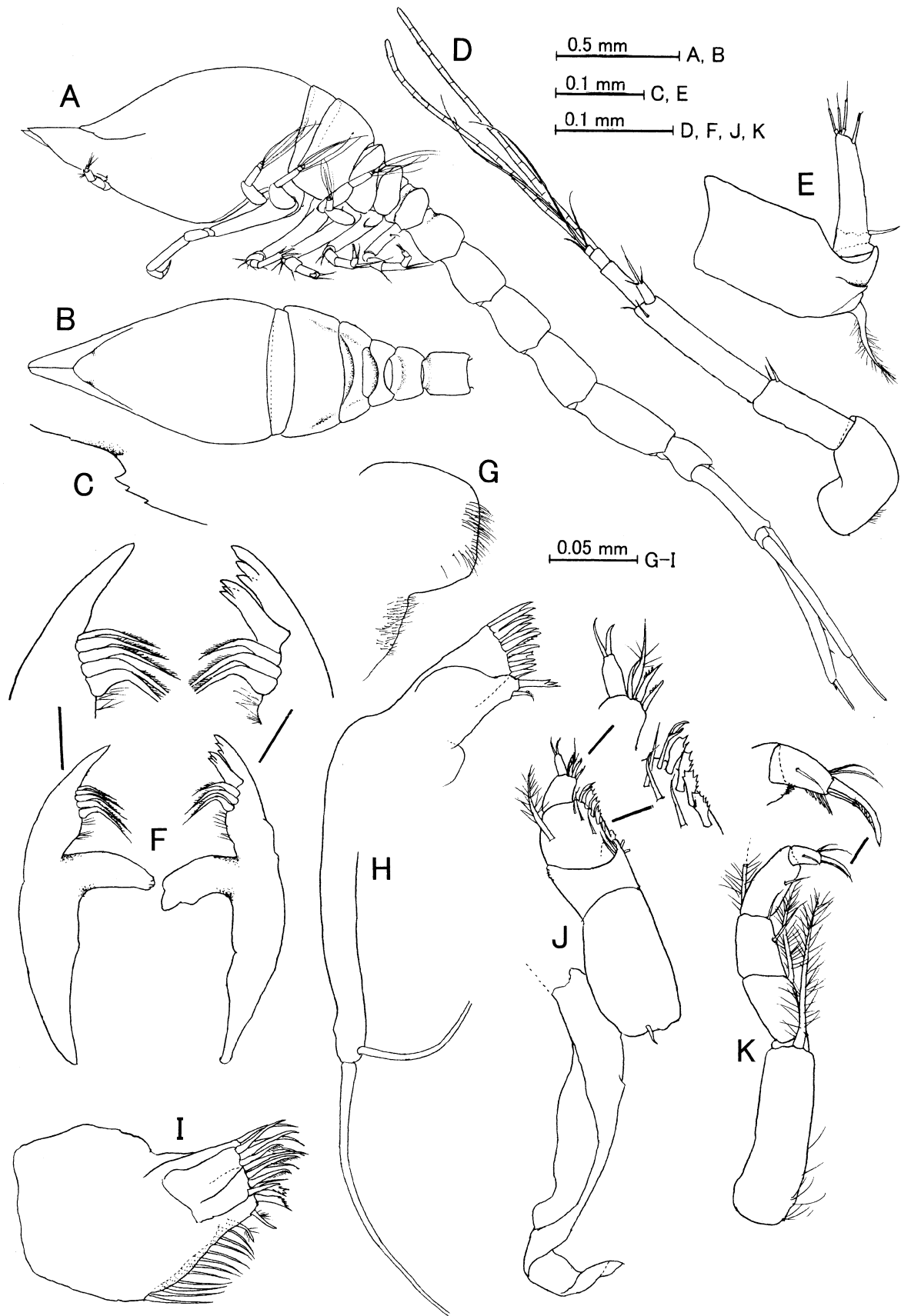


FIGURE 9. *Pseudopicrocuma japonicum* sp. nov., preparatory female. A, lateral view; B, anterior portion of body, from above; C, anterolateral angle D, antenna 1; E, antenna 2; F, right and left mandibles; G, labium; H, maxilla 1; I, maxilla 2; J, K, maxillipeds 1, 2.

