



The Cumacean (Crustacea: Peracarida) Genus *Petalosarsia* (Pseudocumatidae) from the Pacific Ocean

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Abstract

The distribution of the cumacean family Pseudocumatidae is restricted to the North Atlantic, Mediterranean and brackish waters of the Pont-Caspian region, except for three known species of the genus *Petalosarsia*. The present study describes nine species of *Petalosarsia* from Japanese waters, the Sulu Sea, the North-west Pacific, the Indo-West Pacific, and the Tasman Sea, Australia. The occurrence of *P. declivis* (Sars, 1865) in northern Hokkaido agrees with the reported circumpolar distribution of this species. Four species from the Pacific coast of southern Japan and the East China Sea, *P. brevirostris* Gamô 1986, *P. ovalis* **sp. nov.**, *P. ryukyuensis* **sp. nov.** and *P. gamoi* **sp. nov.**, are characterized by prominent dorsolateral carinae with teeth anteriorly and the basis of the 2nd maxilliped with a semicircular plate on the ventral surface. Nine specimens collected from the Sulu Sea included five species, *P. brevirostris*, *P. gamoi*, *P. jonesi* **sp. nov.**, *P. suluensis* **sp. nov.** and *P. longicauda* **sp. nov.** The latter three species were characterized by no or faint dorsolateral carinae on the carapace. Among them, *P. jonesi* was similar to *P. longirostris* from the eastern tropical deep Atlantic. *Petalosarsia australis* **sp. nov.** from the Tasman Sea is characterized by one faint pair of dorsolateral carinae running for the entire length of the carapace. The species richness of *Petalosarsia* in the Sulu Sea and the Indo-West Pacific suggests a wide distribution of ancestors of Pseudocumatidae around the ancient Tethys Sea, with the Ponto-Caspian region located near the center. The habitat of *Petalosarsia* was mostly deeper than 200 m.

Key words: Cumacea, *Petalosarsia*, Pseudocumatidae, Northwest Pacific, Indo-West Pacific

Introduction

The cumacean family Pseudocumatidae is comprised of 13 genera and 29 species. The geographical distribution of this family is mostly restricted to the eastern Atlantic Ocean, Mediterranean Sea, and brackish waters of the Ponto-Caspian region, Caspian Sea and its vicinity (Bacescu 1992; Gerken & McCarthy 2008; Jaume & Boxshall 2008). Members of this family are shallow water inhabitants except for a few species. A molecular analysis of cumacean systematic and evolution suggested that this family could be basal among the 8 currently accepted families (Haye et al. 2005).

The geographic distribution of two genera is somewhat problematic. *Kerguelenica* consists of two species, *Kerguelenica platycephala* Ledoyer, 1977 from the Kerguelen Islands, and *K. petrescui* Gerken & McCarthy, 2008 from the southeastern Australia slope. Both of the localities are far removed from the general distribution of the Pseudocumatidae. Considering the odd distribution and some morphological characters that do not agree with the current family diagnosis, Gerken and McCarthy (2008) proposed that *Kerguelenica* is placed outside of Pseudocumatidae, with the family *incertae sedis*. The distribution of the genus *Petalosarsia* is also unusual within the Pseudocumatidae. *Petalosarsia declivis* Sars, 1865, has been reported from a very wide area, from the boreal regions of the eastern Atlantic and Arctic region to the Sea of Japan (Sars 1900; Bacescu & Muradian 1974). *Petalosarsia longirostris* Jones, 1973 was reported from the eastern tropical deep Atlantic (Jones 1973; Ledoyer 1997), and *P. brevirostris* Gamô, 1986 is known from the southern coast of Honshu, Japan, Northwest Pacific, 126–135 m (Gamô 1986). The shallow water fauna of this region is largely common with the warm water fauna of Indo-West Pacific (Sakai 1965; Shigei 1986).

From 1999 to 2009, cumacean specimens were collected from Japanese waters and the Sulu Sea, Philippines by two Japanese research vessels and two training vessels. In the present study, *Petalosarsia* specimens from these collections are examined. In addition, two *Petalosarsia* specimens from the eastern continental slope of Australia, in the Tasman Sea, were discovered in the collections of the Australian Museum. Morphological characters and geographical distribution of the species are discussed. The results provide new insights into the biogeography of Pseudocumatidae.

Materials and methods

Petalosarsia specimens from the northern hemisphere examined in the present study were collected during surveys of benthic fauna by R/V *Tansei-maru* (cruises KT-99-18, KT-00-8, KT-01-8, KT-01-14, KT-02-3, KT-02-5, KT-04-6, KT-04-20, KT-04-23, KT-05-30, KT-07-1, KT-08-3, KT-08-33), R/V *Hakuho-maru* (cruises KH-00-1, KH-02-4, KH-05-1), T/S *Toyoshio-maru* of the Hiroshima University in 2004, and T/S *Nagasaki-maru* of Nagasaki University (cruises N237, N251, N275, N282). Gear used for collection were beam trawls of 1.8 m, 3m and 4 m span and biological dredges of 1 m span. Small ring nets (30 cm in diameter, 130 cm long) equipped with mesh of 0.5 mm opening were placed 0.5–1 m behind the ground chain of the sledge of the trawls, to collect cumaceans and other epibenthic organisms.

From each trawl catch, muddy or sandy sediments, large animals and objects were removed using two plastic baskets (55 cm × 30 cm × 30 cm and 50 cm × 30 cm × 15 cm respectively), the inner surface of which was covered with nylon mesh of 0.5 mm opening, and iron mesh of 4 mm opening respectively. The shallow basket with coarse mesh was mounted on the deeper basket. The processed sediment samples including tiny organisms were fixed in 5–10 % borate buffered formalin sea water. In the laboratory, cumacean specimens were sorted out of the sediment samples under stereo microscopes (Leica MZ6 and MZ125) and preserved in 5 % borate buffered formalin sea water or 70 % ethanol.

The specimens from Japan and the Sulu Sea were examined under a stereo microscope (Leica MZ125) and a light microscope (Nikon E600), both of which were equipped with *camera lucida*. Total body length of specimens was measured from tip of pseudorostrum to posterior end of abdomen, excluding the telson. Length of pseudorostrum was determined as the length of meeting of pseudorostral lobes in front of the eye lobe. After examination, the specimens were preserved in 70 % ethanol. Type specimens and other specimens designated, from Japanese waters and the Sulu Sea, are deposited in the National Museum of Nature and Science, Tokyo (NSMT). The other specimens are kept as the author's collection.

Australian *Petalosarsia* specimens were collected by the RV Franklin on December 10, 1986 using a benthic sled on sediments consisting of clay, light grey mud and some siltstone. The holotype and paratype are deposited in the collections of the Australian Museum, Sydney, Australia (AM). The specimens were examined with a Leica dissecting microscope and an Olympus XM50 compound microscope, both equipped with *camera lucida*.

Taxonomy

Family Pseudocumatidae Sars, 1878

Genus *Petalosarsia* Stebbing, 1893

Petalosarsia declivis (Sars, 1865)

(Figs. 1, 2)

Petalopus declivis Sars, 1865: 197.

Petalomera declivis Sars, 1883, 13.

Petalosarsia declivis Stebbing, 1893: 308; Sars, 1900, 77–79, pl. 54; Given, 1965, 222, Fig. 5; Bacescu & Muradian, 1974, 224–227, Figs. 5–7.

Material examined. Two ovigerous females, 3.84, 3.72 mm, dissected (NSMT-Cr 22061), off Abashiri, Okhotsk Sea, 44°03.58'N, 144°34.83'E – 44°03.60'N, 144°37.36'E, 104 m (KT-01-14, St. AB-7), 20 September, 2001; 4 ovigerous females, 3.13–3.58 mm, 2 specimens dissected (NSMT-Cr 22062), off Setana, 42°25.37'N, 139°45.91' – 42°25.01'N, 139°46.10E, 122–130 m (KT-04-20, St. ST2-2), 18 September, 2004; 1 ovigerous female, 3.20 mm, dissected (NSMT-Cr 22063), off Rishiri, northern part of the Sea of Japan, 45°12.5'N, 140°48.9'E, 472 m, 4 August 2009 (collected during cruise by R/V *Soyo-maru* of Fisheries Research Agency, Japan).

Description. Ovigerous females (Figs. 1, 2). Body heavily calcified. Carapace with numerous reticular depressions, length 1.0–1.3 times width, length 1.6–1.8 times depth, length 0.31–0.35 times total body length (Fig. 1A). Dorsal surface flat and broadest at hind end; dorsolateral carina with a tooth on anterior end, meeting posteriorly with a transverse ridge near hind margin; very weak lateral ridge present on each side, running parallel to dorsolateral carina; between dorsolateral carina and lateral ridge below forming very shallow sulcus; inferior margin smooth, with no tooth; frontal margin of pseudorostral lobes, between 2 teeth at anterior end of dorsolateral carina, round, 0.35–0.45 times greatest width of carapace. Pseudorostrum short, 0.09–0.13 times length of carapace. Width of rounded eye lobe 0.137–0.157 times greatest width of carapace. Anterolateral angle and antennal notch obsolete. Pereon 0.60–0.70 times carapace. Pleon short, 0.44–0.47 times total body length (Figs. 1A, B).

Antenna 1 (Fig. 1C), 1st article of peduncle 1.05–1.4 times combined length of 2nd and 3rd articles; main flagellum 0.48–0.53 times basal article of peduncle; 1st article 1.2–1.5 times combined length of remaining 2 articles; accessory flagellum minute. Antenna 2 (Fig. 1D) bi-articulate, with plumose terminal seta on distal article, with 2 plumose setae on basal article. Labium with a blunt process on tip (Fig. 1E). Left and right mandibles with 8 and 7 setae respectively (Fig. 1F). Maxilla 1 (Fig. 1G) outer lobe with 10 stout setae on distal margin; inner lobe with 2 simple and 1 tridentate setae on distal margin. Maxilla 2 shown in Fig. 1H. Maxilliped 1 with 1 branchial lobule, basis shorter than remaining distal articles (Fig. 1I). Maxilliped 2 (Fig. 1J), basis 1.0–1.2 times combined length of following 4 articles, with semicircular plate on ventral surface and with a group of 3–5 spines on inner dorsal surface. Maxilliped 3 (Fig. 1K), basis 1.0–1.3 times distal articles together, with 3–4 plumose setae on inner margin; carpus with 3–4 plumose setae and hyaline lamella on inner margin.

Pereopod 1 (Fig. 1L), basis 1.2–1.4 times combined length of ischium and carpus, with 11–13 plumose setae on inner margin; carpus flat, 2.0–2.2 times width and 2.3–2.7 times as long as dactylus; dactylus subequal in length to propodus. Pereopod 2 (Fig. 1M), basis 0.9–1.0 times distal articles together, with 4–5 plumose setae on inner margin; dactylus subequal to carpus, less than twice as long as propodus, with 5 naked setae on distal half of article. Pereopod 3 (Fig. 2A, B), basis 1.5–1.8 times distal articles together, with 2–4 plumose setae; single article minute exopod, with plumose and naked setae on tip. Pereopod 4 (Fig. 2C, D), basis 1.0–1.1 times distal articles together, with 2 plumose setae; locus for exopod on outer margin of basis slightly swollen or decalcified, with a couple of plumose and naked setae. Pereopod 5 (Fig. 2E), basis 0.6–0.7 times distal articles together.

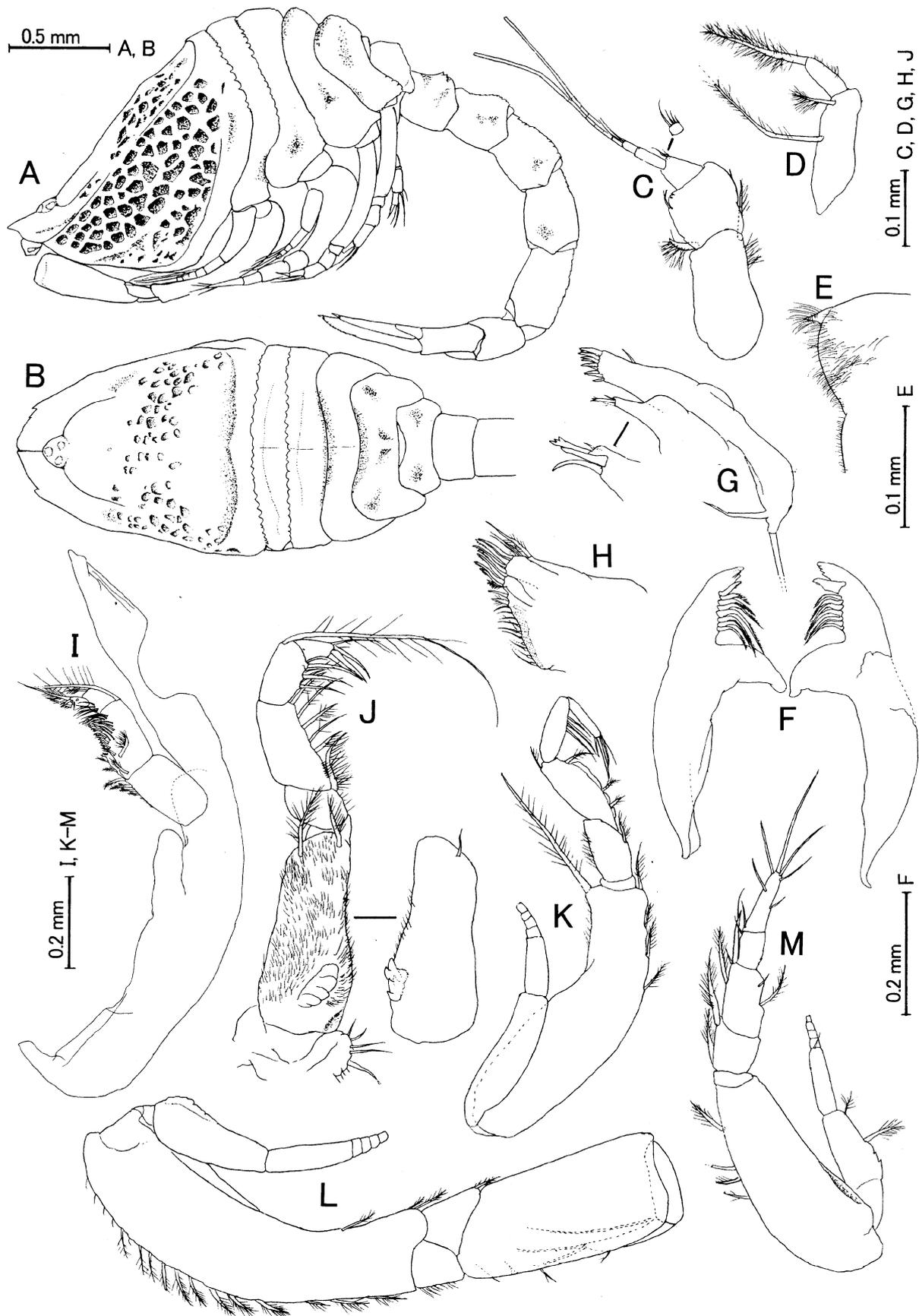


FIGURE 1. *Petalosarsia declivis* (Sars), ovigerous female. A, lateral view; B, anterior portion of body, from above; C, antenna 1; D, antenna 2; E, labium; F, mandibles; G, maxilla 1; H, maxilla 2; I–K, maxillipeds 1–3; L, M, pereopods 1, 2.

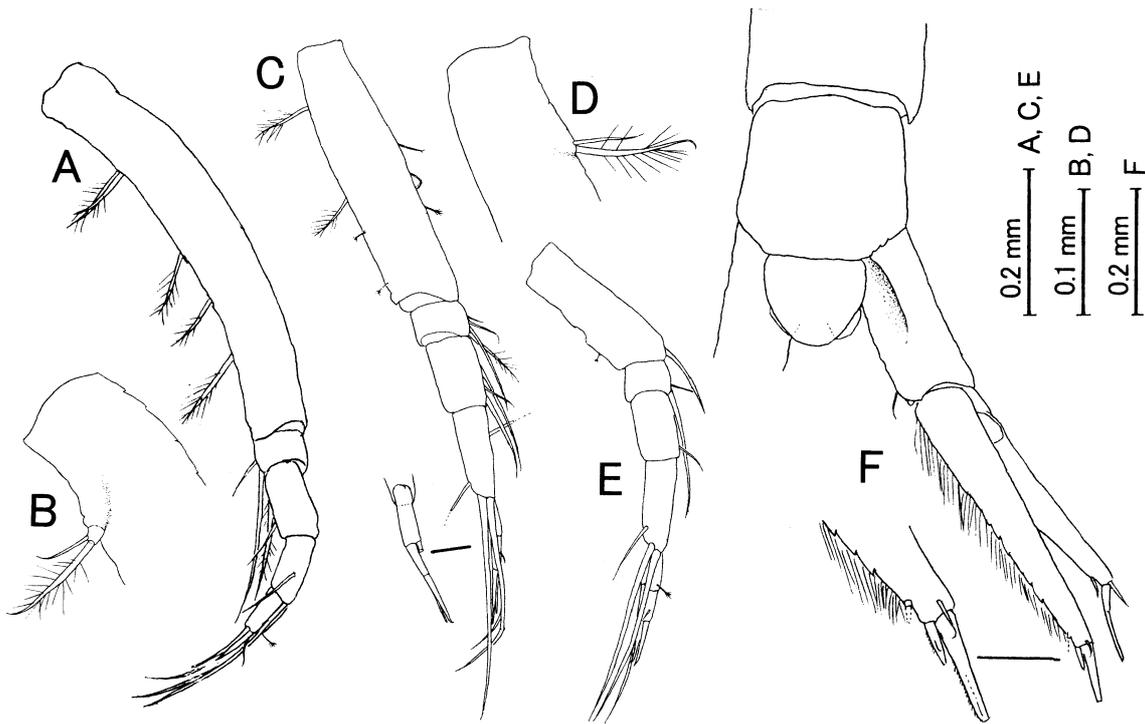


FIGURE 2. *Petalosarsia declivis* (Sars), ovigerous female. A, B, pereopod 3; C, D, pereopod 4; E pereopod 5; F, uropod with pleonite 6.

Uropod (Fig. 2F) peduncle 1.07–1.20 times pleonite 6, 0.68–0.79 times exopod length, 0.58–0.63 times endopod length, with a short seta on inner distal margin; exopod 0.80–0.91 times endopod length, with 3 setae on tip; endopod with numerous hairs on inner margin, armed with 0 or 1 spiniform setae on inner margin and 2 terminal setae. Telson semicircular, 0.41–0.55 times pleonite 6.

Distribution. North Atlantic boreal and Arctic region, NW Canada, Detroit de Davis, Iceland, Scandinavia, Spitsbergen, Beloe More, Novaya Zemlya, Kamchatka, the Sea of Japan. Okhotsk Sea, Alaska, 18–472 m.

Remarks. Female specimens examined in the present study agree well with the description of *Petalosarsia declivis* (Sars, 1900), except that the frontal margin of the carapace is not acute. In addition, the basal article of antenna 2 in the Japanese specimens is furnished with two plumose setae. In the Atlantic specimen described by Sars (1900) and other *Petalosarsia* species from Japan and the Sulu Sea, this article bears a plumose seta.

Sars (1900) showed a tiny bi-articulate exopod on pereopod 3 of a female from the Northeast Atlantic. However, Bacescu and Muradian (1974) observed that exopods on pereopods 3 and 4 were absent in the specimens from the Northwest Atlantic. Japanese specimens were characterized by a minute, single article exopod on pereopod 3 and total absence of an exopod on pereopod 4 except for a couple of setae that may be remnant terminal setae of the exopod. It is possible that the exopods on pereopods 3 and 4 may show variation between individuals, although this was not observed.