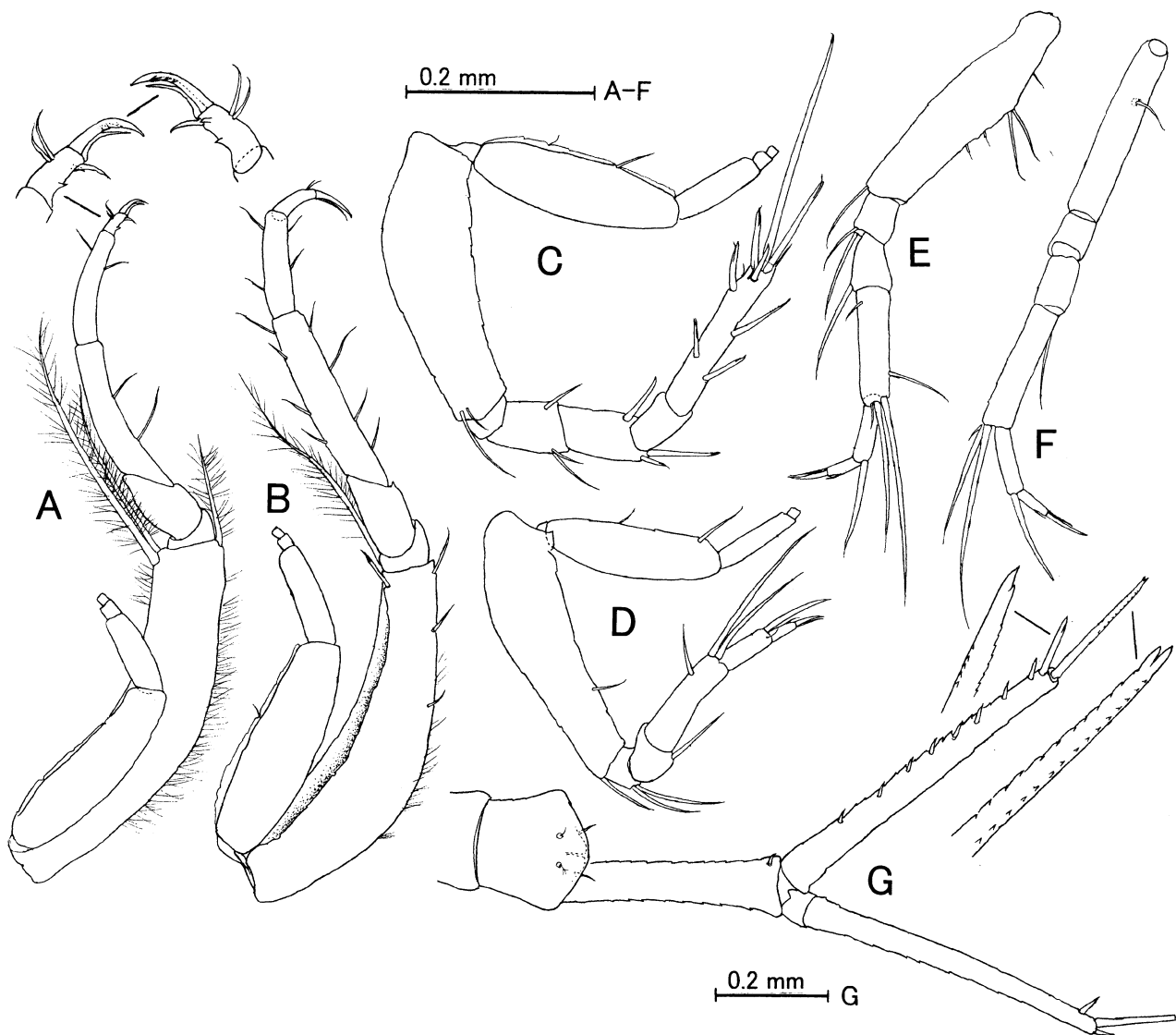


FIGURE 10. *Pseudopicrocuma japonicum* sp. nov., preparatory female. A, maxilliped 3; B–F, pereopods 1–5; G, uropod with pleonite 6.

Antenna 1 (Fig. 11C) similar to preparatory females. Antenna 2 (Fig. 11D) tri-articulate. Mandibles (Fig. 11E) wholly decalcified, distal portion small, with reduced setae; lacinia mobilis not distinguishable from the other setae; incisor process very short. Maxilla 1 (Fig. 11G) without setae on distal margins of both endites. Maxilla 2 (Fig. 11H) without setae on distal margin of broad and narrow endites.

Maxilliped 1 (Fig. 11I) carpus with 4 thin, serrated setae and several simple setae on inner margin; 2 terminal setae on dactylus similar to preparatory females. Two terminal setae on maxilliped 2 (Fig. 11J) minute. Maxilliped 3 (Fig. 12A) basis 1.1 times distal articles together, with 4 stiff plumose setae on inner margin and 2 long plumose setae on outer distal corner; 2 terminal setae on dactylus minute. Pereopod 1 (Fig. 12B), dactylus broken; basis with plumose seta and simple seta on inner margin and outer distal corner, respectively. Pereopods 2–5 (Fig. 12C–F) similar to preparatory females. Uropod (Fig. 12G), peduncle near 2 times pleonite 6, 0.9 times exopod and 0.9 times endopod; thin exopod 0.99 times endopod, with 2 terminal and 1 subterminal setae; endopod with 9 spiniform setae on inner margin; long terminal seta broken.

Adult males, 2.86–3.08 mm (Fig. 13). Carapace length, 0.31–0.33 times total body length; 2.0–2.1 times carapace width, and 1.9–2.0 times carapace depth; dorsal surface weakly arched. Pseudorostrum 0.12–0.15 times carapace length; width of eye lobe 0.27–0.30 times carapace width; corneal lenses absent; antennal notch obsolete (Fig. 13C); anterolateral angle and inferior margin smooth, without teeth. Pereon 0.52–0.62 times carapace length. Pleon without pleopods, 0.48–0.51 times total body length (Fig. 13A); pleonite 6 similar to females (Fig. 13L).