Petalosarsia declivis from Alaska, relatively close to northern Japan, shows two lateral ridges under the dorso-lateral carina of the carapace, according to Given (1965). Japanese female specimens have only 1 weak lateral ridge like the specimens from the Northwest Atlantic, described by Bacescu and Muradian (1974). The morphological variation mentioned above suggests that the name *P. declivis*, as currently used, may represent a species complex. Detailed study of populations from the various localities is necessary to determine if the variation is due to divergence or phenotypic plasticity.

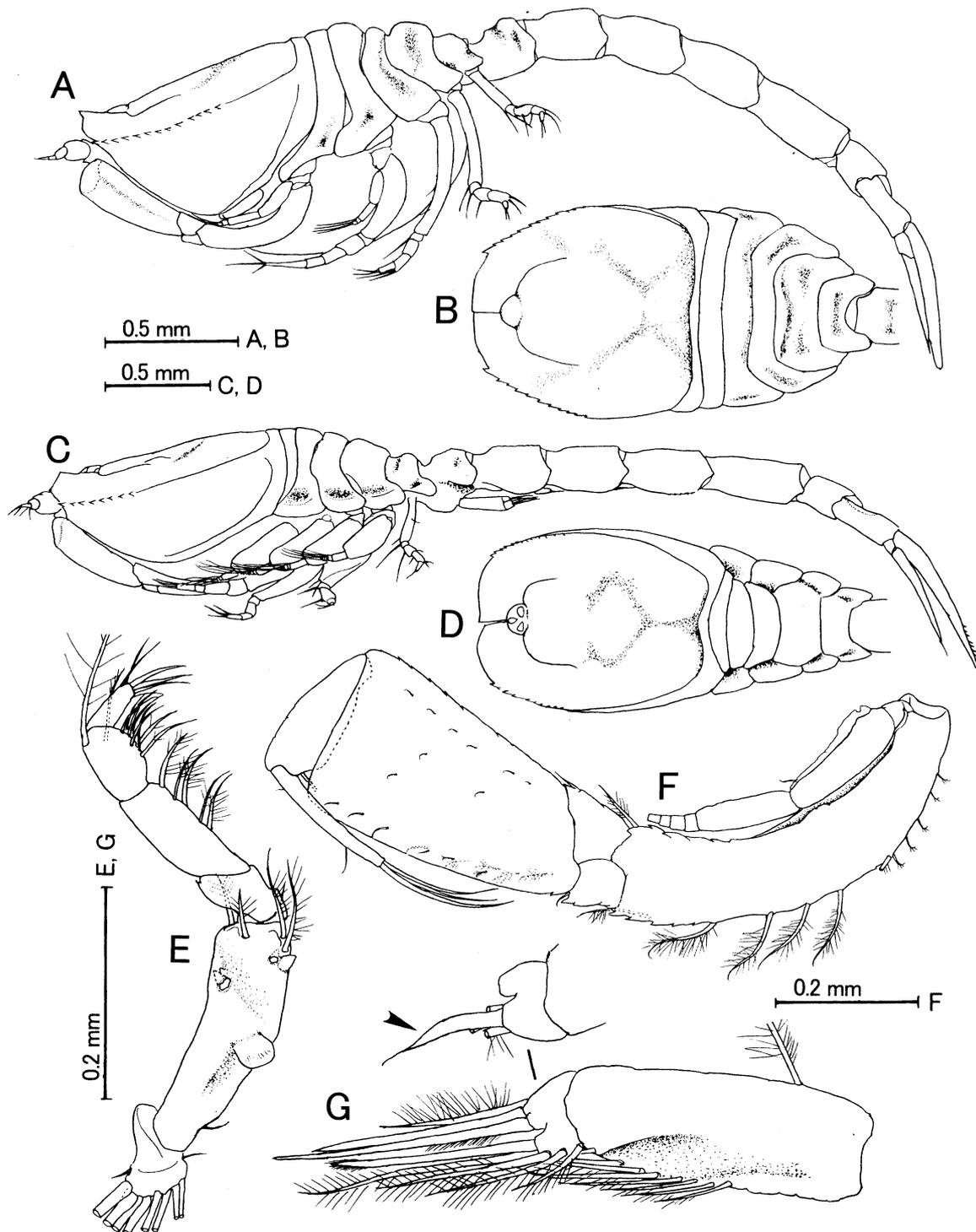


FIGURE 3. *Petalosarsia brevirostris* Gamô. Ovigerous female; A, habitus, lateral view; B anterior portion of body, dorsal view; E, maxilliped 2; F, pereopod 1. Adult male; C, habitus, lateral view; D, anterior portion of body, dorsal view; G, pleopod 1.

***Petalosarsia brevirostris* Gamô, 1986**

(Fig. 3)

Petalosarsia brevirostris Gamô, 1986: 5–10, Figs. 2, 3.

Material examined. Twenty-five ovigerous females (5 specimens dissected, 3.40–3.88 mm) (NSMT-Cr 22064), Enshu Nada, off Honshu Island, 34°36.11'N, 137°59.06'E – 34°36.01'N, 137°59.27'E, 116–155 m (KT -02-5, St.

EN-4-2), 27 May 2002; many ovigerous females (4 specimens dissected, 3.51–3.60 mm), many preparatory females, 3.20–3.42 mm, many adult males, (5 specimens dissected, 4.66–4.76 mm) (NSMT-Cr 22065), East China Sea, 31°19.39'N, 128°19.73'E, 305 m (N282, St. W-5), 8 June, 2009; 1 preparatory female, Ashizuri Misaki, Shikoku Island, 32°44.3'N, 132°41.1'E, 124–125 m (KT-99-18, St. DG-8), 17 December, 1999; 1 preparatory female, 1 adult male, Enshu Nada, 34°35.37'N, 138°04.88'E, 115–117 m (KT-02-5, St. EN-2-1-1), 26 May 2002; 1 preparatory female, 6 adult males, 2 juveniles, Enshu Nada, off Honshu Island, 34°34.78'N, 138°04.89'E, 69–74 m (KT-02-5, St. EN2-2), 26 May 2002; 2 preparatory females, 2 adult males, 2 juveniles, east of Izu Peninsula, Honshu Island, 34°41.11'N, 139°00.78'E, 86–96 m (KT-02-5, St. IZE-3) 29 May 2002; 1 ovigerous female, 1 juvenile male, 34°50.88'N, 138°44.78'E 130–134 m (KT-02-5, St. IZW-1), 29 May 2002; 9 ovigerous females, 7 preparatory females 8 adult males, 2 subadult males, 1 juvenile, off Okinoshima, 32°43.95'N, 134°41.99'E, 131–136 m (KT-05-30, St. OS-1-2), 22 November 2005; 1 subadult male, off Okinoshima, 32°41.07'N, 134°42.17'E 181–183 m (KT-05-30, St. OS-2), 22 November 2005; 1 preparatory female, 2.69 mm (NSMT-Cr 22066), the Sulu Sea, 07°56.50'N, 118°10.09'E – 07°55.36'N, 118°10.33'E, 292–296 m (KH-02-4, St. S1-B), 23 November 2002.

Distribution. Pacific coast of southern Japan, off Kyusyu and Nansei Isles, East China Sea, Sulu Sea, Philippines, 69–609 m.

Remarks. Specimens agree well with the description by Gamô (1986). However, minor alterations and additional descriptions include:

(1) basis of maxilliped 2 of females with round thin plate on ventral surface and a short simple seta on inner margin near basal end; ventral surface near distal end with a few spines (Fig. 3E).

(2) Gamô observed minute exopods on pereopods 3 and 4, which were "difficult to see" in a female specimen from the southern coast of Honshu Island. In the present study, exopods on these legs were absent except for a couple of possible remnant terminal setae in the female specimens from the southern coast of Honshu, near the locality where Gamô's specimens were collected. However, bi-articulate exopods were present in most specimens collected off Kyushu and Nansei Islands, the East China Sea. Thus this character is variable between individuals.

(3) the main flagellum of antenna 1 in adult males is 5-articulate, which is common with other species examined in the present study.

(4) Gamô described the adult male of *P. brevisrostris* with five pairs of pleopods, 3rd to 5th of which are of minute button-like single article, furnished with a terminal plumose seta. McCarthy et al. (2005) suspected that these minute projection on pleonite 3–5 were not actually pleopods, but plumose setae observed occasionally in male cumacean specimens. Adult male specimens examined in the present study do not have pleopod articles on pleonite 3–5, but only plumose setae, examined under a light microscope. Thus the males have only two pairs of pleopods.

(5) Inner and outer rami of pleopod 1 are partially fused; outer ramus with a short, robust naked seta on posterior side (indicated by arrowhead in Fig. 3G).

(6) Telson of adult males is triangular, exceeding opening of anus.

A specimen collected from the Sulu Sea is characterized by the dorsolateral carina on the carapace bearing three faint teeth, whereas Japanese specimens have 8–13 teeth. However, this character may reflect that the specimen was damaged during collection or preservation.

***Petalosarsia ovalis* sp. nov.**

(Figs. 4–6)

Material examined. Holotype ovigerous female, 4.20 mm (NSMT-Cr 22067), Okinawa Trough, East China Sea, 29°29.7'N, 127°46.8'E – 29°30.4'N, 127°46.8'E, 1018–1027 m (KT-04-23, St. D1-b'), 12 October 2004. Paratypes; 1 subadult male, 4.90 mm (NSMT-Cr 22068), Okinawa Trough, 26°15.16'N, 125°17.22'E – 26°13.85'N, 125°18.43'E, 991–955 m (KT-02-3, St. E-2), 26 April 2002; 1 preparatory female, 4.39 mm (NSMT-Cr 22069), Okinawa Trough, 24°56.19'N, 124°54.39'E – 24°56.71'N, 124°56.18'E, 1012–1006 m (KT-02-3, St. C-2), 27 April 2002; 1 ovigerous female, 3.98 mm (NSMT-Cr 22070), off Aguni Isl., Okinawa Trough, 26°24.94'N, 127°20.46'E – 26°25.68'N, 127°20.12'E, 734–761 m (KT-08-33, St. AG5-2), 17 December 2008; 1 ovigerous female, 3.84 mm (NSMT-Cr 22071), west of Koshiki Isles., 31°36.86'N, 128°28.35'E, 534 m (N251, St. M), 14 November 2007; 1 preparatory female, 4.03 mm (NSMT-Cr 22072), East of Ryukyu Island, 26°36.39'N,

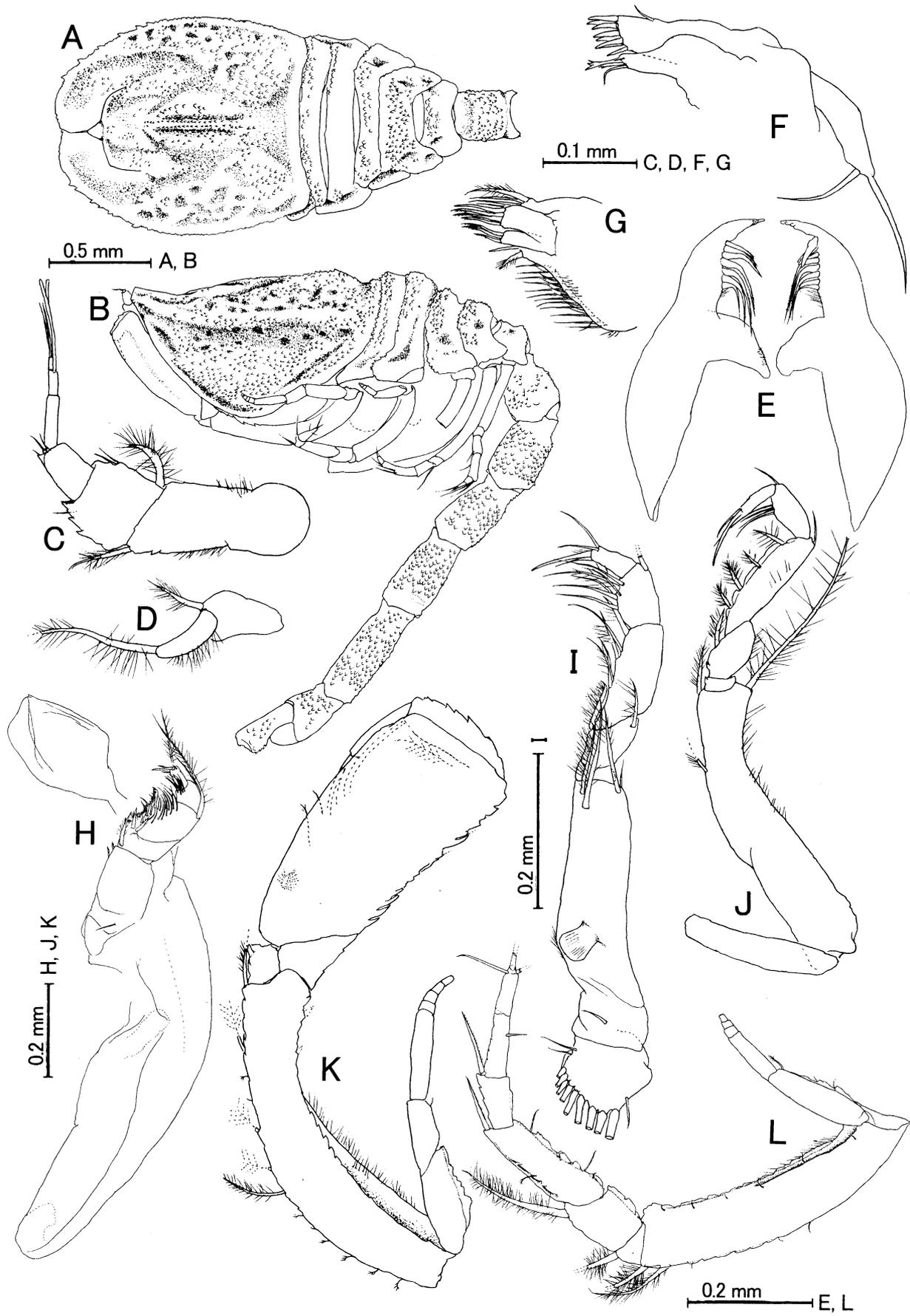


FIGURE 4. *Petalosarsia ovalis* sp. nov., ovigerous female. A, lateral view; B, anterior portion of body, from above; C, antenna 1; D, antenna 2; E, mandibles; F, maxilla 1; G, maxilla 2; H–J, maxillipeds 1–3; K, L, pereopods 1, 2.

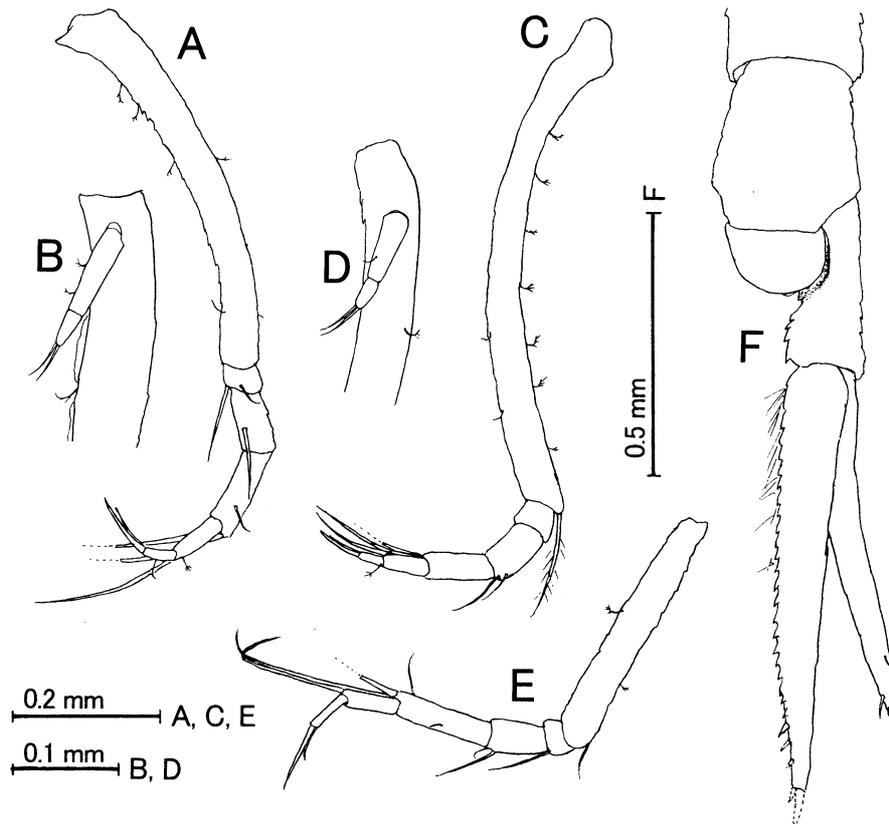


FIGURE 5. *Petalosarsia ovalis* sp. nov., ovigerous female. A, B, pereopod 3; C, D, pereopod 4; E, pereopod 5; F, uropod with pleonite 6.

128°27.33'E – 26°37.09'N, 128°28.14'E, 513–724 m (KH-05-1, St. PS-9), 25 May, 2005; 1 preparatory female, 3.56 mm (NSMT-Cr 22073), west of Kyusyu Island, 32°09.11'N, 129°31.25'E, 495 m (N282, St. B-1), 7 June, 2009; 1 subadult male, 4.07 mm (NSMT-Cr 22074), west of Kyushu Island, 31°42.93'N, 128°35.72'E – 31°42.05'N, 128°34.76'E, 498–501 m (N237, St. F-2), 9 May, 2007.

Description. Ovigerous and preparatory females (Figs. 4, 5). Body well calcified, covered with minute scale like sculpture. Carapace (Figs. 4A, B) oval seen from above, length 1.03–1.15 times width, length 1.55–1.78 times depth, length 0.28–0.30 times total body length. Width of hind margin 0.71–0.77 times (ovigerous females) and 0.58–0.65 times (preparatory females) greatest width of carapace. Dorsal surface flat, with shallow depressions, surrounded by a pair of prominent but dull dorsolateral carina running for entire length of carapace and a transverse ridge near hind margin; anterior portion with 3–6 minute teeth; just below anterior portion of dorsolateral carina with shallow sulcus; frontal margin of pseudorostral lobes, between anterior end of dorsolateral carina, 0.45–0.49 times greatest width of carapace; ventral margin smooth, anterolateral angle and antennal notch obsolete; pseudorostrum short and truncate, 0.08–0.11 times length of carapace. Width of small, triangular eye lobe 0.09–0.10 times width of carapace. Pereon 0.60–0.66 times (ovigerous females) and 0.52–0.59 times (preparatory females) carapace length. Pleon 0.53–0.55 times total body length.

Antenna 1 (Fig. 4C) 1st article of peduncle 1.25–1.42 times combined length of 2nd and 3rd articles; distal end of 2nd article fringed with thin, broad collar surrounding basal region of 3rd article; main flagellum of 3 articles, 0.53–0.56 times basal article of peduncle; 1st article of main flagellum 1.23–1.46 times distal 2 articles combined; accessory flagellum minute. Antenna 2 (Fig. 4D) of 2 articles, with a plumose seta on distal end of each article. Maxilliped 1 (Fig. 4H) with 1 branchial lobule; basis shorter than distal segments together. Maxilliped 2 (Fig. 4I), basis 1.20–1.27 times combined length of following 4 articles, with thin plate on ventral surface and with a short seta near proximal end; blunt spines absent near distal end of basis. Maxilliped 3 (Fig. 4J), basis 1.10–1.14 times distal articles together, with 1–3 plumose setae on inner margin; carpus with hyaline lamella on inner margin.