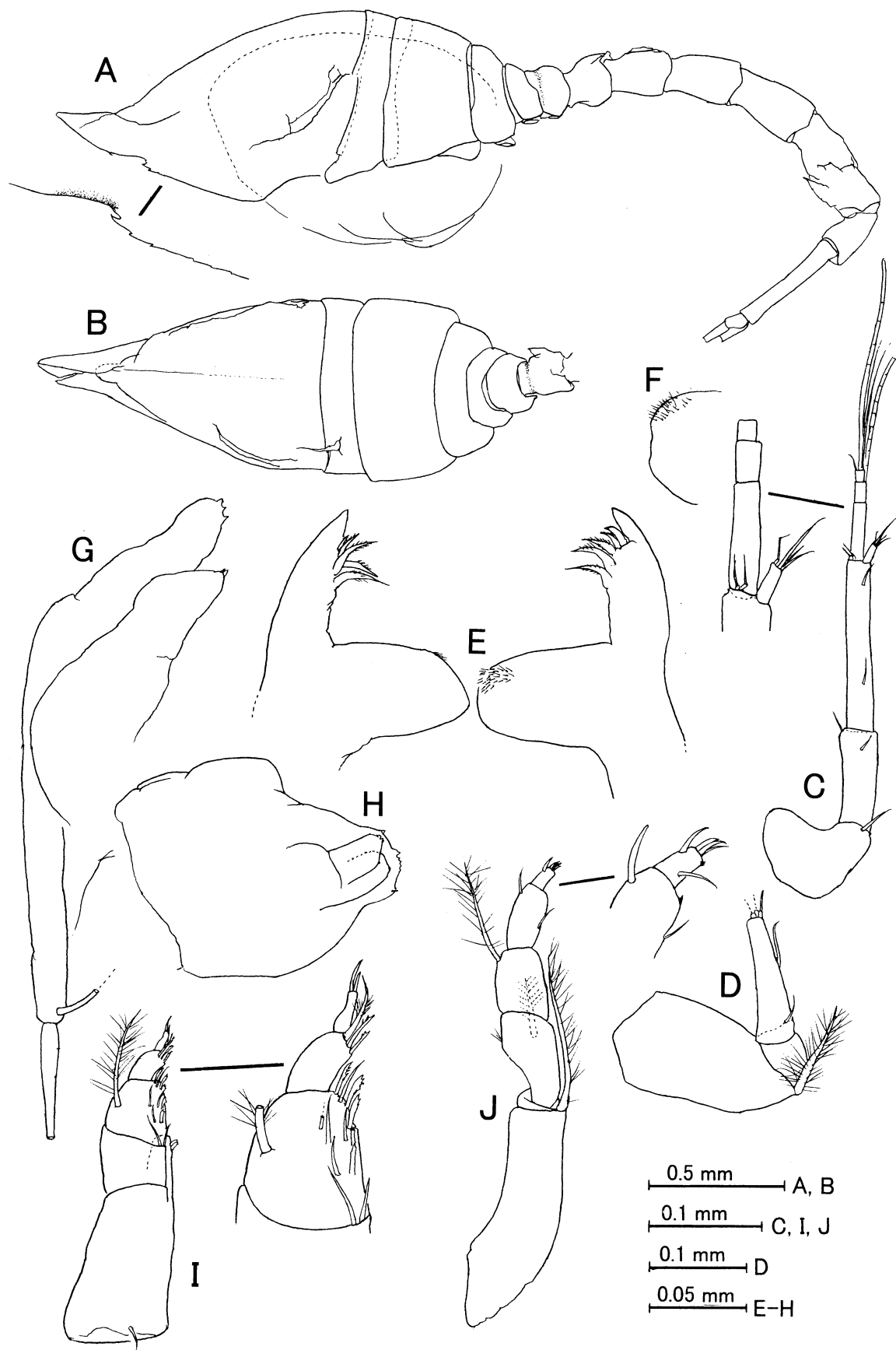


FIGURE 11. *Pseudopicrocuma japonicum* sp. nov., ovigerous female. A, lateral view; B, anterior portion of body, from above; C, antenna 1; D, antenna 2; E, right and left mandibles; F, labium; G, maxilla 1; H, maxilla 2; J, K, maxillipeds 1, 2.

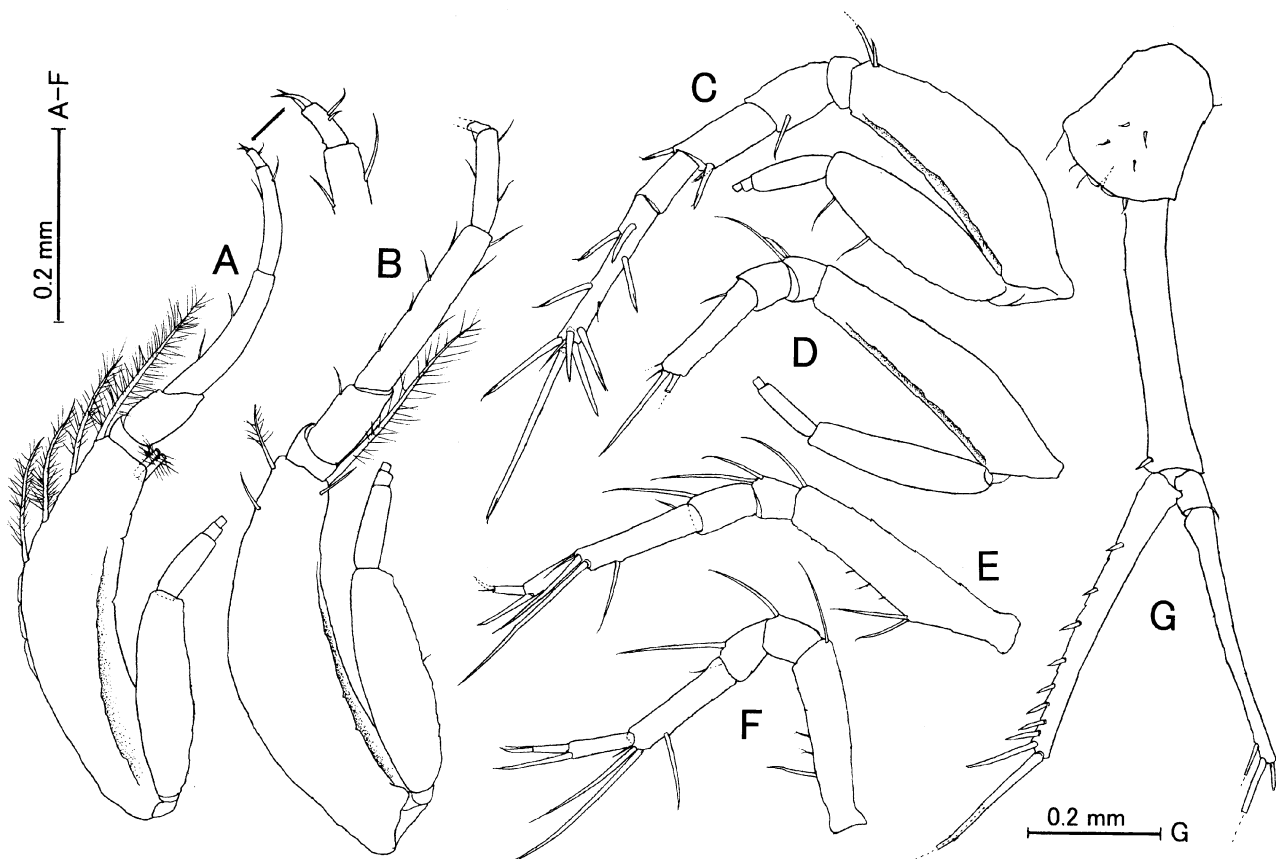


FIGURE 12. *Pseudopicrocuma japonicum* sp. nov., ovigerous female. A, maxilliped 3; B–F, pereopods 1–5; G, uropod with pleonite 6.

Antenna 1 (Fig. 13 D) peduncle article 1 0.31–0.42 times combined length of articles 2 and 3, with a few simple setae on distal corner; article 2 with a group of 7–10 aesthetascs; article 3 1.52–1.97 times article 2, with numerous aesthetascs on lateral margin. Main flagellum 4-articulate, 0.36–0.39 times article 3 of peduncle; accessory flagellum as long as article 1 of main flagellum. Antenna 2 (Fig. 13E) clasping form, peduncle distal 2 articles fused; flagellum of 4–5 large articles and 2 small articles; articles 2–5 with triangular process on inner margin; small articles with several thin setae.

Maxilliped 3 (Fig. 13F) basis 1.2–1.3 times distal articles together, with plumose seta on inner distal corner and fine hairs on inner margin; carpus with 2 simple setae on inner margin; dactylus small, with stiff hooked terminal setae. Pereopods 1–3 with well-developed exopods (Fig. 13G–I) Pereopod 1 (Fig. 13G) basis 1.0–1.1 times distal articles together, with plumose seta on outer distal corner; carpus 1.6–1.8 times propodus; dactylus with 2 terminal setae. Pereopod 2 (Fig. 13 H) basis 0.9 times distal articles together; carpus subequal in length to merus; dactylus 2.3–2.8 times carpus. Pereopod 3 (Fig. 13I) basis 1.2–1.4 times combined length of distal articles; carpus 1.9–2.1 times merus and 1.5–2.0 times propodus, with 2 stiff setae on distal margin. Pereopod 4 (Fig. 13J) basis 0.8 times remaining distal articles, with a couple of simple setae on lateral margin; merus 1.1–1.5 times ischium; carpus 1.9–2.4 times merus and 1.5–2.1 times propodus. Pereopod 5 (Fig. 13K) basis 0.5–0.6 times distal articles together; merus 0.9–1.2 times ischium; carpus 2.1–2.4 times merus and 1.5–1.6 times propodus.

Uropod (Fig. 13L) peduncle 1.9–2.4 times pleonite 6, 0.55–0.65 times exopod, and 0.58–0.68 times endopod, with minute spiniform seta on inner distal corner; exopod 1.02–1.06 times endopod, with 1 long and 1 short terminal setae; endopod with 14–18 spiniform setae on inner margin and long bi-dentate terminal seta.

Etymology. The species name refers to the type locality, Japan.

Remarks. The new genus *Pseudopicrocuma* is similar to the genus *Picrocuma* from the shallow waters of eastern Australia (Hale, 1936, 1945) in (1) overall shape of carapace, pereon, pleon and pereopods (2) well developed exopods present on maxilliped 3 and pereopod 1–3, (3) males having no pleopods, (4) male antenna 2 peduncle articles 4 and 5 fused, flagellum of clasping form. The former genus is distinguishable from the latter by