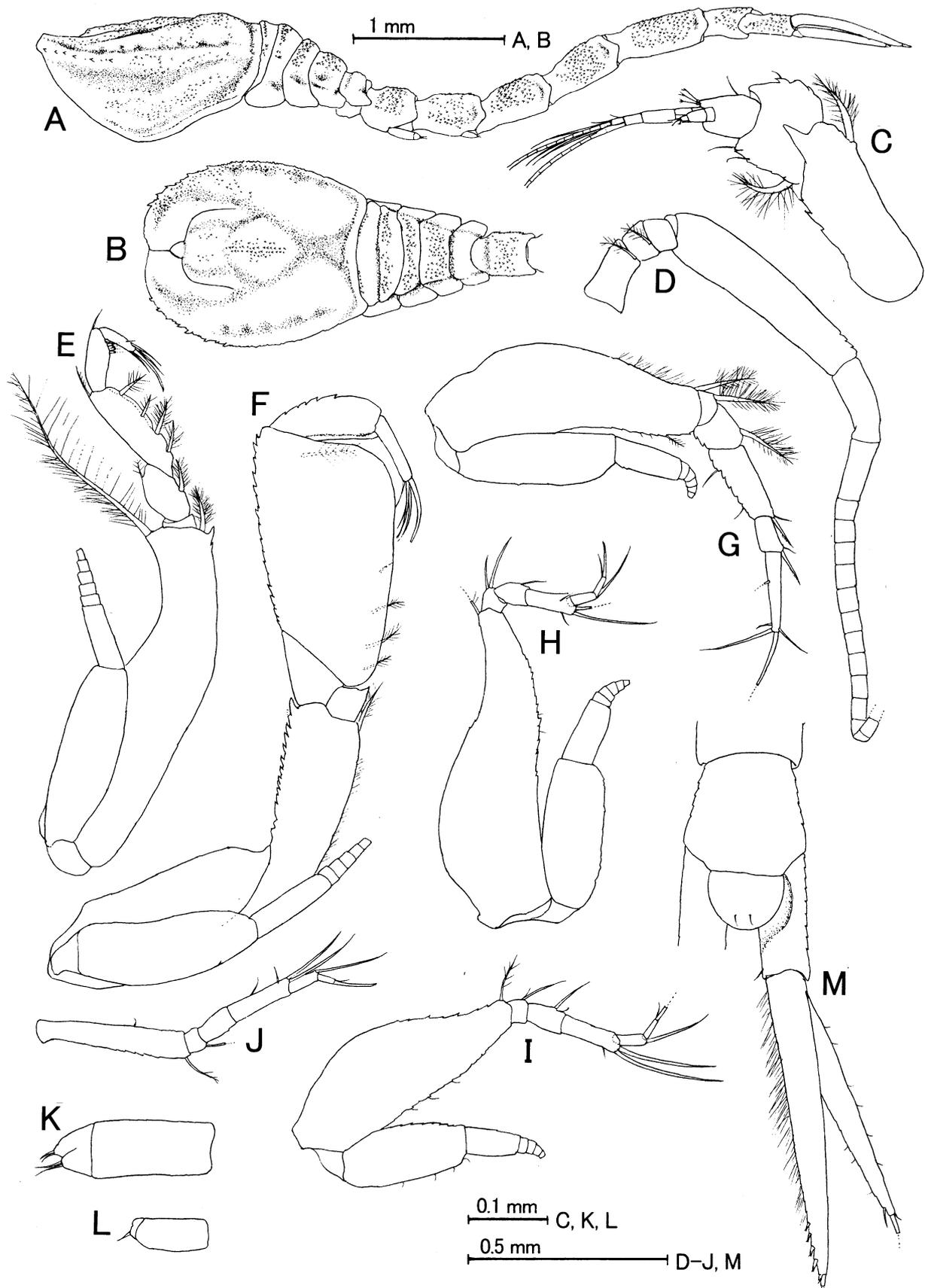


FIGURE 6. *Petalosarsia ovalis* sp. nov., subadult male. A, lateral view; B, anterior portion of body, from above; C, antenna 1; D, antenna 2; E, maxilliped 3; F–J, pereopods 1–5; K, L, pleopods 1, 2; M, uropod with pleonite 6.

Pereopod 1 (Fig. 4K), basis 1.14–1.27 times combined length of ischium and carpus, with 3–5 plumose setae on inner margin; length of carpus 1.9–2.1 times width, 3.0–3.35 times dactylus length, 0.68–0.75 times basis length. Pereopod 2 (Fig. 4L), basis, 0.7–0.9 times distal articles together, with 1–3 long plumose setae and several short ciliate setae on inner margin; exopod short, not reaching distal end of basis. Pereopod 3 (Figs. 5A, B), basis slender, 2.0–2.4 times combined length of distal articles; plumose setae on inner and outer margin very small; bi-articulate exopod present or absent except for a pair of remnant naked setae. Pereopod 4 (Fig. 5C, D), basis slender, 1.2–1.6 times remaining distal articles; setae and exopod similar to pereopod 3. Pereopod 5 (Fig. 5E), basis 0.8–1.0 times distal articles together.

Uropod (Fig. 5F), peduncle 1.02–1.19 times pleonite 6 length, 0.54–0.59 times exopod length; exopod 0.78–0.85 times endopod, with a short seta on inner margin and a short terminal seta; endopod inner margin serrated, with 3–4 spiniform setae on inner margin and 2 terminal setae. Telson semicircular, 0.33–0.36 times length of pleonite 6 (Fig. 5F).

2 subadult males (Fig. 6). Overall appearance similar to preparatory females. Carapace length 0.29–0.30 times total body length, length 1.18 times greatest width and 1.83–1.92 times depth; width of hind margin 0.57–0.60 times greatest width of carapace; dorsolateral carina blunt, with 3–7 teeth; frontal margin 0.50–0.53 times greatest width; pseudorostrum 0.089 times length of carapace; width of eye lobe 0.088–0.104 times greatest width of carapace. Pereon 0.55–0.58 times carapace. Pleon 0.52–0.55 times total body length, with 2 pairs of pleopods.

Main flagellum of antenna 1 of 5 articles (Fig. 6C); accessory flagellum of 3 articles. Antenna 2 (Fig. 6D), peduncle with 2 plumose setae. Maxilliped 3 (Fig. 6E), basis 1.3–1.4 times length of remaining distal articles.

Pereopod 1 (Fig. 6F), basis 1.46 times combined length of ischium and carpus; carpus 1.8–1.9 times its width and 3.1–3.3 times dactylus length. Pereopod 2 (Fig. 6G), basis 1.0–1.1 times remaining distal articles; dactylus subequal to carpus. Pereopods 3 and 4 (Fig. H, I), basis 2.4, 1.4–1.5 times remaining distal articles respectively, with developed exopods. Pereopod 5 (Fig. 6J), basis 0.8–0.9 times distal articles combined. Pleopod 1 and 2 (Fig. 6K, L), outer and inner rami fused for about half of their length, with undeveloped setae; peduncle with no seta on margin.

Uropod (Fig. 6M), peduncle 1.06–1.12 times pleonite 6 length, 0.52 times exopod length, and 0.42–0.43 times endopod length; exopod 0.81–0.82 times endopod length; endopod with 4 spiniform setae on inner margin. Telson semicircular, 0.42–0.47 times pleonite 6 length.

Etymology. The species name refers to the oval shape of the carapace as seen from above.

Distribution. Off Kyushu and Nansei Islands, East China Sea, 495–1012 m depth.

Remarks. The overall appearance of the new species resembles *P. brevirostris* Gamô, 1986 and *P. ryukyuensis* sp. nov., but is distinguishable from these two species by (1) dorsolateral carina of carapace blunt for entire length, (2) frontal margin and hind end of carapace narrow, resulting in oval shape of carapace from dorsal view, (3) small eye lobe, (4) basis of maxilliped 2 in females without spines near distal end, (5) pereopod 1 with narrower carpus and shorter dactylus, (6) exopod of pereopod 2 in females does not reach distal end of basis, and (7) pereopod 3 and 4 with only reduced plumose setae on inner and outer margin.

Petalosarsia ryukyuensis sp. nov.

(Figs. 7–9)

Material examined. Holotype ovigerous female (NSMT-Cr 22075), 3.44 mm, allotype adult male (NSMT-Cr 22076), 3.96 mm, paratypes 1 ovigerous female and 1 juvenile, 3.17 mm and 2.65 mm (NSMT-Cr 22077), south-east of Kumejima Island, Okinawa Trough, East China Sea, 25°30.96'N, 126°29.21'E, 25°30.88'N, 126°29.21'E – 25°48.97'N, 126°29.55'E, 372–375 m (KH-05-1, St. OT-14), 15 May, 2005.

Description. Holotype ovigerous female (Figs. 7, 8). Body moderately calcified, surface of integument smooth. Carapace length 1.00 times width, length 1.59 times depth, length 0.26 times total body length (Fig. 7A); anterior portion of dorsal surface with dorsolateral carina with 3 teeth; transverse ridge near hind margin absent. Frontal margin of pseudorostral lobes, between foremost teeth of dorsolateral carina, 0.60 times greatest width of carapace (Fig. 7B); pseudorostrum short and truncate, 0.11 times carapace length; anterolateral angle and antennal notch obsolete. Width of rounded eye lobe 0.15 times width of carapace. Pereon 0.74 times carapace; side plates of pereonite 2 and 3 well developed. Pleon 0.55 times total body length (Fig. 7A).

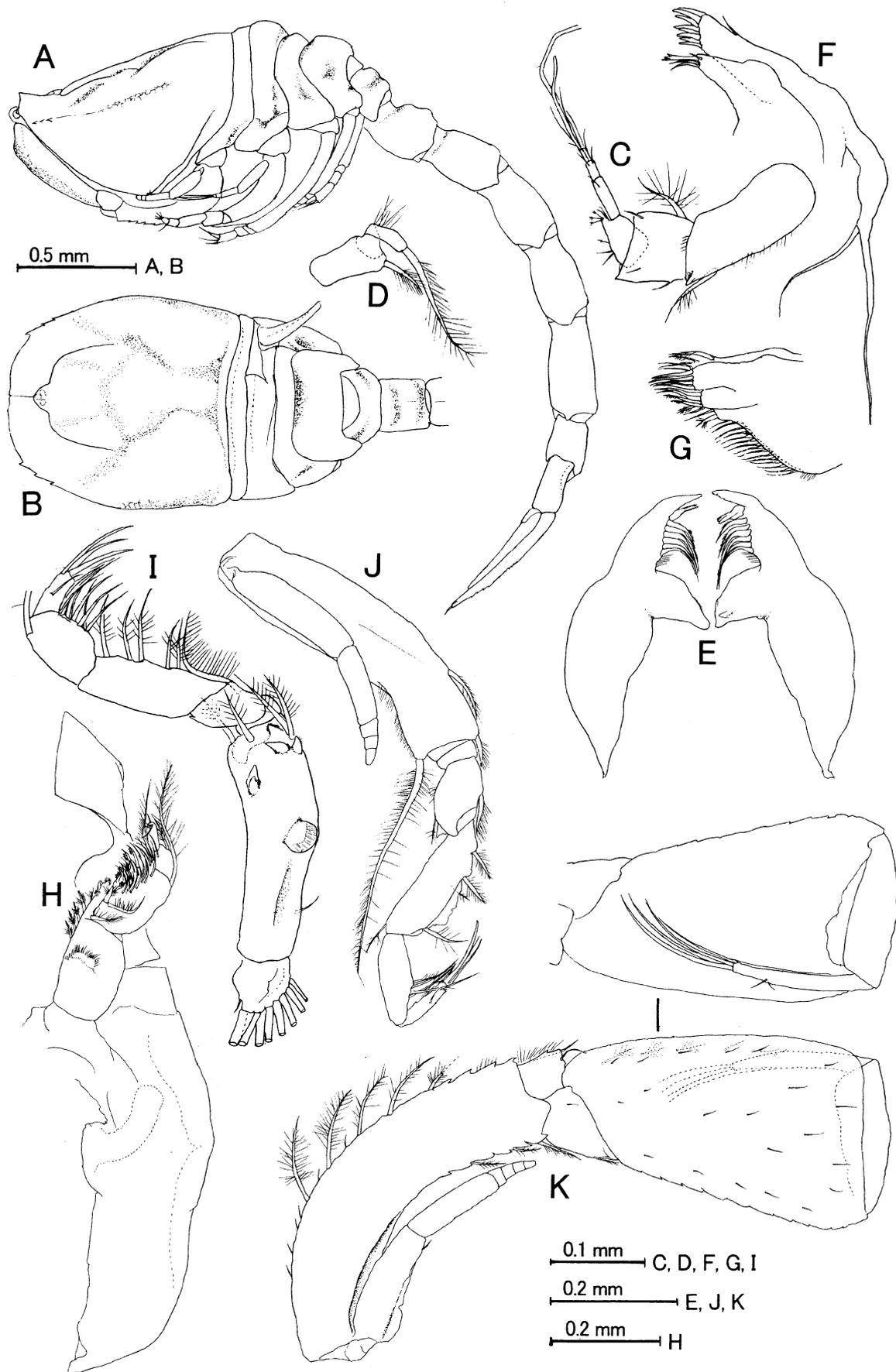


FIGURE 7. *Petalosarsia ryukyuensis* sp. nov., ovigerous female. A, lateral view; B, anterior portion of body, from above; C, antenna 1; D, antenna 2; E, mandibles; F, maxilla 1; G, maxilla 2; H–J, maxillipeds 1–3; K, pereopod 1.

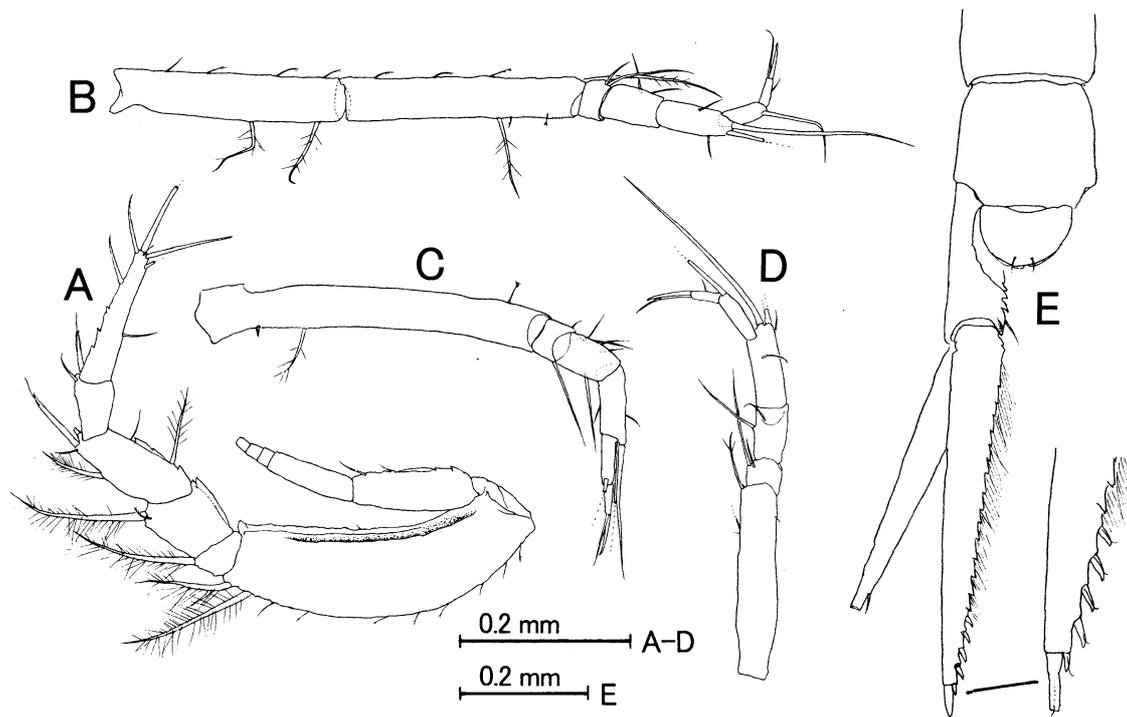


FIGURE 8. *Petalosarsia ryukyuensis* sp. nov., ovigerous female. A–D, pereopods 2–5; E, uropod with pleonite 6.

Antenna 1 (Fig. 7C), 1st article of peduncle 1.58 times combined length of 2nd and 3rd articles; 2nd peduncular article widely open distally; distal end of 2nd article fringed with thin, broad collar exceeding joint with 3rd article; conical 3rd article small; main flagellum of 3 articles, 0.54 times basal article of peduncle, with 2 aesthetascs; accessory flagellum minute. Antenna 2 (Fig. 7D) of 2 articles, with a plumose seta on distal end of each article. Maxilliped 1 (Fig. 7H) with 1 branchial lobule; basal article with a short brush of setae. Maxilliped 2 (Fig. 7I) basis, 0.95 times combined length of ischium, merus, carpus and propodus, with a round plate on ventral surface, a short seta on inner margin and 4 spines near distal end. Maxilliped 3 (Fig. 7J) basis 0.87 times distal articles together, with 2 plumose setae on inner margin.

Pereopod 1 (Fig. 7K) basis 1.1 times combined length of ischium and carpus, with 5 plumose setae on inner margin; carpus 1.7 times its width, 2.2 times dactylus length, 0.83 times basis length. Pereopod 2 (Fig. 8A) basis 0.8 times distal articles together, with 2 plumose setae on inner margin; dactylus longer than carpus. Pereopod 3 (Fig. 8B) basis 2.2 times remaining distal articles, with 3 long and 7 short plumose setae; exopod absent. Pereopod 4 (Fig. 8C) basis 1.55 times remaining distal articles; exopod absent. Pereopod 5 (Fig. 8D) basis 0.8 times remaining distal articles.

Uropod (Fig. 8E), peduncle 1.31 times pleonite 6 length, 0.58 times exopod length, 0.45 times endopod length; exopod 0.78 times endopod. Endopod with 4 setae on inner margin and with 2 terminal setae. Telson semicircular, 0.49 times length of pleonite 6.

Allotype adult male (Fig. 9). Carapace length 0.30 times total body length, length 1.27 times greatest width and 1.96 times depth (Fig. 9A, B); only anterior portion with lateral carina, with 4 teeth; hind margin of dorsal surface without ridge; frontal margin between lateral carina 0.72 times greatest width (Fig. 9B); pseudorostrum 0.078 times length of carapace. Width of eye lobe 0.16 times width of carapace. Pereon 0.55 times carapace (Fig. 9A). Pleon 0.53 times total body length, with 2 pairs of pleopods (Fig. 9A).

Antenna 1 (Fig. 9C) 1st article of peduncle 1.64 times combined length of 2nd and 3rd; main flagellum of 5 articles; 1st article with 10 aesthetascs; accessory flagellum of 3 articles, as long as proximal 3 articles of main flagellum combined. Antenna 2 (Fig. 9D) peduncle with 1 plumose seta; flagellum of 22 articles, exceeding posterior end of telson. Maxilliped 3 (Fig. 9E) basis 1.1 times remaining distal articles, with 5 plumose setae on inner margin. Basis of maxilliped 3 and pereopods 1–4 strongly constructed at proximal portion, with well developed exopods.