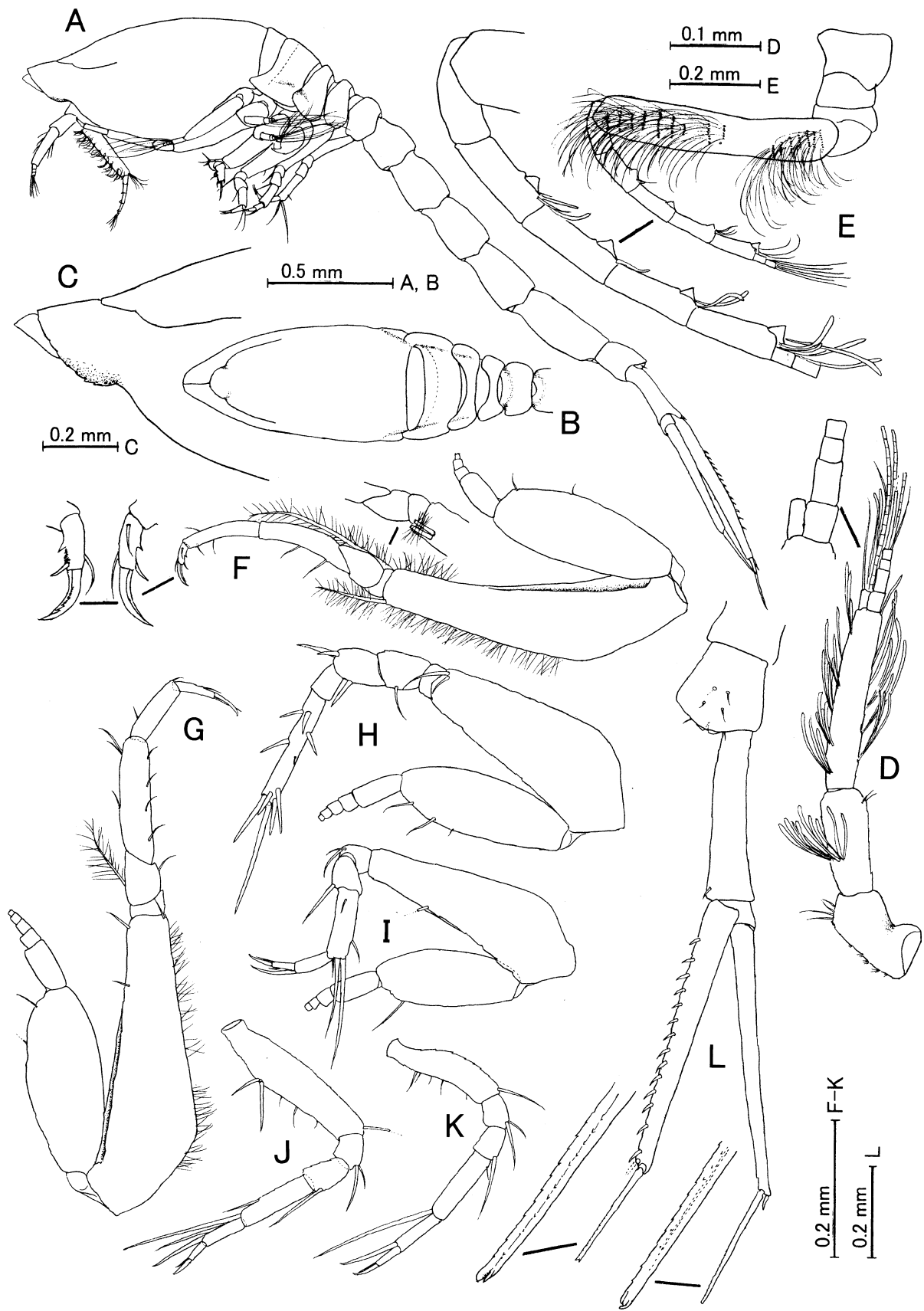


FIGURE 13. *Pseudopicrocuma japonicum* sp. nov., adult male. A, lateral view; B, anterior portion of body, from above; C, anterior portion of carapace, lateral view; D, antenna 1; E, antenna 2; F maxilliped 3; G–K, pereopods 1–5; Q, uropod with pleonite 6.

(1) Antenna 1 main flagellum tri-articulate in female and 4-articulate in males (bi-articulate in both sexes of *Picrocuma*), (2) male antenna 1 with many aesthetasc-like sensory setae on peduncle articles 2 and 3 (no aesthetasc-like sensory setae in *Picrocuma*) (3) mandibles navicular (basal region somewhat truncate in *Picrocuma*), and (4) uropod slender; rami very elongate, nearly 2 times peduncle (strongly constructed; rami much shorter than peduncle in *Picrocuma*). Character (2) is rather rare in cumaceans, except for *Thalycrocuma sarradini* Corbera et al., 2008 from the Lucky Strike hydrothermal vent field in Mid Atlantic, which has sensory setae only on peduncle article 3.

Pseudopicrocuma japonicum is characterized by (1) eye lobe large, without corneal lenses, (2) maxilliped 1 with degenerated branchial lobules, (3) maxilliped 2 with serrated, claw-like stiff terminal seta, (4) maxilliped 3 carpus and propodus slightly curved inward; dactylus minute, with serrated, claw-like stiff terminal seta, (5) uropod rami elongate, terminal setae bi-dentate. In addition, the ovigerous female of *Pseudopicrocuma japonicum* is characterized by degeneration of mouthparts (1) decalcification of mandibles, (2) reduction or loss of setae on mandibles, maxilla 1 and maxilla 2, (3) reduced terminal setae on maxillipeds 2 and 3.

Distribution. Southeast of Yakushima-Tanegashima, Pacific coast of southern Japan, north of Minami-Ensei Knoll, Okinawa Trough, 566–1679 m.