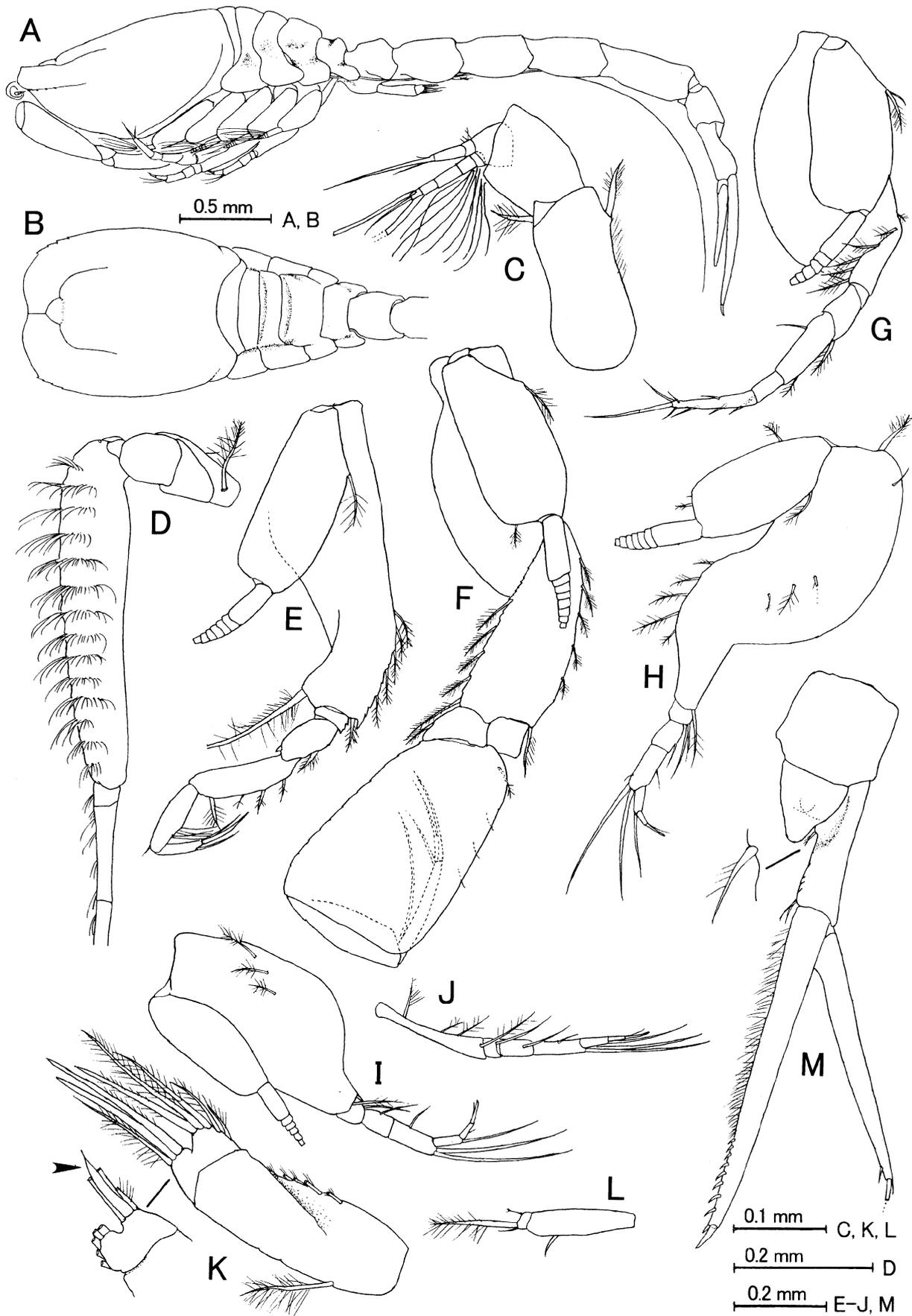


FIGURE 9. *Petalosarsia ryukyuensis* sp. nov., adult male. A, lateral view; B, anterior portion of body, from above; C, antenna 1; D, antenna 2; E, maxilliped 3; F–J, pereopods 1–5; K, L, pleopod 1, 2; M, uropod with pleonite 6.

Pereopod 1 (Fig. 9F) basis 1.45 times combined length of ischium and carpus; length of carpus 1.6 times its width, 2.15 times dactylus length, 0.59 times basis length; distal margin much broader than proximal margin. Pereopod 2 (Fig. 9G) basis 1.1 times remaining distal articles, dactylus slightly longer than carpus. Pereopods 3, 4 (Fig. 9H, I) basis broad at base, 2.45 and 1.6 times length of remaining distal articles respectively. Pereopod 5 (Fig. 9J) slender, basis 0.8 times remaining distal articles, with 3 plumose setae. Pleopod 1 (Fig. 9K), outer and inner rami fused; outer ramus with 3 long plumose seta (2 of them stiff and almost naked) on ventral side and 1 thick, short naked seta (arrow head) on dorsal side; inner ramus with 5 plumose setae (1 of them stiff and almost naked); inner margin of peduncle with 7 plumose setae.

Uropod (Fig. 9M), peduncle 1.47 times pleonite 6 length, 0.57 times exopod length and 0.45 times endopod length; exopod 0.79 times endopod length; endopod with 7 or 8 spiniform setae on inner margin. Telson (Fig. 9M) reaching over anus, triangular shape, 0.70 times pleonite 6 length.

Etymology. The species name refers to the locality that the specimens were collected at, the Ryukyu Islands.

Distribution. Southeast of Kumejima Island, Okinawa Trough, 372–375 m.

Remarks. The Shape of appendages of the present new species is similar to *Petalosarsia brevirostris* Gamô, 1986, but can be distinguished from the latter by (1) carapace with lateral carina only on anterior portion, while all *P. brevirostris* specimens examined have sharp dorsolateral carina running for the entire length of the carapace (Fig. 3A–D), and (2) ridge near hind margin of dorsal surface of carapace obsolete in female and wholly absent in male, and (3) carpus of pereopod 1 in two ovigerous females long, 0.82–0.83 times basis (0.64–0.72 in *P. brevirostris*, 10 specimens, Fig. 3F).

Petalosarsia gamoi sp. nov.

(Figs. 10–12)

Material examined. Holotype ovigerous female, 5.02 mm (NSMT-Cr 22078), Tosa Bay, 32°48.0'N, 133°46.6'E – 32°47.6'N, 133°45.4'E, 1053–1056 m (KT00-8, St. BT-4), 27 June 1999. Paratypes; 1 ovigerous female, 4.33 mm (dissected), 1 adult male, 3.90 mm, (KT00-8, St. BT-4); 1 ovigerous female, 5.02 mm (dissected), 1 manca larva (NSMT-Cr 22079), Tosa Bay, 32°57.6'N, 133°44.7'E – 32°57.6'N, 133°42.0'E, 994–1001 m (KT-00-8, St. BT-3), 25 June 2000; 2 ovigerous females, 5.48 m, 4.81 mm (dissected), 1 adult male, 4.79 mm (dissected), 1 preparatory female, 1 subadult male, 2 juveniles, 1 manca larva (NSMT-Cr 22080), Hyuga Basin, 32°23.4'N, 132°15.1'E – 32°25.2'N, 132°17.2'E, 1501–1516 m (KT-99-18, St. BT-4), 16 December, 1999; 1 ovigerous female, 4.81 mm (dissected) (NSMT-Cr 22081), Kumano Basin, 33°43.7'N, 136°46.2'E – 33°44.3'N, 136°47.6'E, 1966–1989 m (KT-04-6, St. KN-8-2), 2 May, 2005; 1 ovigerous female, 3.80 mm (NSMT-Cr 22082), 08°05.97'N, 118°20.78'E – 08°06.70'N, 118°20.43'E, 514–516 m (KH-02-4, St. 7A), 23 November 2002.

Other material. 1 preparatory female, Kumano Basin, 33°50.0'N, 136°32.6'E – 33°50.0'N, 136°28.9'E, 1947–2023 m (KT-99-18, St. BT-9), 20 December 1999; 1 preparatory female, 34°25.98'N, 139°52.32'E – 34°24.64'N, 139°52.36'E, 1478–1492 m (KT-02-5, St. MY) 28 May 2002; 1 preparatory female, 2 subadult males, 1 juvenile, 1 manca larva, off Chiba, 35°01.72'N, 140°47.89'E – 35°03.12'N, 140°49.14'E, 1160–1219 m (KT-01-8, St. TK-2), 23 June 2001; 1 juvenile, 1 manca larva, Shima Spur, 33°59.33'N, 136°51.25'E – 33°58.29'N, 136°51.43'E, 857–918 m (KT-05-30, St. KB-1-4), 24 November, 2005; 1 subadult male, Kumano Basin, 33°45.87'N, 136°42.01'E – 33°46.89'N, 136°42.65'E, 1910–2011 m (KT-05-30, St. KB-2-2), 24 November 2005; 1 preparatory female, Hyuga Basin, 32°16.97'N, 132°28.96'E – 32°19.23'N, 132°30.75'E, 1651–1677 m (KT-07-1, St. HB-1), 22 February 2007; 1 subadult male, Tosa Basin, 32°57.29'N, 133°43.90'E – 32°57.03'N, 133°45.50'E, 1009–1222 m (KT-07-1, St. TB-1-3), 21 February 2007; 1 preparatory female, 1 juvenile, west of Okinawa Isl., 26°27.06'N, 127°32.25'E – 26°27.50'N, 127°32.10'E, 641–650 m (TY06, St. 8), 27 May 2006; 3 preparatory females, 29°19.14'N, 127°40.87'E, 1017 m (N275, St. Q), 30 November 2008; 1 ovigerous female, 28°34.07'N, 127°02.62'E, 608 m (N295, St. R2-1), 19 November 2009. 1 adult male, 4.62 mm, Okinawa Trough 26°11.34'N, 124°54.27'E – 26°12.65'N, 124°55.47'E, 1493–1533 m (KT-02-3, St. E-1), 26 April 2002.

Description. Ovigerous females (Figs. 10, 11). Body well calcified, carapace with numerous small depressions, length 1.36–1.57 times width, length 1.87–1.99 times depth, length 0.28–0.30 times total body length. Dorsal surface surrounded by a pair of marked dorsolateral carina running entire length of each side, and a transverse ridge near hind margin, dorsolateral carina curved slightly outward at side of frontal lobe, with 9–13 teeth on anterior

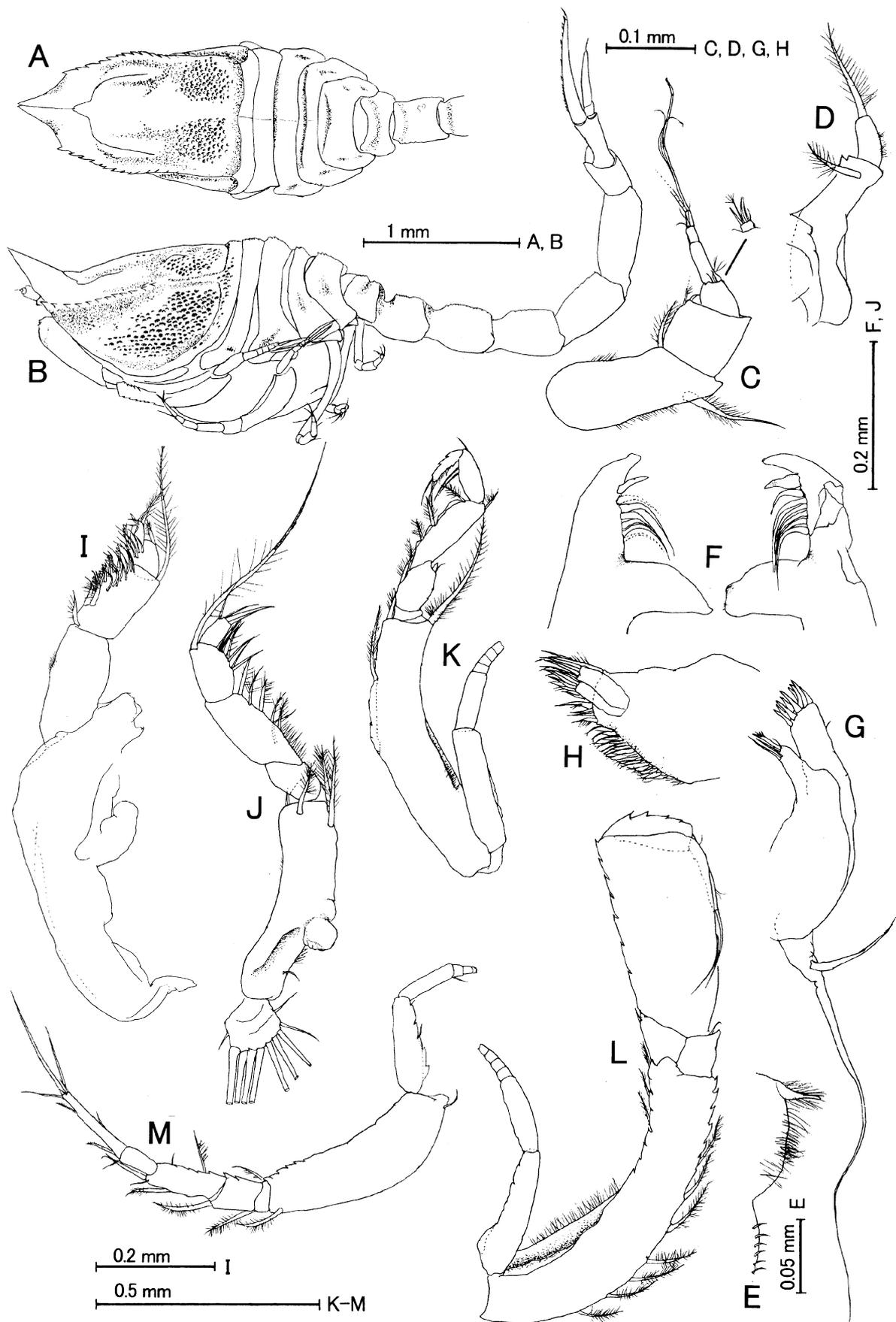


FIGURE 10. *Petalosarsia gamoi* sp. nov., ovigerous female. A, lateral view; B, anterior portion of body, from above; C, antenna 1; D, antenna 2; E, labium; F, mandibles; G, maxilla 1; H, maxilla 2; I-K, maxillipeds 1-3; L, M, pereopods 1, 2.

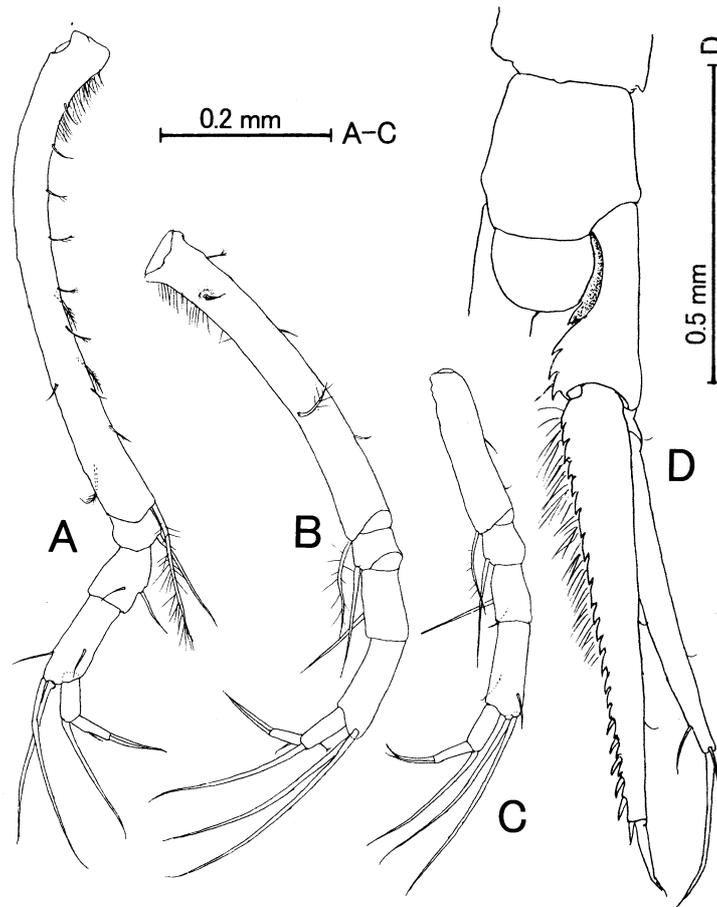


FIGURE 11. *Petalosarsia gamoi* sp. nov., ovigerous female. A–C, pereopods 3–5; D, uropod with pleonite 6.

portion; just below row of teeth, shallow depression like sulcus present; transverse ridge present near hind margin of each side; width of anterior portion of pseudorostral lobes, between foremost teeth of left and right dorsolateral carina, 0.47–0.51 times greatest width of carapace; pseudorostrum long and acute, 0.21–0.25 times length of carapace; inferior margin smooth; anterolateral angle and antennal notch obsolete. Width of triangular eye lobe 0.125–0.16 times width of carapace. Pereon 0.57–0.66 times carapace; side plates of pereonite 1–3 well developed. Pleon 0.51–0.53 times total body length.

Antenna 1 (Fig. 10C) 1st article of peduncle 1.2–1.5 times combined length of 2nd and 3rd articles; distal end of 2nd article fringed with thin, broad collar exceeding joint between 2nd and 3rd articles; main flagellum tri-articulate, 0.5–0.6 times 1st article of peduncle; 1st article of main flagellum 1.1–1.6 times combined length of 2nd and 3rd; accessory flagellum minute. Antenna 2 (Fig. 10D) bi-articulate, with a plumose seta on distal end of each article. Labium with fine hairs and minute hook-like setae on inner margin (Fig. 10E). Mandibles, maxilla 1 and 2 are normal for the genus (Fig. 10F–H). Maxilliped 1 (Fig. 10I) with 1 branchial lobule; basal article longer than combined length of remaining distal articles. Maxilliped 2 (Fig. 10J) basis, 1.05–1.2 times combined length of ischium, merus, carpus and propodus, with a round plate on ventral surface, without spines near distal end. Maxilliped 3 (Fig. 10K) basis 1.1–1.2 times distal articles together, with 2–3 plumose setae on inner margin; carpus with 3–4 setae on inner margin.

Pereopod 1 (Fig. 10L) basis 1.2–1.35 times combined length of ischium and carpus, with 6–8 plumose setae on inner margin; length of carpus 2.0–2.2 times width and 2.4–2.7 times dactylus length, 0.61–0.70 times basis length. Pereopod 2 (Fig. 10M), basis 0.8–0.9 times distal articles together, with 1–2 plumose setae on inner margin; dactylus longer than carpus. Pereopod 3 (Fig. 11A) basis 1.9–2.1 times length of remaining distal articles, with 2–5 long and several short plumose setae; exopod absent except for a pair of remnant terminal setae. Pereopod 4 (Fig. 11B) basis 1.3–1.4 times length of remaining distal articles, with 0–1 plumose seta; exopod absent. Pereopod 5 (Fig. 11C) basis 0.6–0.8 times length of remaining distal articles.