Discussion

Relationship between *Atlantocuma* and *Pseudopicrocuma*

Two genera described in the present study are currently placed in the family Nannastacidae, based on the combination of characters (1) no pleopods in both sexes, and (2) uropod endopod uni-articulate, that are shared by all nannastacid genera and by no bodotriid genera, although some doubt on these criteria remains (see below). The new genus *Pseudopicrocuma*, which is similar to *Picrocuma*, is also rather similar to *Atlantocuma*, except for (1) well developed exopods present on maxilliped 3 and pereopods 1–3 in males and females (maxilliped 3 and pereopods 1–4 in males, on maxilliped 3 and pereopod 1 in female in *Atlantocuma*), (2) uropod peduncle shorter than rami (much longer in *Atlantocuma*, arrangement of setae is similar to each other), and (3) male antenna 2 clasping form, peduncle distal 2 articles fused (flagellum normal form, distal 2 articles of peduncle fused in *Atlantocuma*), (4) ocular lobe large (normal size in *Atlantocuma*). In addition, ovigerous females of these 2 genera were characterized by a similar trend in degeneration of mouthparts and associated morphological change (1) complete decalcification of mandibles, (2) diminishing or loss of setae on mandibles, maxilla 1, maxilla 2, inner margin of maxillipeds 1 and 2 (terminal seta on dactylus of maxilliped 2 and 3 also reduced in *P. japonicum*), (3) carapace elevated posteriorly, and (4) maxilliped 3 with row of stiff plumose setae on inner margin of basis. No food residue was observed in all ovigerous females of both species, suggesting they completely stop feeding. Although cumacean life cycles have not been investigated sufficiently, degeneration of mouthparts has only been observed previously in the monotypic genus *Claudicuma* (Nannastacidae, Roccatagliata 1981), suggesting a possible close relationship to *Atlantocuma* and *Pseudopicrocuma* with quite different arrangement of exopods on pereopods. This causes a problem in cumacean taxonomy which largely depends on sexual characters.

Generally, cumaceans show marked sexual dimorphism, including arrangement of their pereopods and pleopods: males typically have higher numbers of well-developed exopods than females (usually on maxilliped 3 and pereopods 1–4) as more advanced swimming apparatus, along with pleopods which are present in males. Along with presence or absence of a telson, these characters are important for taxonomy of cumaceans.

Exceptionally, some cumacean genera are characterized by the close similarity between males and females possibly due to suppression of sexual dimorphism, especially the same arrangement of well-developed exopods in both sexes; Pseudocumatidae (with 2 pairs of pleopods), *Kerguelenica* (no pleopods in both sexes, Ledoyer 1977; Gerken & McCarthy 2008) and *Fontainella* (with two pairs of small pleopods in males, Băcescu & Muradian 1978; López-González et al. 1996); Nannastacidae (with no pleopods in both sexes), *Almyracuma* (Jones and Burbank 1959, Petrescu and Heard 2004), *Thalycrocuma* (Corbera et al. 2008), *Picrocuma* (Hale 1936, 1945; Muhlenhardt-Siegel 2003); Bodotriidae (usually having five pairs of pleopods in males), *Spilocuma* (with no pleopods, Watling 1977; Omholt & Heard 1979), *Mancocuma* (with two pairs of small pleopods in males, Zimmer 1943, 1980), and

Speleocuma (with two pairs of pleopods in males, Corbera 2002). *Pseudopicrocuma*, a new genus, is an additional case. Similarity of this genus to *Atlantocuma*, which is characterized by normal sexual dimorphism, suggests that these genera should be treated as exceptional cases in cumacean phylogenetic analysis based only on external morphology.

The adult male antenna 2 is rather different between *Atlantocuma* and *Pseudopicrocuma*. Male antenna 2 of Japanese *Atlantocuma*, with the flagellum of 10 (plus 1 minute) articles, is almost normal, but possibly represents a primitive form of a clasping antenna, based on (1) flagellum shorter than peduncle, (2) the appendage occasionally bent between peduncle and flagellum (Fig. 8A), and (3) flagellum article 1 with steep taper at basal region (Fig. 4F). In *Pseudopicrocuma*, this appendage (Fig. 13E) is obviously clasping, representing a more derived form; (1) the appendage geniculate between peduncle and basal article of flagellum; (2) flagellum of only 4 (1 specimen) or 5 (4 specimens) large articles with triangular process on inner margin, except for distal 2 minute ones. Fusion of the peduncle articles 4 and 5 would make this appendage work as an advanced clasping arm. The flagellum of *Pseudopicrocuma* consisting of about half the number of articles, compared with *Atlantocuma*, may be a result of fusion of the articles of the flagellum. In *Nippoleucon hinumensis* (Leuconidae), incomplete fusion of the articles of the male antenna 2 flagellum occurs at proximal region (Gamô 1967).

Two genera possibly related to *Pseudopicrocuma*

***Spilocuma* (Bodotriidae).** This genus, which consists of 2 species from the eastern coast of North America (western Atlantic), 1–3 m (Watling 1977; Omholt & Heard 1979), is characterized by (1) adult males have no pleopods, (2) well developed exopods present on maxilliped 3 and pereopods 1–3, reduced exopods present on pereopod 4 in both sexes, (3) male antenna 2 flagellum short, clasping form. Watling (1977) placed the new genus in the newly established subfamily Mancocumatinae. The subfamily was accepted by Băcescu (1988) and Corbera (2002). However, Haye (2007) did not recognize Mancocumatinae (including *Spilocuma*, *Mancocuma*, *Pseudoleptocuma*, and *Speleocuma*) as a valid subfamily, based on morphological phylogenetic analysis, placing the members in the subfamily Vaunthompsoninae. *Spilocuma* is closely similar to *Pseudopicrocuma* and *Picrocuma* except for (1) reduced exopod present on pereopod 4, (2) uropod endopod bi-articulate (3) male antenna 1 main flagellum 3-articulate.