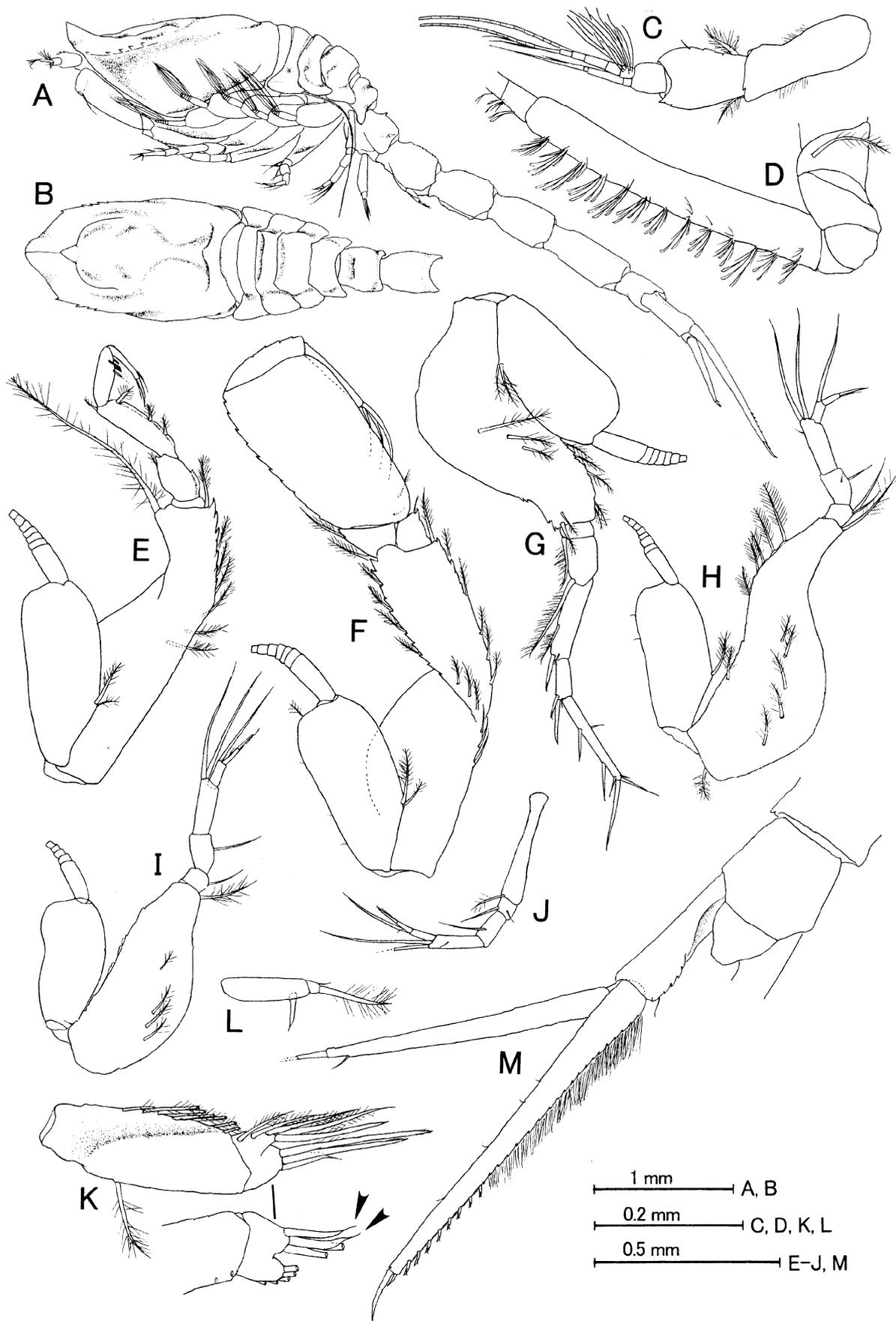


FIGURE 12. *Petalosarsia gamoi* sp. nov., adult male. A, lateral view; B, anterior portion of body, from above; C, antenna 1; D, antenna 2; E, maxilliped 3; F–J, pereopods 1–5; K, L, pleopods 1, 2; M, uropod with pleonite 6.

Uropod (Fig. 11D), peduncle 1.26–1.32 times pleonite 6 length, 0.59–0.67 times exopod length and 0.48–0.55 times endopod length; exopod 0.81–0.86 times endopod length, with 3 setae near apical end, terminal one thick and long; endopod with 5–7 spiniform setae on inner margin, 2 terminal setae. Telson 0.34–0.46 times pleonite 6 length.

Adult male (Fig. 12). Carapace length 0.32 times total body length, length 1.72 times greatest width and 2.23 times depth; only anterior portion with lateral carina, with 5 teeth; hind margin of dorsal surface without ridge; frontal margin between lateral carina 0.70 times greatest width; pseudorostrum 0.162 times length of carapace; width of eye lobe 0.15 times width of carapace. Pereon 0.53 times carapace. Pleon 0.52 times total body length, with 2 pairs of pleopods. Pleonites 1–6 with groove on ventral surface, very shallow on pleonite 6.

Antenna 1 (Fig. 12C) basal article of peduncle 1.2 times combined length of 2nd and 3rd; main flagellum of 5 articles; 1st article with 13 aesthetascs; accessory flagellum of 3 articles, subequal in length to proximal 3 articles of main flagellum combined. Antenna 2 (Fig. 12D) peduncle with plumose seta; flagellum short, reaching middle portion of pleonite 3, of 22 articles. Maxilliped 3 (Fig. 12E) basis 1.3 times remaining distal articles, with 6 plumose setae on inner margin.

Pereopod 1 (Fig. 12F) basis 1.4 times combined length of ischium and carpus; carpus length 1.8 times width, 2.4 times dactylus length, 0.60 times basis length. Pereopod 2 (Fig. 12G) basis 0.9 times length of remaining distal articles. Pereopods 3, 4 (Fig. 12H, I) basis broad at base, 2.0 and 1.4 times remaining distal articles respectively. Pereopod 5 (Fig. 12J) basis 0.8 times remaining distal articles. Pleopod 1 (Fig. 12K) outer and inner ramus fused; outer ramus with 2 stiff and long, almost naked seta on ventral side and 2 robust, short naked seta (arrow heads) on dorsal side; inner ramus with 5 plumose setae (1 of them stiff and almost naked); inner margin of basal article with 6 plumose setae. Pleopod 2 (Fig. 12L) rudimentary.

Uropod (Fig. 12M) peduncle 1.48 times pleonite 6 length, 0.52 times exopod length and 0.41 times endopod length; exopod 0.80 times endopod; endopod with 8 or 9 spiniform setae on inner margin. Telson (Fig. 12M) triangular shape, 0.72 times pleonite 6.

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

Distribution. Pacific coast of southern Japan, off Kyushu and Nansei Islands, East China Sea, 608–2023 m, Sulu Sea, 514–516 m.

Remarks. The present new species is similar to *P. brevirostris* in that the dorsal surface of the carapace of females has strong, sharp edged dorsolateral carina whose anterior portion is serrated, and a ridge near the hind margin, but is distinguishable from the latter species by (1) elongate carapace, with acute, long pseudorostrum, (2) ocular lobe triangular (rounded in *P. brevirostris*), (3) carpus of pereopod 1 narrow, 2.01–2.16 times its width (1.48–1.65 in *P. brevirostris*), 2.43–2.70 times dactylus (1.82–2.20 in *P. brevirostris*) (4) dorsolateral ridge of adult male running along only anterior portion of carapace, (5) antenna 2 of adult male short, reaching middle portion of pleonite 3, and (6) outer ramus of pleopod 1 with two thick naked setae (arrow heads).

A single ovigerous female from the Sulu Sea agrees well with specimens from Japanese waters, but shows minor morphological variation including (1) teeth on dorso-lateral ridges very small, not easily observable, (2) dorsal crest of pereonite 4 serrated for posterior half, while specimens in Japan serrated for entire length.

Petalosarsia jonesi sp. nov.

(Figs. 13–15)

Material examined. Holotype, ovigerous female, 2.99 mm (NSMT-Cr 22083), western region of the Sulu Sea, 08°06.41'N, 118°29.18'E – 08°07.32'N, 118°28.44'E, 796–804 m (KH-02-4, St. 8A), 23–24 November 2002. Paratype ovigerous female, 2.68 mm (NSMT-Cr 22084), paratype young male, posterior portion of pleon lost, 0.79 mm in carapace length (NSMT-Cr 22085), western region of the Sulu Sea, 08°06.41'N, 118°26.49'E – 08°07.04'N, 118°26.06'E, 688–693 m, (KH-02-4, St. 7B), 23 November 2002.

Description. Ovigerous female (Figs. 13, 14). Integument weakly calcified and smooth. Carapace laterally compressed, length 1.9 times width, length 1.4 times depth, length 0.29 times total body length; dorsal surface arched, without dorsolateral carina and transverse ridge; ventral margin smooth; anterolateral angle and antennal notch hardly discernible, but defined by 2–3 teeth (Fig. 13C, D); width of anterior portion of pseudorostral lobes

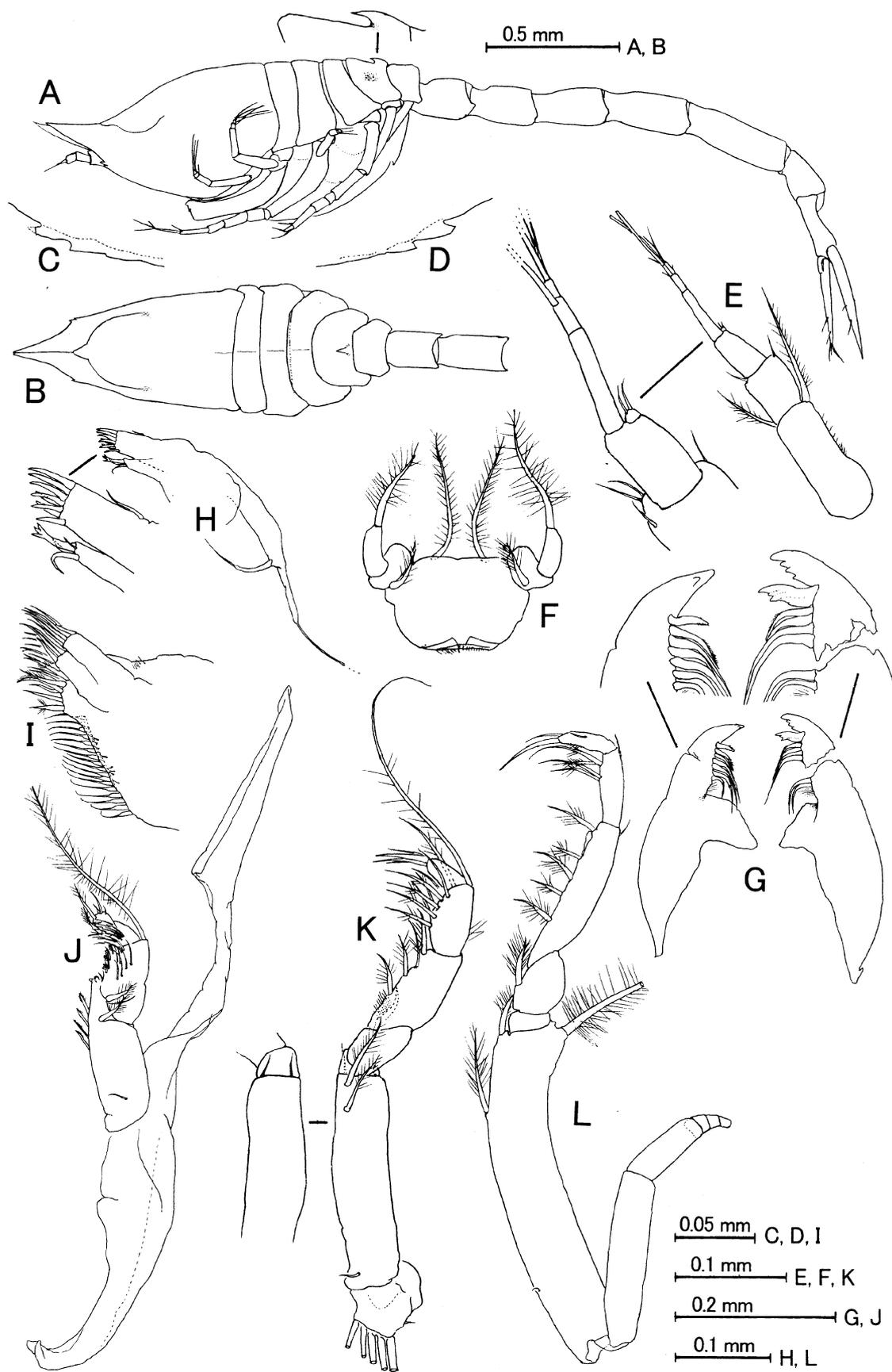


FIGURE 13. *Petalosarsia jonesi* sp. nov., ovigerous female. A, lateral view; B, anterior portion of body, from above; C, D, anterolateral angle of carapace; E, antenna 1; F, antenna 2 and labrum; G, mandibles; H, maxilla 1; I, maxilla 2; J-L, maxillipeds 1-3.

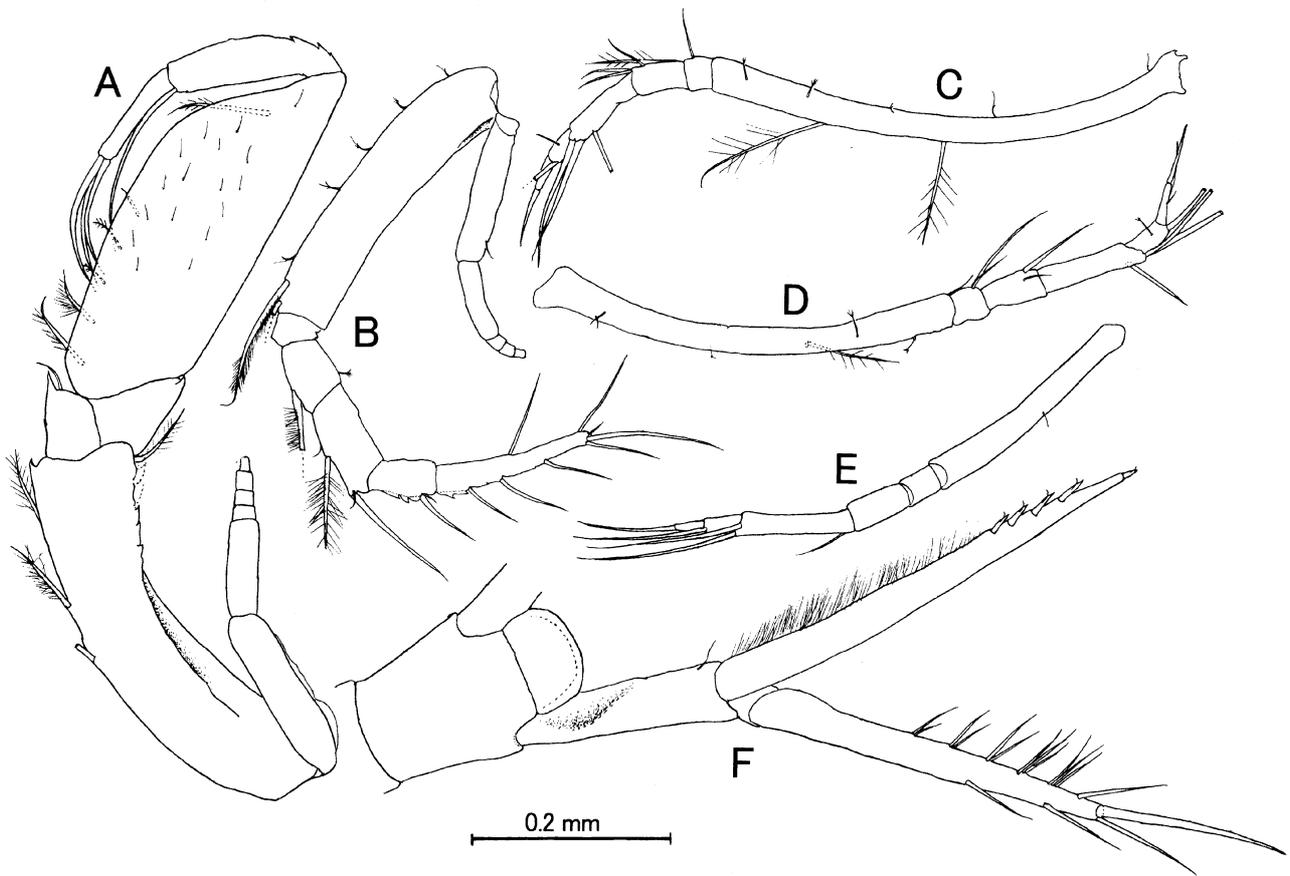


FIGURE 14. *Petalosarsia jonesi* sp. nov., ovigerous female. A–E, pereopods 1–5; E, uropod with pleonite 6.

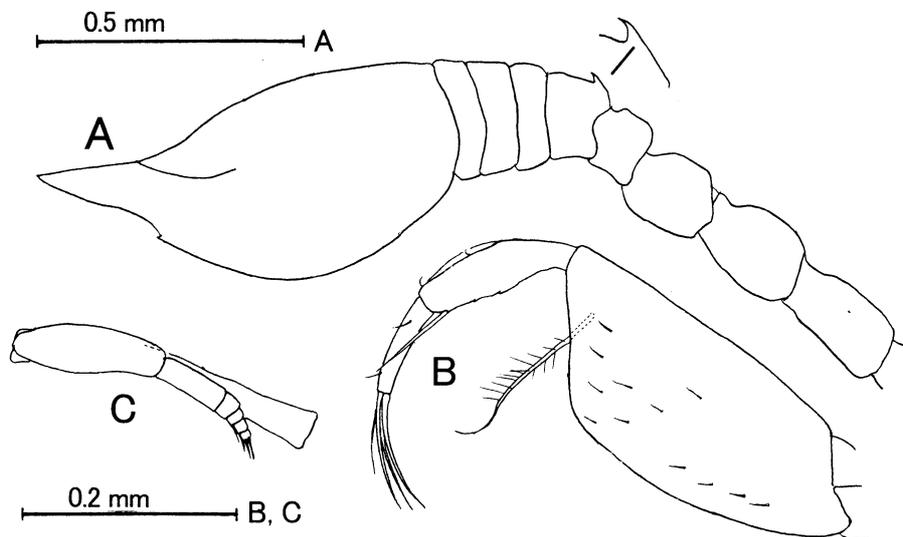


FIGURE 15. *Petalosarsia jonesi* sp. nov., young male. A, anterior portion of body, lateral view; B, distal three articles of pereopod 1; C, pereopod 4.

(between teeth of left and right antennal notch), 0.48 times width of carapace; pseudorostrum slightly dorsally directed, 0.26 times length of carapace. Width of triangular eye lobe 0.13 times width of carapace; pseudorostrum long and slightly dorsally directed, 0.26 times carapace length. Pereon 0.62–0.65 times length of carapace; pereonite 4 with a prominent tooth projecting forward on dorso-posterior margin. Pleon very slender, 0.52 times length of carapace.

Antenna 1 (Fig. 13E) 1st article of peduncle 1.2 times combined length of 2nd and 3rd articles; 2nd and 3rd peduncular articles equal in length; distal end of 2nd article not fringed with thin collar; main flagellum of 3 articles, 0.7 times 1st peduncular article; 1st article of main flagellum 2.0 times combined length of 2nd and 3rd; accessory flagellum minute, with 2 apical setae. Antenna 2 (Fig. 13F) bi-articulate, with a plumose seta on each article. Maxilliped 1 (Fig. 13J) with 1 branchial lobule; basal article subequal in length to remaining distal articles. Maxilliped 2 (Fig. 13K) basis, 1.0 times combined length of ischium, merus, carpus and propodus, with a short seta near proximal end. Maxilliped 3 (Fig. 13L) basis 1.0 times distal articles together, with 2 plumose setae on inner margin; carpus with 5 plumose setae on inner margin.