Presence or absence of reduced exopods on pereopods does not seem to be an important character in a few cumacean groups. In *Petalosarsia declivis* (Pseudocumatidae), rudimentary exopods on female pereopods 3 and 4 were present or absent varying between individuals (Akiyama and Gerken, 2012). In the case of pereopods 3 and 4 without reduced exopods, a couple of possible remnant terminal setae of exopods were observed. Similar setae are also observed on pereopod 4 of *Pseudopicrocuma* (Fig. 10E, 12E, 13J) and female pereopods 2–4 of *Atlantocuma gamoi* (Fig. 2A–C, 3M–O), *A. ojii* (Fig. 6B–D, 7L–N), and *Atlantocuma* sp. from Antarctic region (Gamô 1987, the manca larvae were described as *Cyclaspis* (?) sp.). In addition, variation of articulation of uropod endopod between uni- and bi-articulate is seen even within the genus *Bodotria* (Bodotriidae, Bodotriinae). Petrescu (1998) established the subgenus *Atlantobodotria*, mainly based on bi-articulate uropod endopod.

Although Haye (2007) placed *Atlantocuma* (and *Picrocuma*) outside the family Bodotriidae, the affinity between *Pseudopicrocuma* and *Spilocuma* suggests that further analysis on their phylogeny should be necessary. Weak evidence which supports the affinity of these genera to Bodotriidae is that female antenna 2 of these genera is similar to some genera of Bodotriidae, such as *Hypocuma* and *Apocuma*. In Nannastacidae, this appendage is reduced, consisting only of the basal article.

***Claudicuma* (Nannastacidae).** Roccatagliata (1981) placed the newly established genus, from the shore of the la Plata River, Argentine, in the Nannastacidae, while noting the affinity of the genus to *Picrocuma*. This genus is similar to *Pseudopicrocuma* and *Picrocuma*, except for (1) pereonite 2 and 3 of ovigerous females fused, (2) exopod absent on pereopod 2 in females, and (3) last 2 articles of peduncle of male antenna 2 not fused. In addition, mouthparts (mandibles, maxilla 1 and 2) and guts of ovigerous females are degenerate making a large volume of marsupium, as in *Pseudopicrocuma*. In the Bodotriidae and most Nannastacidae, maxilla 2 is characterized by a row of comb-like simple setae on the inferior margin, while in *Claudicuma* this row is replaced a few plumose setae. This character is shared by another genus living in fresh or brackish waters, *Almyracuma* (Jones and Bur-

banck 1959; Petrescu 2004), and a different family, Leuconidae, indicating specialized morphology possibly as a result of adaptation of their life to a low salinity habitat.

Geographic distribution

Previous reports of the genus *Atlantocuma* revealed the wide geographic distribution, the Atlantic (Băcescu and Muradian 1974; Jones 1984), western Indian Ocean (Ledoyer 1988), Antarctic (Ledoyer 1993; Gamô 1987), and Southwest Pacific (Corbera 2006). Distribution of *A. gamoi* and *A. ojii* in the Northwest Pacific, which is remote from the other localities, suggests very wide distribution of the genus.

A problematic cumacean geographic distribution has been reported in the genus *Kerguelenica* (Pseudocumatidae), which is far distant from the general distribution of Pseudocumatidae (Ledoyer 1977; Gerken and McCarthy 2008). Distributions of four possibly related genera, *Pseudopicrocuma* from bathyal waters of Japan, *Picrocuma* from shallow water of eastern coast of Australia, Southwest Pacific, *Spilocuma* from shallow water of eastern coast of United States, Northwest Atlantic, and *Claudicuma* from la Plata River, Argentina, Southwest Atlantic, may be another case of cumacean unusual geographic distribution. These genera, consisting of 1–3 species for each genus, share a noteworthy morphological character, eye lobe without corneal lenses in both males and females, which is unusual in both shallow water Bodotriidae and Nannastacidae which have well defined cornea lenses, especially in the adult males. Their ancestor may be a deep-sea inhabitant, characterized by very wide geographic distribution, like the genus *Atlantocuma*.

Acknowledgements

I thank Dr. T. Oji of Nagoya University, the director of R/V *Tansei-maru* cruises (KT-08-3, KT-10-16), Dr. J. Hashimoto of Nagasaki University, the director of T/S *Nagasaki-maru* cruise (N295) for facility for this work. Thanks are also due to captains, crews and researchers on board during cruises by R/V *Tansei-maru* and T/S *Nagasaki-maru* for their kind help.

References

- Akiyama, T. & Gerken, S. (2012) The cumacean (Crustacea: Peracarida) genus *Petalosarsia* from the Pacific Ocean. *Zootaxa*, 3320, 1–35.
- Băcescu, M. (1988) Crustaceorum catalogus 7. In: Gunner HE, Holthuis LB (eds) Cumacea I. SPB Academic Publishing, The Hague, p1–173.
- Băcescu, M. & Muradian, Z. (1974) *Campylaspis*, *Styloptocuma*, *Atlantocuma*, new genera of cumacea from the deep waters of the Atlantic. *Revue Roumaine de Biologie*. 19 (2), 71–79.
- Băcescu, M. & Muradian, Z. (1978) *Fontainella mediterranea* gen. n., sp. n., Cumacé (Pseudocumatidae) trouvé en Méditerranée orientale. *Revue Roumaine de Biologie. Série de Biologie Animale*, 23 (1), 3–7.
- Corbera, J. (2002) Amphi-Atlantic distribution of the Mancocumatinae (Cumacea: Bodotriidae), with description of a new genus dwelling in marine lava caves of Tenerife (Canary Islands). *Zoological Journal of the Linnean Society*, 134, 453–461.
- Corbera, J. (2006) Arthropoda, Crustacea, Cumacean. In: Desbruyeres, D., M. Segonzac & M. Bright (eds.), Handbook of Deep-Sea Hydrothermal Vent Fauna. *Denisia*, 18, 370.
- Corbera, J., Segonzac, M. & Cunha, M.R. (2008) A new deep-sea genus of Nannastacidae (Crustacea, Cumacea) from the Lucky Strike hydrothermal vent field (Azores Triple Junction, Mid-Atlantic Ridge). *Marine Biological Research*, 4, 180–192.
- Gamô, S. (1967) Studies on the Cumacea (Crustacea, Malacostraca) of Japan. Part I. *Publications of the Seto Marine Biological Laboratory*, 15, 133–163.
- Gamô, S. (1987) Cumacean crustaceans obtained by the 26th Japanese Antarctic research expedition (1984–1985), with descriptions of four new species. *Proceedings of the NIPR Symposium of Polar Biology*, 1, 145–160.
- Gerken, S. & McCarty, A. (2008) *Kerguelenica petrescui* (Crustacea: Cumacea), a new species from Australian waters. *Journal of Crustacean Biology*, 28(3), 564–571.
- Hale, H.M. (1936) Cumacea from a South Australian reef. *Record of the South Australian Museum*, 5, 404–438.
- Hale, H.M. (1945) Australian Cumacea. No. 9. The family Nannastacidae. *Record of the South Australian Museum*, 8,

145–218.

- Haye, P. (2007) Systematics of the genera of Bodotriidae (Crustacea: Cumacea). *Zoological Journal of the Linnean Society*, 151, 1–58.
- Jones, N.S. (1984) The Family Nannastacidae (Crustacea, Cumacea) from the deep-Atlantic. *Bulletin of British Museum (Natural History) Zoology*, 46, 207–289.
- Jones, N.S. & Burbank, W.D. (1959) *Almyracuma proximoculi* gen. et sp. nov. (Crustacea, Cumacea) from brackish water of Cape Cod, Massachusetts. *Biological Bulletin*, 116(1), 115–124.
- Ledoyer, M. (1977) Cumaces (Crustacea) del Iles Kerguelen recueillis par le N. O. "La Japonaise" en 1972 et 1974 et par le M. S. "Marion-Dufresne" en 1974. *Conte National Francais des Recherches Antarctiques*, 42, 193–213.
- Ledoyer, M. (1988) Cumaces (Crustacea) profonds de la region de L'île de Mayotte, Canal de Mozambique, Ocean Indien (Campagne Benthedi, 1977). *Mésogée*, 48, 131–172.
- Ledoyer, M. (1993) Cumacea (Crustacea) de la campagne EPOS 3 du R. V. polarstern en mer de Waddel, Antarctique. *Journal of Natural History*, 27, 1041–1096.
- López-González, P. J., Bandera, M.E., Alfonso, M. I. & García-Gómez, J.C. (1996) A rare Mediterranean cumacean, *Fountainella mediterranea* (Crustacea), at the threshold of the Atlantic Ocean. *Cahiers de Biologie Marine*, 37, 113–120.
- Mühlenhardt-Siegel, U. (2003) Shallow-water cumacean Crustacea from Australia and Lombok (Indonesia): families Bodotriidae and Leuconidae. *Records of the South Australian Museum*, 36, 21–57.
- Mühlenhardt-Siegel, U. (2005) New cumacean species (Crustacea: Peracarida) from the deep-sea expedition DIVA-1 with RV "Meteor" to the Angola Basin in July 2000. Families Lampropidae, Bodotriidae. *Organisms Diversity & Evolution*, 5, 113–130.
- Omholt, E. & Heard R.W. (1979) A new species of *Spilocuma* (Cumacea: Bodotriidae: Mancocumatinae) from the Gulf of Mexico. *Proceedings of the Biological Society of Washington*, 92, 184–194.
- Petrescu, I. (1995) Cumaceans (Crustacea: Peracarida) from the South American coasts collected by the R/V "Vema". *Travaux du Muséum National d' Histoire Naturelle «Grigore Antipa»*, 35, 49–86.
- Petrescu, I. (1998) Cumaceans (Crustacea: Cumacea) collected by the expedition of "Grigore Antipa" National Museum of Natural History from the coasts of Tanzania (1973–1974). Part I. Family Bodotriidae. *Travaux du Muséum National d' Histoire Naturelle «Grigore Antipa»*, 40, 227–310.
- Petrescu, I. & Heard, R.W. (2004) Redescription of *Almyracuma proximoculi* Jones & Burbank, 1959 (Crustacea: Cumacea: Nannastacidae) and description of a new species, *A. bacescui* n. sp. from the Gulf of Mexico. *Travaux du Muséum National d' Histoire Naturelle «Grigore Antipa»*, 47, 97–109.
- Roccataglieata, D. (1981) *Claudicum platensis* Gen et sp. nov. (Crustacea, Cumacea) de la ribera Argentina del Rio de Plata. *Physis (Buenos Aires), Section B*, 39, 79–87.
- Tafe, D. J. & Greenwood, J.G. (1996) The Bodotriidae (Crustacea: Cumacea) of Moreton Bay, Queensland. *Memoirs of the Queensland Museum*, 39, 391–482.
- Watling, L. (1977) Two new genera and a new subfamily of Bodotriidae (Crustacea: Cumacea) from eastern North America. *Proceedings of the Biological Society of Washington*, 89, 593–598.
- Zimmer, C. (1943) Über neue und weniger bekannte Cumaceen. *Zoologischer Anzeiger*, 141, 148–167.
- Zimmer, C. (1980) Cumaceans of the American Atlantic boreal coast region (Crustacea: Peracarida). *Smithsonian Contribution to Zoology*, 302, 1–29.