Pereopod 1 (Fig. 14A) basis 1.0 times combined length of ischium and carpus, with 3 plumose setae on inner margin; length of carpus 2.4 times width and 3.2 times dactylus length, 0.85 times basis length. Pereopod 2 (Fig. 14B) basis 0.75 times distal articles together, with 2 plumose setae on inner margin; dactylus much longer than carpus. Pereopod 3 (Fig. 14C) basis 2.2 times length of remaining distal articles, with 2 plumose setae; exopod absent. Pereopod 4 (Fig. 14D) basis 1.6 times length of remaining distal articles, with plumose seta; exopod absent. Pereopod 5 (Fig. 14E) basis 0.9 times length of remaining distal articles.

Uropod (Fig. 14F) peduncle slender, 1.31 times pleonite 6 length, 0.59 times exopod, 0.50 times endopod length, with minute setae on inner margin; near inner distal corner not serrated; exopod 0.85 times endopod length, with 2 setae on outer margin and brush of setae on inner margin; terminal seta long; endopod with 4 spiniform setae on inner margin; terminal setae small. Telson somewhat flattened at posterior margin, 0.25–0.36 times pleonite 6 length.

Paratype young male, posterior half of abdomen and uropods lost. Overall appearance similar to ovigerous females. Pleon with no pleopods (Fig. 15A). Carpus of pereopod 1 shorter than female (Fig. 15B). Pereopod 4 with developed exopod (Fig. 15C).

Etymology. The species name is dedicated to Dr. Norman S. Jones, who made great contribution to cumacean taxonomy and described *Petalosarsia longirostris*.

Distribution. Sulu Sea, 688–804 m depth.

Remarks. The present new species is closely allied to *Petalosarsia longirostris* Jones, 1973 from the tropical deep Atlantic, 1624–1796 m, with a combination of characters which differ from the other Japanese species: (1) carapace without dorsolateral carina, dorsal surface arched, (2) antenna 1 slender, 2nd article of peduncle equal in length to the 3rd, (3) inner distal corner of carpus in pereopod 1 not near rectangular, but forming obtuse angle, (4) pereopod 2 with some stiff, naked setae on inner margin of distal three articles, arranged like a comb, (5) uropod peduncle slender, shallowly concaved on proximal inner margin, not completely covering opening of anus when left and right uropods closed. *Petalosarsia jonesi* can be distinguished from *P. longirostris* by (1) inferior margin of carapace not serrated, (2) dorsal crest of pereonite 4 with a marked spine projecting forward, (3) exopod on pereopod 3 absent, (4) uropod peduncle a little longer than pleonite 6, and (5) uropod exopod with a brush of simple setae on inner margin. Another noteworthy character is that the basis of maxilliped 2 lacks round plate or other ornaments on the ventral surface or inner margin.

Petalosarsia suluensis sp. nov.

(Figs. 16, 17)

Material examined. Holotype juvenile female, 2.59 mm (NSMT-Cr 22086), 10°36.48'N, 121°31.56'E – 10°35.74'N, 121°30.98'E, 362–372 m (KH-02-4, St. SA2), 8 December 2002. Paratypes; 1 juvenile female, 2.49 mm (NSMT-Cr 22087), same locality and date as holotype female (KH-02-4, St. SA2); 1 adult male, 4.09 mm (NSMT-Cr 22088), 07°58.38'N, 118°16.27'E – 07°57.48'N, 118°16.68'E, 367–368 m (KH-02-4, St. S1-C), 23 November, 2002.

Description. Juvenile female (Fig. 16). Body weakly calcified, surface of integument smooth. Carapace length 0.29 times total body length, without carina or ridges, dorsal surface arched; anterolateral angle with a tooth (Fig. 16C); frontal margin between the teeth on anterolateral angle 0.67 times greatest width of carapace (Fig. 16B); pseudorostrum 0.19 times as length of carapace. inferior margin smooth, without tooth. Width of eye lobe 0.19 times width of carapace. Pereon 0.52 times carapace. Pleon 0.55 times total body length (Fig. 16A).

Antenna 1 (Fig. 16D) 1st article of peduncle 1.55 times combined length of 2nd and 3rd; 2nd article not open distally; subequal to 3rd; main flagellum of 3 articles, with 2 aesthetascs; 1st article 1.45 times combined length of 2nd and 3rd. Maxilliped 3 (Fig. 16E) basis 1.2 times length of distal articles together.

Pereopod 1 (Fig. 16F) basis 1.1 times combined length of ischium and carpus, without plumose seta on inner margin; carpus length 1.9 times width, 2.9 times dactylus length, 0.77 times basis length. Pereopod 2 (Fig. 16G), basis 0.8 times length of distal articles together. Pereopod 3 (Fig. 16H) basis 1.8 times length of remaining distal articles; exopod absent. Pereopod 4 (Fig. 16I) basis 1.1 times length of remaining distal articles; exopod absent. Pereopod 5 (Fig. 16J) basis 0.6 times length of remaining distal articles.

Uropod (Fig. 16K), peduncle 1.21 times pleonite 6 length, 0.60 times exopod length, 0.50 times endopod length; exopod 0.82 times endopod length, with 3 setae on inner margin, 2 terminal setae; endopod with 3 spiniform setae on inner margin and with 2 terminal setae. Telson semicircular, 0.58 times length of pleonite 6.

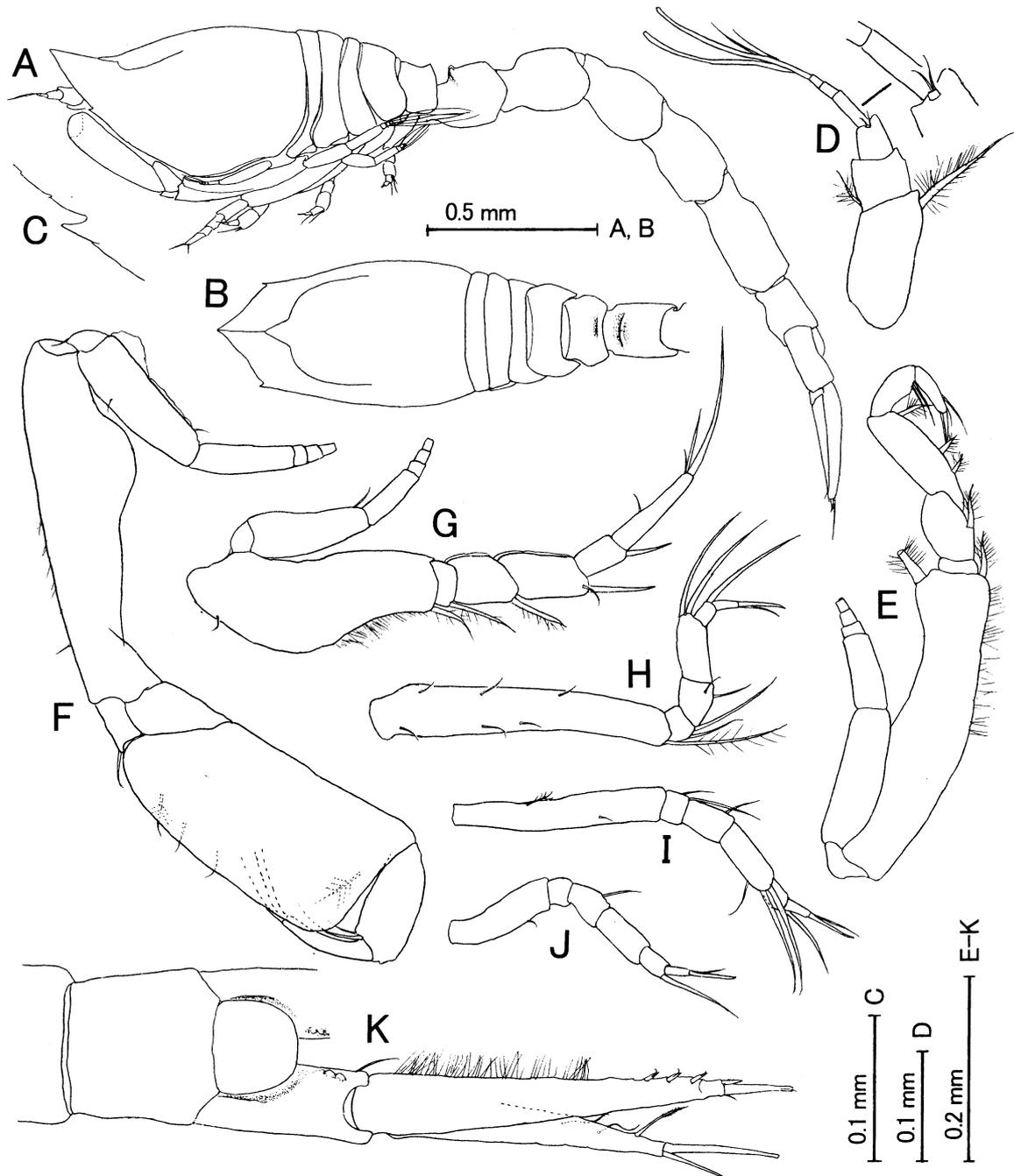


FIGURE 16. *Petalosarsia suluensis* sp. nov., juvenile female. A, lateral view; B, anterior portion of body, from above; C, anterolateral angle of carapace; D, antenna 1; E, maxilliped 3; F–J, pereopods 1–5; K, uropod with pleonite 6.

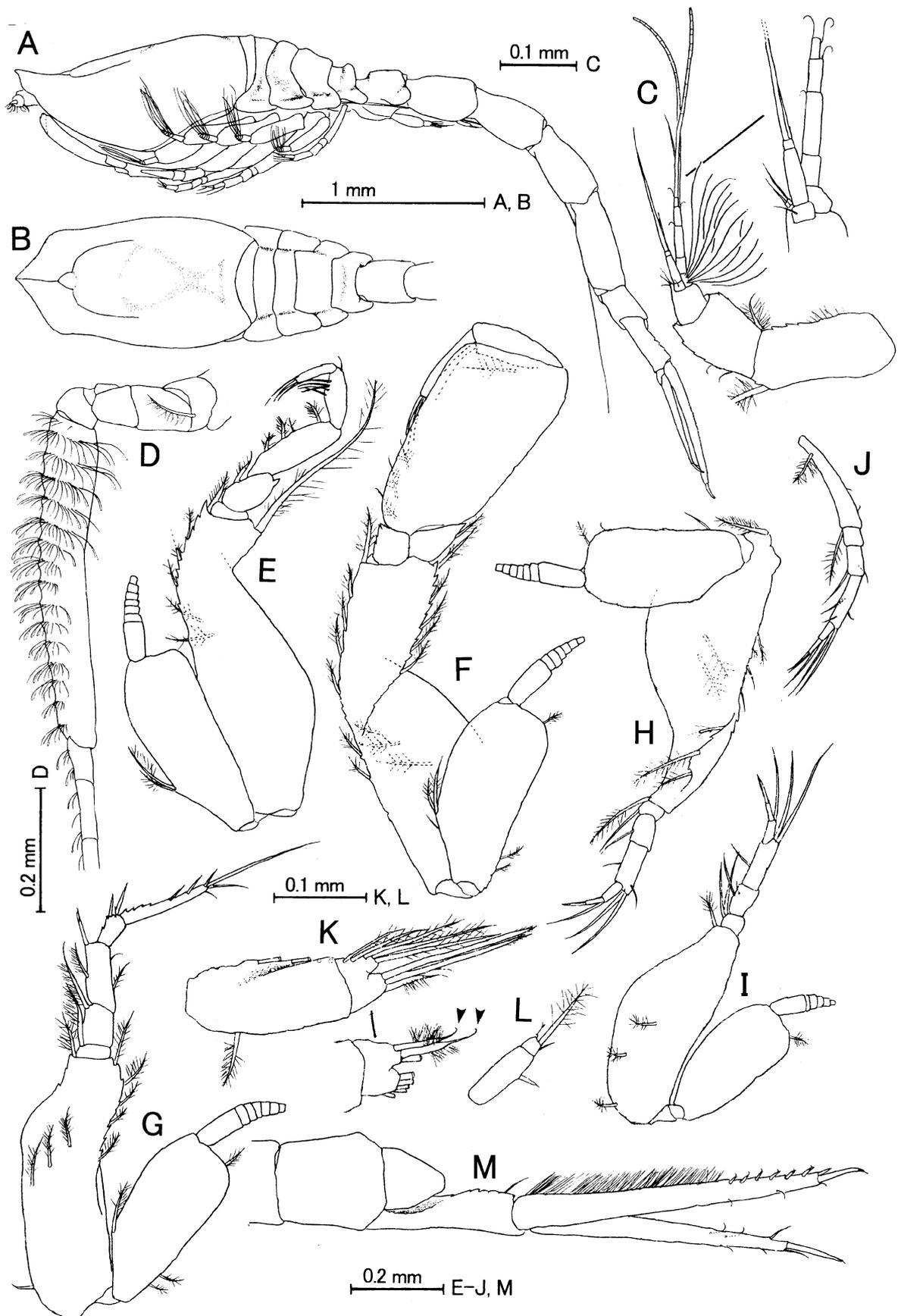


FIGURE 17. *Petalosarsia suluensis* sp. nov., adult male. A, lateral view; B, anterior portion of body, from above; C, antenna 1; D, antenna 2; E, maxilliped 3; F–J, pereopods 1–5; K, L, pleopods 1, 2; M, uropod with pleonite 6.

Adult male (Fig. 17). Carapace length 0.31 times total body length, length 1.75 times greatest width and 2.21 times depth; dorsolateral carina absent, anterolateral angle without tooth and antennal notch. Width of frontal margin about 0.8 times greatest width of carapace; pseudorostrum 0.18 times length of carapace; width of eye lobe 0.135 times width of carapace. Pereon 0.54 times carapace. Pleon 0.53 times total body length, with 2 pairs of pleopods.

Antenna 1 (Fig. 17C), 1st article of peduncle 1.3 times combined length of 2nd and 3rd; main flagellum of 5 articles; 1st article with 12 aesthetascs; accessory flagellum of 3 articles, shorter than proximal 3 articles of main flagellum combined. Antenna 2 (Fig. 17D), peduncle with plumose seta; flagellum of 22 articles, exceeding posterior end of telson. Maxilliped 3 (Fig. 17E) basis 1.3 times remaining distal articles, with 6 plumose setae on inner margin and inner distal corner. Basis of maxilliped 3 and pereopods 1–4 strongly constructed, with well developed exopods.

Pereopod 1 (Fig. 17F) basis 1.4 times combined length of ischium and carpus; carpus length 1.8 times width, 2.55 times dactylus length, 0.63 times basis length. Pereopod 2 (Fig. 17G) basis 1.1 times length of remaining distal articles, dactylus slightly longer than carpus. Pereopods 3, 4 (Fig. 17H, I) basis broad at base, 2.2 and 1.5 times length of remaining distal articles respectively. Pereopod 5 (Fig. 17J) thin, basis 0.75 times length of remaining distal articles. Pleopod 1 (Fig. 17K), outer and inner rami partially fused; outer ramus with 2 long, almost naked setae on ventral side and 2 robust, short plumose setae (arrow heads) on dorsal side; inner ramus with 5 plumose setae; inner margin of peduncle with 4 plumose setae on inner margin and plumose seta on outer margin. Pleopod 2 normal for the genus (Fig. 17L).

Uropod (Fig. 17M) peduncle 1.48 times pleonite 6 length, 0.61 times exopod length, 0.53 times endopod length; exopod 0.86 times endopod length, with 3 short setae on inner margin, 2 minute setae on outer margin, 2 terminal setae; endopod with 6 spiniform setae on inner margin and 2 terminal setae. Telson (Fig. 17M) triangular, 0.56 times pleonite 6.

Etymology. The species name refers to the locality, the Sulu Sea, that the specimens were collected.

Distribution. Western Sulu Sea, Philippine, 362–372 m.

Remarks. This species resembles *Petalosarsia longirostris* Jones, 1973 and *P. jonesi* sp. nov. in having the carapace without dorsolateral carina. However, these specimens are distinguishable from the latter two species by combination of (1) carapace not compressed laterally, its inferior margin is not serrated, (2) pereonite 3–5 without blunt or sharp spines on dorsal crest, (3) main flagellum 1st article of antenna 1 much less than twice the length of remaining two articles, (4) inner distal corner of carpus of pereopod 1 nearly rectangular, (5) uropod peduncle in female specimen short, slightly longer than pleonite 6, and (6) antenna 2 of adult male with long flagellum exceeding posterior end of abdomen.

***Petalosarsia longicauda* sp. nov.**

(Fig. 18)

Material examined. Holotype subadult male, 4.25 mm (NSMT-Cr 22089), 06°18.41'N, 119°10.82'–06°18.65'N, 119°11.34'E, 1131–1392 m (KH-00-1, St. B2-5), 23 February 2000.

Description. Subadult male (Fig. 18). Carapace length 0.28 times total body length (Fig. 18A), length 1.78 times greatest width and 1.89 times depth; anterior portion with lateral carina, with 4 teeth; very weak dorsolateral carina with 4 teeth present on anterior portion (Fig. 18B); dorsal surface arched; transverse ridge near hind margin absent; frontal margin between lateral carina 0.73 times greatest width of carapace; pseudorostrum 0.20 times length of carapace; width of eye lobe 0.18 times width of carapace. Pereon 0.51 times carapace. Pleon 0.58 times total body length, with 2 pairs of pleopods (Fig. 18A).

Antenna 1 (Fig. 18C) 1st article of peduncle 1.3 times combined length of 2nd and 3rd; main flagellum of 5 articles; accessory flagellum of 3 articles, 0.27 times main flagellum. Antenna 2 (Fig. 18D) peduncle with plumose seta; flagellum of 21 articles. Maxilliped 3 (Fig. 18E) basis 1.25 times remaining distal articles, without seta on inner margin.

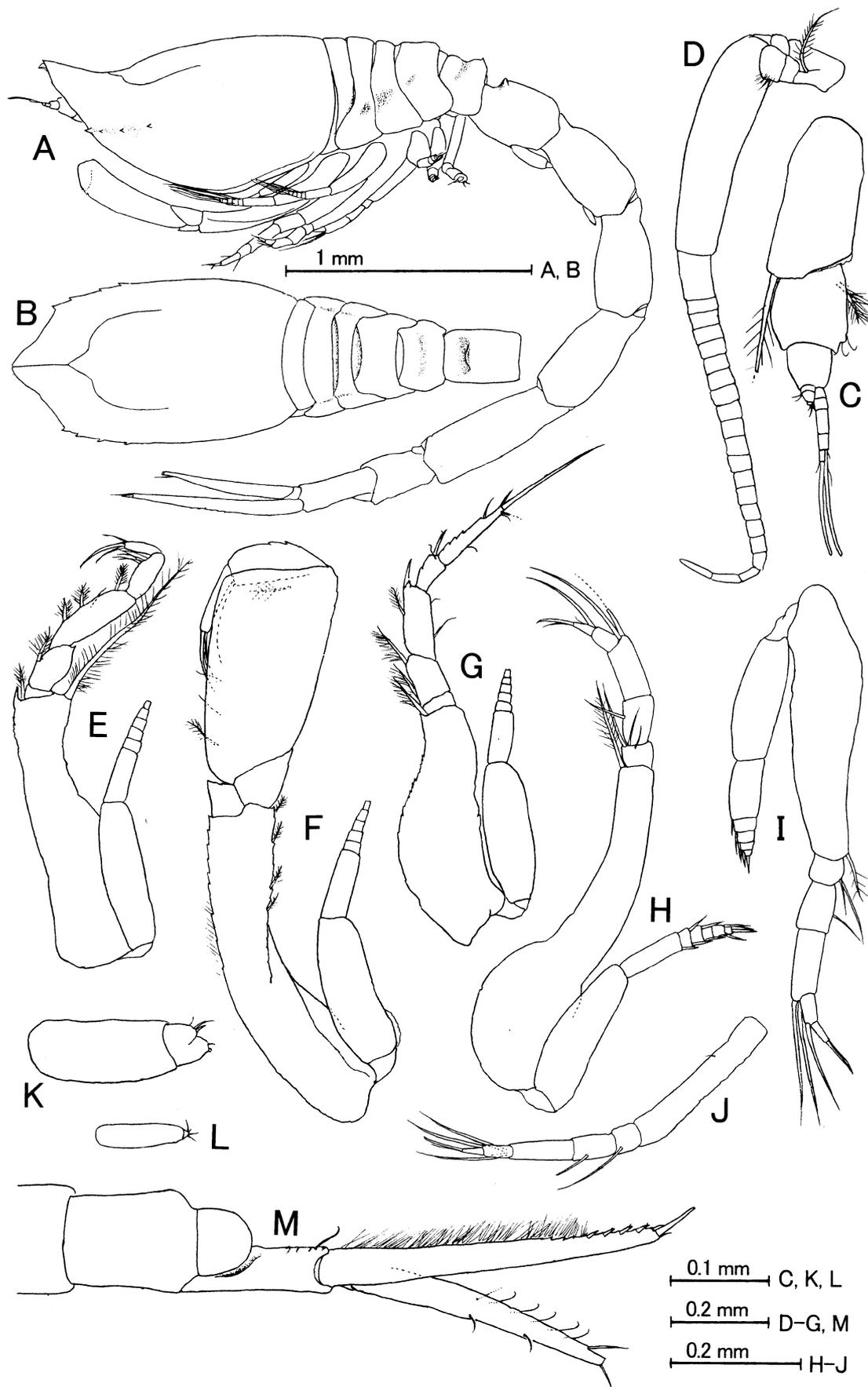


FIGURE 18. *Petalosarsia longicauda* sp. nov., subadult male. A, lateral view; B, anterior portion of body, from above; C, antenna 1; D, antenna 2; E, maxilliped 3; F–J, pereopods 1–5; K, L, pleopods 1, 2; M, uropod with pleonite 6.

Pereopod 1 (Fig. 18F) basis 1.3 times combined length of ischium and carpus; carpus length 1.9 times its width, 3.1 times dactylus length, 0.66 times basis length. Pereopod 2 (Fig. 18G) basis 0.94 times remaining distal articles. Pereopods 3, 4 (Fig. 18H, I) basis broad at base, 2.05 and 1.4 times length of remaining distal articles respectively. Pereopod 5 (Fig. 18J) basis 0.95 times length of remaining distal articles. Pleopod 1 (Fig. 18K) undeveloped, with a few short setae on tip of rami. Pleopod 2 with minute rami (Fig. 18L).

Uropod (Fig. 18M) peduncle 1.13 times pleonite 6 length, 0.53 times exopod length, 0.45 times endopod length; exopod 0.84 times endopod length, with 7 short setae on inner margin, 2 short setae on outer margin, terminal setae lost during collection; endopod with 4 spiniform setae on inner margin, 2 terminal setae. Telson (Fig. 18M) semicircular, 0.41 times pleonite 6.

Etymology. The species name refers to the elongate pleon.

Distribution. South of the Sulu Sea, Philippine, 1131–1392 m.

Remarks. This species is separated from other members of the genus by the combination of (1) dorsal surface of carapace arched, anterior portion of lateral margin with very weak ridge with four teeth, (2) pleon rather long, 0.58 times total body length, (3) inner margin of basis of maxilliped 3 and pereopods without plumose setae, (4) uropod exopod with a row of several thin setae on inner margin.

Petalosarsia australis sp. nov.

(Figs. 19–21)

Material examined. Holotype subadult male, 4.6 mm (AM P85740), Tasman Sea, 40°45'56''S, 149°01'37''E – 40°46'32''S, 149°01'16''E, 2400–2500 m (FR1086-04), 10 December 1986. Paratype ovigerous female, dissected, missing pleonite 6–uropods (AM P85739), Tasman Sea, 40°45'56''S, 149°01'37''E – 40°46'32''S, 149°01'16''E, 2400–2500 m (FR1086-04), 10 December 1986.

Description. Ovigerous female (Figs. 19–21). Body not well calcified, covered with minute scale like sculpture. Carapace (Figs. 19A, C), oval seen from above, length 1.58 times depth, length 1.19 times width. Dorsal surface flat, surrounded by a pair of weak dorsolateral carinae; ventral margin smooth, anterolateral angle and antennal notch obsolete; pseudorostrum short, 0.1 times length of carapace. Width of small, triangular eye lobe 0.1 times width of carapace. Pereon 0.7 times carapace length. Pleon broken off at posterior border of pleonite 5.

Antenna 1 (Fig. 19D) 1st article of peduncle 0.75 times combined length of 2nd and 3rd articles; main flagellum of 3 articles, 0.7 times basal article of peduncle; 1st article of main flagellum 1.2 times distal 2 articles combined; accessory flagellum minute. Antenna 2 (Fig. 19D, E) of 3 articles, with a pappose seta on distal end of article 1 and article 3. Mandibles, maxilla 1 and maxilla 2 are normal for the genus (Fig. 19F–H).

Maxilliped 1 (Fig. 20A) basis shorter than distal segments together. Maxilliped 2 (Fig. 20B) basis 1.30 times combined length of following 4 articles; blunt spines absent near distal end of basis. Maxilliped 3 (Fig. 20C) basis 1.2 times distal articles together, with 2 plumose setae on inner margin.

Pereopod 1 (Fig. 20D), basis 1.16 times combined length of ischium and carpus, with 4 pappose setae on inner margin; length of carpus 2.4 times width, 3.7 times dactylus length, 0.7 times basis length. Pereopod 2 (Fig. 20E) basis 0.8 times distal articles together, with 3 long plumose setae and several short setae on inner margin; exopod reaching distal end of basis. Pereopod 3 (Fig. 21A), basis slender, 1.8 times combined length of distal articles; bi-articulate exopod present, tiny. Pereopod 4 (Fig. 21B), basis slender, 1.3 times remaining distal articles; uni-articulate exopod present. Pereopod 5 (Fig. 21C), basis 0.8 times distal articles together.

Telson and uropods missing.

Holotype subadult male (Fig. 19B). Overall appearance similar to ovigerous female. Carapace length 0.3 times total body length; pseudorostrum 0.16 times length of carapace. Pereon length 0.55 times carapace length. Pleon length 0.56 times total body length, with 2 pairs of pleopods.

Uropod (Fig. 21D), peduncle 1.1 times pleonite 6 length, 0.5 times exopod length, and at most 0.37 times endopod length; exopod at most 0.8 times endopod length; endopod with 8 stout setae with single setule on inner margin, proximal part of medial margin lined with fine hair-like setae. Telson subquadrate, 0.47 times pleonite 6 length.

Etymology. The species name is from the Latin austral, meaning south, referring to the location of collection being in the Tasman Sea in the Southern Hemisphere.

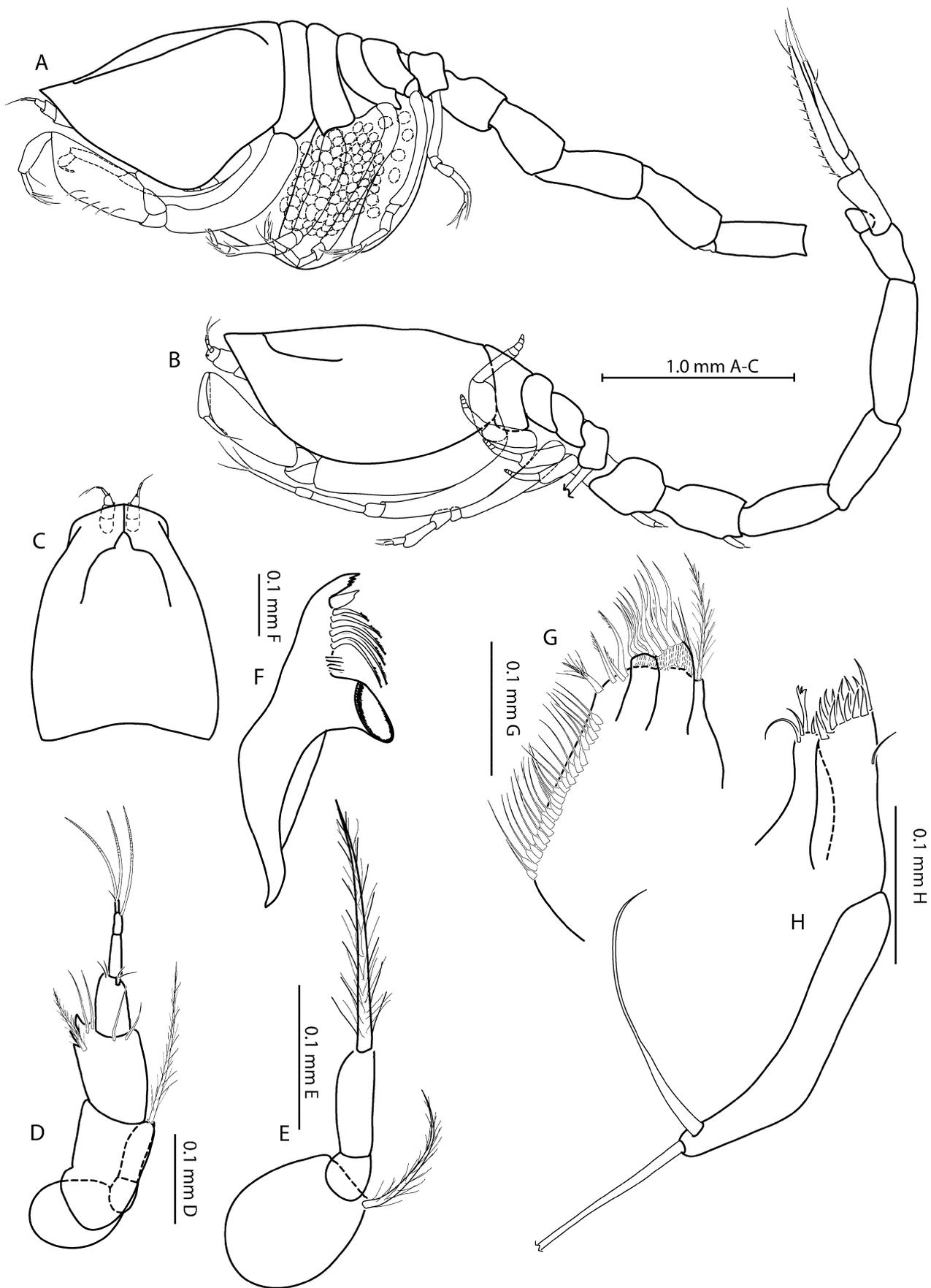


FIGURE 19. *Petalosarsia australis* sp. nov., A, C–H, ovigerous female; B, subadult male. A, B, lateral view; C, carapace, dorsal view; D, antenna 1 and 2; E, antenna 2; F, left mandible; G, maxilla 1; H, maxilla 2.

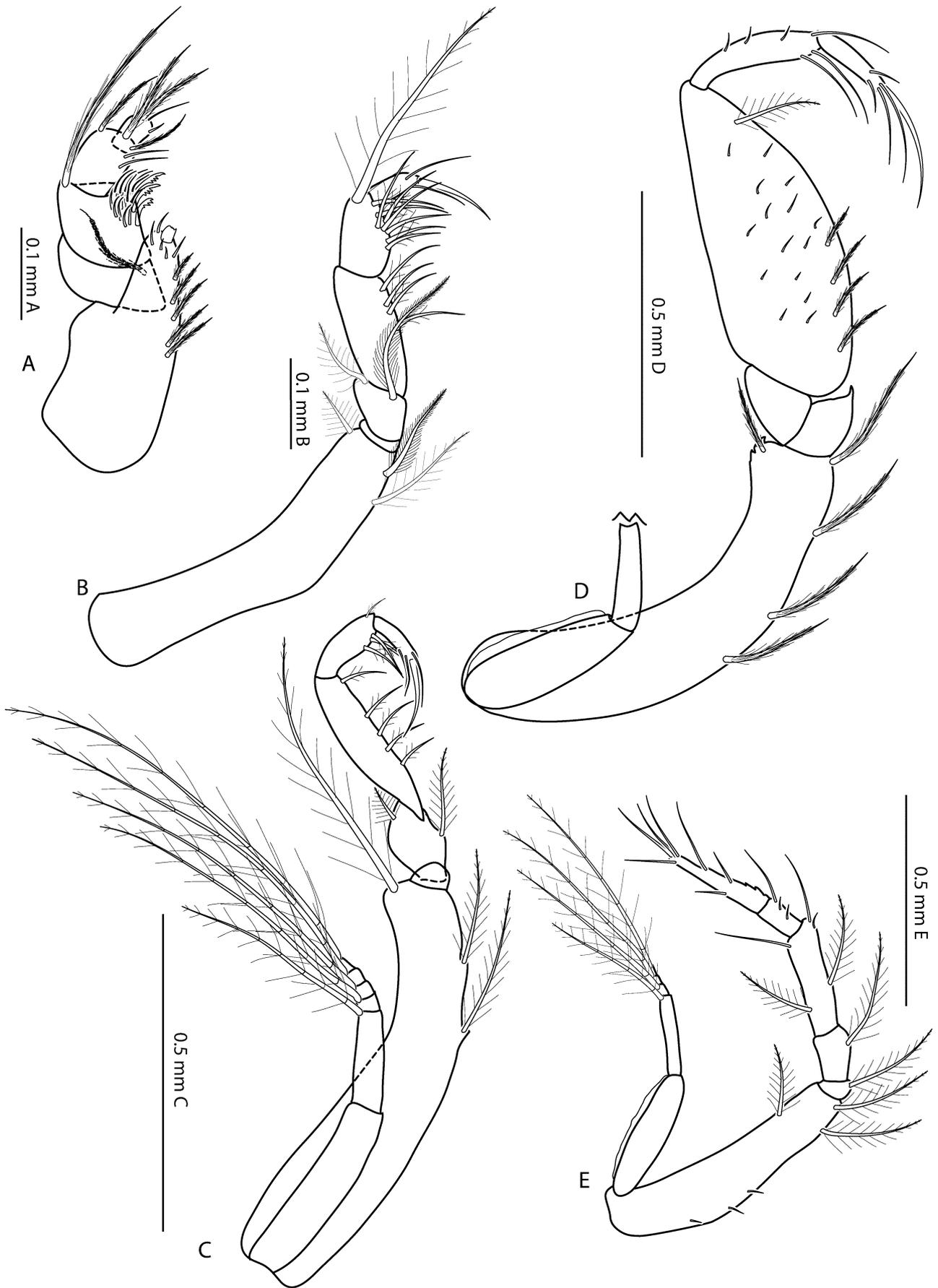


FIGURE 20. *Petalosarsia australis* sp. nov., ovigerous female. A–C, maxillipeds 1–3; D, E, pereopods 1, 2.

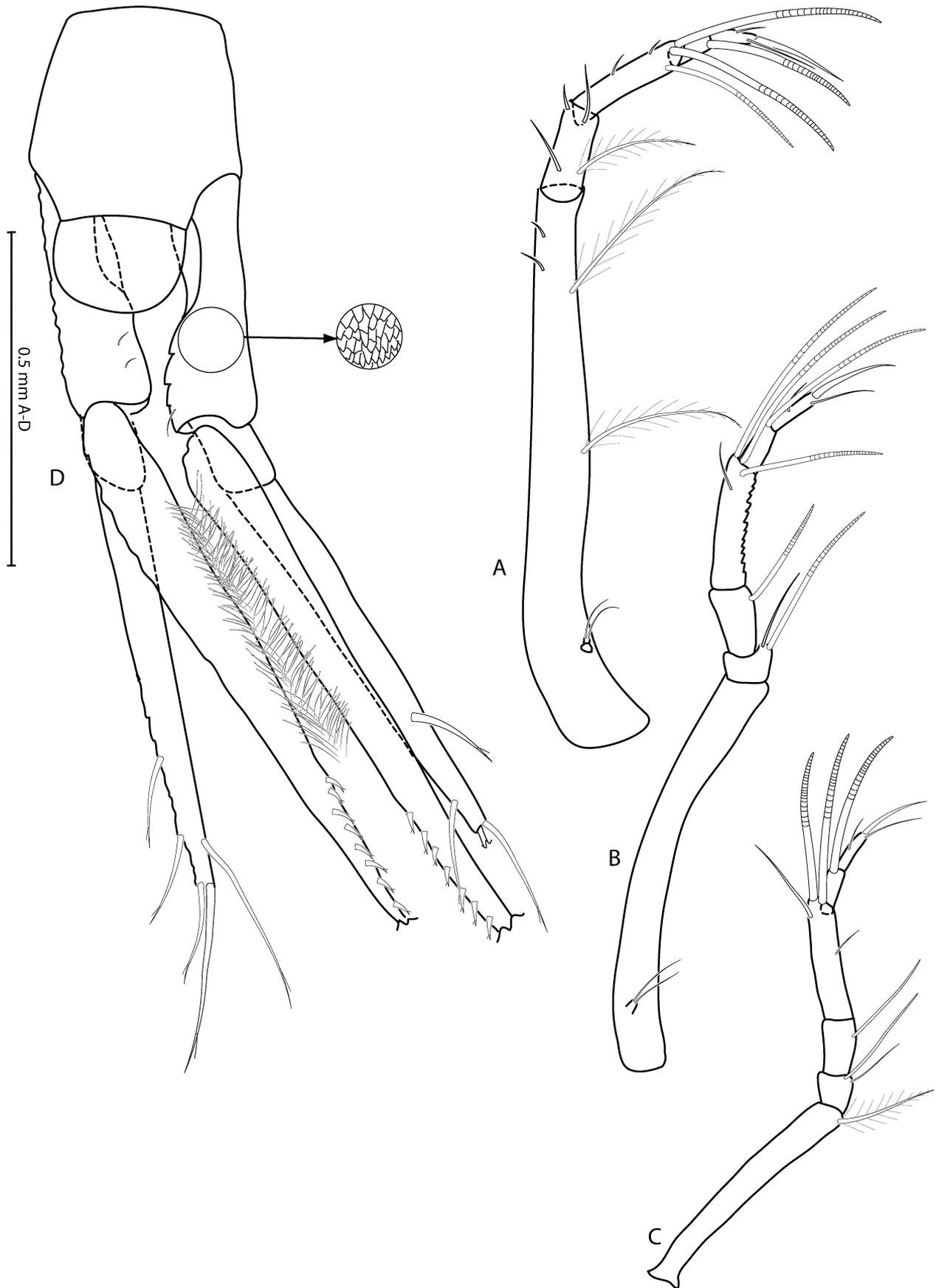


FIGURE 21. *Petalosarsia australis* sp. nov., A–C, ovigerous female; D, subadult male. A–C, pereopods 3–5; D, uropods with pleonite 6.

Distribution. Tasman Sea, 2400–2500 m depth.

Remarks. This is the first record of the genus *Petalosarsia*, and the first certain record of a pseudocumatid cumacean, from the Southern Hemisphere. The present species is characterized by the combination of (1) faint dorso-lateral carina, without teeth, running for entire length of carapace, (2) female antenna 2 tri-articulate, (3) basis of maxilliped 2 without projections or spines, and (4) medial margin of pereopod 1 carpus being a constant curve from the articulation with the merus to the articulation with the propodus, without a distinct medial and distal margin or acute distomedial corner.

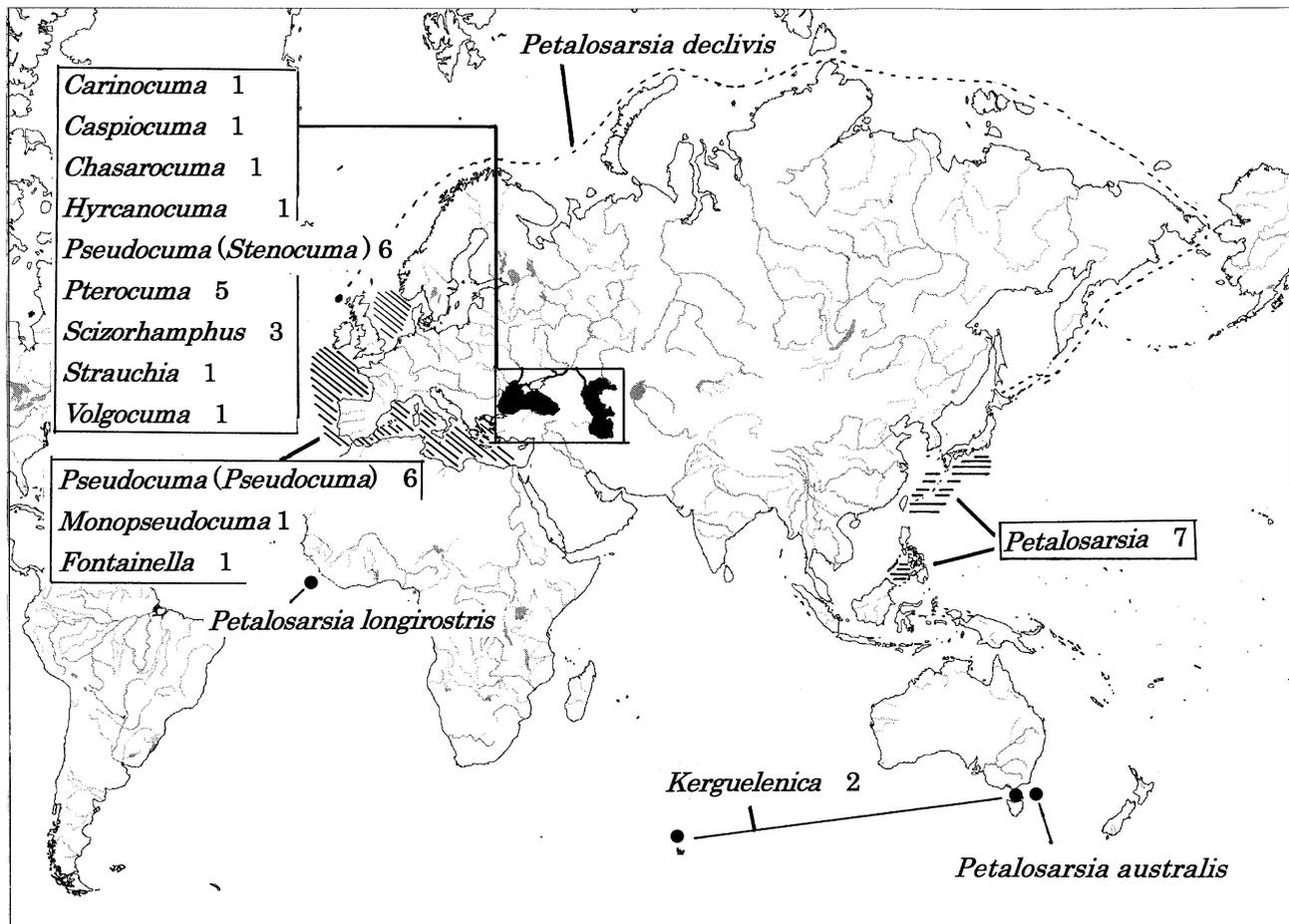


FIGURE 22. Distribution of each genus of the family Pseudocumatidae. Roman numerals indicate the number of species in each genus except for *Petalosarsia*, in which *P. declivis*, *P. longirostris*, and *P. australis* are excluded.

Discussion

Notes on taxonomy of *Petalosarsia*

Antenna 1: articulation of the antenna 1 main and accessory flagellae have not been described well in both the male and female of *Petalosarsia* (Sars 1900; Jones 1973; Bacescu & Muradian 1974; Gamô 1986). The main flagellae of antenna 1 of all females examined in the present study were tri-articulate, with the basal article longest. The accessory flagellae were minute, with a few or several short apical setae. Antenna 1 of adult and subadult males were characterized by 5-articulate main flagellum and tri-articulate elongate accessory flagellum, including *P. brevirostris* which Gamô (1986) described with a 4-articulate main flagellum. Basal articles of the main flagellum in adult males are furnished with 8–13 aesthetascs.

Antenna 2: Whereas adult males of *P. declivis* and *P. brevirostris* have antenna 2 with a long flagellum reaching the posterior end of the pleon (Sars 1900, Bacescu 1974; Gamô 1986), males of *P. longirostris* have a short flagellum reaching a little beyond the pereon (Jones 1973). The present study describes two additional long-flagellum species (*P. ryukyuensis* and *P. suluensis*) and 1 short-flagellum species (*P. gamoi*). In all the short flagellum species and in *P. brevirostris*, the flagellum was of 22 articles.

Exopods on pereopods 3 and 4 in females: In the Pseudocumatidae, pereopods 3 and 4 of females bear rudimentary or no exopods. Presence or absence of the rudimentary exopods vary between individuals of *P. declivis* (Bacescu & Muradian 1974). A similar situation was observed in *P. brevirostris* and *P. ovalis*. Thus presence or absence of rudimentary exopods is not a reliable character for taxonomy of *Petalosarsia*. In the females without exopods on pereopods 3 and 4, a couple of setae were observed at the same location on the basis where an exopod would be, possibly representing remnant terminal setae of the exopods. Such variation within single species may also occur in other genera of Pseudocumatidae.

Pleopods: Males of Pseudocumatidae have been reported to have two pairs of pleopods, except for two genera. Recently, McCarthy et al., (2006) erected *Monopseudocuma* which has one pair of pleopods, to contain the single species *M. gilsoni* (removed from the genus *Pseudocuma*). In the genus *Petalosarsia*, results of previous studies are rather confusing. Males of *P. declivis* (Sars 1865) have two pairs of pleopods (Sars 1900; Bacescu & Muradian 1974). In *P. longirostris*, Jones (1973) reported only one pair of pleopods in two adult male specimens. However, Ledoyer (1997) figured a male specimen of *P. longirostris* with two pairs of pleopods. In *P. brevirostris*, Gamô (1986) observed five pairs of pleopods in male specimens. However, McCarthy et al. (2006) deduced that the males have two pairs of pleopods, and the "pleopods" on pleonite 3–5 are only plumose setae, which was confirmed in the present study. All other species examined in the present study, *P. australis*, *P. ovalis*, *P. ryukyuensis*, *P. gamoi*, *P. suluensis* and *P. longicauda* have two pairs of pleopods. Thus males of the genus are characterized by having two pairs of pleopods.

The male second pleopods are small and not well developed in *Petalosarsia*. In the illustration by Sars (1900), the second pleopod of *P. declivis* lacks rami. However, Bacescu and Muradian (1974) observed undeveloped pleopods with rami with two minute apical setae in specimens from the West Atlantic. *Petalosarsia brevirostris* has more developed 2nd pleopods, with a long plumose setae on the apical end of the rami (Gamô 1986). Also, adult males of *P. ryukyuensis*, *P. gamoi* and *P. suluensis* have the 2nd pleopod with a well-developed plumose seta.

Telson: Sexual dimorphism has not been reported in the telson of Pseudocumatidae, which is semicircular except for the genus *Kerguelenica* which is characterized by a triangular telson in both males and females. In *Petalosarsia declivis* and *P. longirostris*, a semicircular telson is figured in both male and female specimens (Sars 1900; Jones 1973). However, in *P. brevirostris*, *P. ryukyuensis*, *P. gamoi* and *P. suluensis*, adult male telsons are triangular, similar to *Kerguelenica*. Thus *Petalosarsia* species from southern Japan and the Sulu Sea show distinct sexual dimorphism in the shape of telson. Another noteworthy point is that the telson of the genus occasionally bears two very short setae distally (see Figs. 6M, 8E).

Geographic distribution and morphological characters of *Petalosarsia*

Petalosarsia declivis: Bacescu and Muradian (1974) reported a very wide distribution of *P. declivis* in cold waters surrounding the Arctic region, which agree with the occurrence of this species in northern Japan. In the present study, *P. declivis* specimens were collected only in northern Hokkaido, which is in the southern part of the Okhotsk Sea. Females of *P. declivis* are characterized by (1) prominent dorsolateral carina of carapace which lacks a tooth on the anterior portion, (2) basis of the maxilliped 2 is furnished with a thick semicircular plate on the ventral surface and a group of 3–5 robust spines on the dorsal surface.

Petalosarsia brevirostris, *P. ovalis*, *P. ryukyuensis* and *P. gamoi:* *P. brevirostris* and *P. gamoi* were collected from a wide geographic area of the Northwest and Indo-West Pacific, i. e., Pacific coast and East China Sea around Honshu, Kyushu and Nansei Islands, and the Sulu Sea. *Petalosarsia ovalis* and *P. ryukyuensis* were collected from a rather restricted region, off Kyushu and Nansei Island, East China Sea, located around the central area of the distribution of the former two species. All four species are characterized by: (1) dorsal surface of carapace flat, with prominent dorso-lateral carina with 3–10 teeth, running on anterior portion or entire length of carapace, (2) basis of maxilliped 2 with a round plate on ventral surface and a seta on inner margin.

Petalosarsia jonesi, *P. suluensis* and *P. longicauda:* These 3 species, collected only from the Sulu Sea, Philippines, are characterized by (1) dorsal surface of carapace arched, dorsolateral carina absent or very weak, (2) uropod endopod with simple setae on inner margin, in addition to three setae near distal end. The basis of maxilliped 2 in ovigerous females of *P. jonesi* was characterized by no projection or spine on its surface.

Petalosarsia longirostris: The only northern hemisphere species which is not found in Japanese waters nor the Sulu Sea is *P. longirostris* from the west coast of Africa, East Atlantic (Jones, 1973; Ledoyer, 1997). This species is similar to *P. jonesi* except that the uropod endopod lacks a brush of setae on the inner margin. These two species are characterized by (1) inner and distal margins of carpus of pereopod 1 meeting at a rather obtuse angle; in the other species, these margins meet at a near right angle for covering the mouth when left and right ones are closed,

(2) antenna 1 rather slender, 2nd article of peduncle not dilated distally, (3) peduncles of uropods are thin, and do not cover the opening of the anus when left and right uropods are closed.

Petalosarsia australis: This species, from the southeastern continental shelf of Australia, shares two morphological characters with *P. jonesi* from the Sulu Sea and *P. longirostris* from the tropical eastern Atlantic; (1) dorso-lateral carina of carapace faint, (2) basis of maxilliped 2 with no projection or spines. Unique morphological characters of *P. australis* include (1) although overall shape of the carpus of pereopod 1 is rather similar to the latter two species, the medial margin of this article is a constant curve from the articulation with the merus to the articulation with the propodus, without a distinct medial and distal margin, and thus not meeting at the right angle or obtuse angle seen in the other *Petalosarsia* described in the present study, (2) the female has a tri-articulate antenna 2, which is unusual within the family.

Biogeography and depth of habitats in the family Pseudocumatidae

Except for *Petalosarsia* and *Kerguelenica*, the cumacean family *Pseudocumatidae* is restricted to the Northeast Atlantic, Mediterranean, and the Ponto-Caspian region, including the Caspian Sea, Azov Sea, Black Sea and associated rivers (Ekman 1953; Bacescu 1951, 1992; Lomakina 1958; Gerken & McCarthy 2008; Jaume & Boxshall 2008). Nine out of the 12 genera (20 out of 30 species) are inhabitants of the Ponto-Caspian region (Fig. 22). *Pseudocuma* (*Pseudocuma*) consists of six species, one from the Ponto-Caspian region, one from the Black Sea and the Mediterranean, and the remaining four found in the North Atlantic. Both of the monotypic genera *Monopseudocuma* and *Fontainella* are distributed outside of the Ponto-Caspian region (López-González et al. 1996; McCarthy et al. 2006). In Japanese waters and the Sulu Sea, only representatives of *Petalosarsia* were collected.

Distribution of the genus *Petalosarsia* is unusually wide within the Pseudocumatidae (Fig. 22); one species occurs in the Eastern Atlantic, one species in the Northeast Atlantic, boreal and Arctic region reaching the Northwest Pacific, seven species are known from the Northeast Pacific and Indo-West Pacific, and 1 species is known from the Tasman Sea in the southern hemisphere. Occurrence of the genus in the Indo-West Pacific, especially *P. jonesi* which is similar to *P. longirostris* from the East Atlantic, suggests that ancestors of Pseudocumatidae were distributed widely around the ancient Tethys Sea, with the Ponto-Caspian region located near center of the area.

Another case of a cumacean distribution pattern associated with fauna of Tethyan origin was reported in Mancocumatinae living in the Atlantic Ocean, which include a genus dwelling in marine lava caves (Corbera 2002). However, Haye's 2007 phylogenetic analysis did not support the Mancocumatinae as a valid subfamily, and placed the species within the subfamily Vaunthompsoniinae. However, she did discuss a possible Tethyan origin for the Bodotriidae.

The genus *Kerguelenica* consists of *K. platycephala* Ledoyer 1977 and *K. petrescui* Gerken & McCarthy, 2008, from the Antarctic and southeast continental shelf of Australia respectively, very far from the previously known distribution of all other genera of Pseudocumatidae (Ledoyer 1977; Gerken & McCarthy 2008), which has been problematic in elucidating pseudocumatid biogeography. The new record of *Petalosarsia australis* in Australian waters expands the distribution of the Pseudocumatidae into the region occupied by *Kerguelenica*. However, identification of the taxonomic affinities of *Kerguelenica* is still rather problematic (see below).

Pseudocumatidae have been reported from shallow water, except for a few species from outside of the Ponto-Caspian region and Mediterranean Sea. The habitat of the nine genera of Pseudocumatidae living in the Ponto-Caspian region is less than 30 m except for five species, whose deepest habitat ranges 50–264 m (Bacescu 1992). *Monopseudocuma gilsoni* (Gilson, 1906) from the Northeast Atlantic is characterized by a wide depth range; McCarthy et al. (2006) examined some specimens from 2200–2765 m depth in addition to specimens from 20–34 m depth. The present results show that *Petalosarsia* is primarily an inhabitant of the deep sea. The two known species of *Kerguelenica* were collected from 195 and 1800 m depth (Gerken & McCarthy 2008), suggesting that this genus also consists of deep-sea species. Current species of Pseudocumatidae may have successfully survived in shallow water habitat only in the Ponto-Caspian region and its vicinity. Further investigation of the Indo-West Pacific is expected to reveal further undescribed deep-sea species of Pseudocumatidae.

Taxonomic status of the genus *Kerguelenica*

Ledoyer (1977) placed the newly erected genus in Pseudocumatidae with doubt, noting that the elongate bi-articulate accessory flagellum of antenna 1 female and the telson with two terminal setae in the female do not agree with description of the other members of the family. Gerken and McCarthy (2008) proposed that the genus should be

placed outside of the family because of the lack of a clear affinity with any of the recognized telson bearing families, supported by a morphological phylogenetic analysis of the Pseudocumatidae (McCarthy 2007). However, their family placement is still uncertain, based on the following points.

Kerguelenica is characterized by similarities between the males and the females; (1) the long accessory flagellum of antenna 1, (2) well developed exopods on maxilliped 3 and pereopods 1 and 2, (3) lack of pleopods in both sexes, (4) triangular telson with a pair of terminal setae, and (5) similar uropods. The similarities suggest either suppression of sexual dimorphism or sexual maturity of the male at an early developmental stage (neotenic, as suggested by Day (1980, p. 196) to explain the lack of sexual dimorphism in the Gynodiastylidae), which is related to the difficulty in determining the family affinity of this genus. Another noteworthy character is that the female antenna 2 of *K. petrescui* is different from that of *Petalosarsia* and other Pseudocumatidae (this appendage of *K. platycephala* is rather similar to that of *Petalosarsia*).

Some *Petalosarsia* species share some morphological characters with *Kerguelenica*; (1) overall appearance including dorso-ventrally compressed carapace with prominent carina on its lateral margin, (2) similar shape of maxillipeds and pereopods (except for pereopod 1), which occasionally have hyaline lamella, and (3) strongly constructed uropod with a short peduncle, about 1/2 as long as the rami. Although the robust integument of the posterior portion of telson of *Kerguelenica* is unique in Pseudocumatidae, the telson of *P. australis* from Australia is somewhat robust, although of the typical semicircular *Petalosarsia* shape.

However, the dorso-ventral compression is somewhat different in placement, with *Kerguelenica* being similar to some of the more flattened Lampropidae, with a relatively low proportion of the body volume ventral to the marginal carina, with a dorsal elevation above the carina to accommodate the branchial chamber, whereas in *Petalosarsia* the flattening of the carapace is more dorsal, and the bulk of the body volume is ventral to the dorso-lateral carina.

There are examples from other families that are also similar to *Kerguelenica* in these characters, and in other characters. The family Gynodiastylidae all are entirely without pleopods in the males and frequently with the males and females of very similar appearance, as is reflected in the family name. *Litogynodiastylis attenuata* (Hale 1946) has a robust uropod with a short peduncle. The maxilliped and pereopod morphology are similar across many cumaceans, especially the latter three pairs of pereopods. Thus, the taxonomic affinities of *Kerguelenica* remain problematic. Either molecular analysis or identification and clarification of additional phylogenetically informative characters across the Cumacea could solve this problem.

Key to species of *Petalosarsia*

1. carapace with distinct dorsolateral carina 2
- carapace without or with faint dorsolateral carina 6
2. carapace with sharp dorsolateral carina running entire length on each side 3
- carapace with short or dull dorsolateral carina on each side 5
3. dorsolateral carina without tooth *P. declivis* (Sars, 1865)
- dorsolateral carina serrated with about 10 teeth 4
4. pseudorostrum short and truncated, 0.09–0.12 times as carapace length *P. brevisrostris* Gamô, 1986
- pseudorostrum long and acute, 0.21–0.25 times as carapace length *P. gamoi* **sp. nov.**
5. dorsolateral carina dull, run entire side surface *P. ovalis* **sp. nov.**
- dorsolateral carina only at anterior portion of carapace *P. ryukyensis* **sp. nov.**
6. carapace with faint dorsolateral carina 7
- carapace without dorsolateral carina 8
7. carapace with faint dorsolateral carina with a few teeth on anterior portion *P. longicaudata* **sp. nov.**
- carapace with faint dorsolateral carina without teeth for entire length *P. australis* **sp. nov.**
8. inner distal corner of pereopod 1 carpus forming rectangular angle *P. suluensis* **sp. nov.**
- inner distal corner of pereopod 1 carpus forming obtuse angle 9
9. pereonite 3–5 with brunt spines on dorsal surface *P. longirostris* Jones, 1973
- pereonite 4 with a spine directed forward on dorsal surface *P. jonesi* **sp. nov.**

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