Zootaxa 4200 (1): 109–130
http://www.mapress.com/j/zt/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

http://doi.org/10.11646/zootaxa.4200.1.4
http://zoobank.org/urn:lsid:zoobank.org:pub:BD517CC9-99BD-4254-B55E-9D0445AFA70F

Copepods (Cyclopoida) associated with top shells (Vestigastropoda: Trochoidea: Tegulidae) from coastal waters in southern Japan, with descriptions of three new species

DAISUKE UYENO
Graduate School of Science and Engineering, Kagoshima University, 1-21-35 Korimoto, Kagoshima 890-0065, Japan.
E-mail: duyeno@kagoshima-u.ac.jp

Abstract

Four species of copepods are described based on specimens of both sexes from tegulid top shells (Vestigastropoda) caught from coastal waters of southern Japan. Three species, including two undescribed and one known of the genus *Panaietis* (Copepoda: Cyclopoida: Anthessiidae) were found in the pharynx and esophagus of gastropods. *Panaietis incamerata* Stebbing, 1900, *P. doraconis* **n. sp.**, and *P. satsuma* **n. sp.** are distinguished from its congeners by the dorsal plates on the first pedigerous somite, the genital somite, the shape of the spines on legs, the number of setae on legs 1 and 2, and the position and shape of leg 5. *Pseudanthessius imo* **n. sp.** (Cyclopoida: Pseudanthessiidae) was found in the mantle cavity of the host. This copepod differs from its congeners in the proportions of the caudal ramus, the armature and proportion of the antenna, the armature of the exopod and general shape of the endopod of leg 4, and the presence of a post-rostral process.

Key words: new species, Vestigastropoda, *Tectus*, *Panaietis, Pseudanthessius*, Ryukyu Islands, symbiotic copepods

Introduction

Many copepods are known to be parasites or commensals of the Mollusca. Almost all anthessids (Cyclopoida), which contains six genera and more than 50 species, have been found associated with molluscan hosts. In contrast, species of the family Pseudanthessiidae (Cyclopoida) utilize various invertebrates as hosts, not only molluscs (Boxshall & Halsey 2004). Previous studies conducted off the Ryukyu Islands and in the Seto Inland Sea by the author have reported an anthessid and four splanchnotrophid copepod species (Uyeno & Nagasawa 2012a, 2012b). Of these copepods, *Anthessius isamusi* Uyeno & Nagasawa, 2012 (Anthessiidae) was found on *Turbo marmoratus* Linnaeus (Vestigastropoda: Turbinidae), an important fishery resource in the Indo-Pacific region (Poutires 1998). In southern Japan, top shells have a high market value as well as *T. marmoratus*. Top shells of the genus *Tectus* Montfort, 1810 (Vestigastropoda: Tegulidae) are widely distributed throughout tropical to temperate waters in the Indo-Pacific region (Palomares & Pauly 2015). Some species are locally caught as fishery resources to be used as food and as manufactured items for export, like shell buttons and jewelry goods (Poutires 1998).

In this study, two new species of Anthessiidae and one of Pseudanthessiidae are described, and *Panaietis incamerata* Stebbing, 1900 is redescribed. All descriptions are based on specimens of both sexes collected from three species of *Tectus* caught in marine waters of the Ryukyu Islands and southern Kyusyu, Japan.

Materials and methods

Top shells were collected from rocky shores in coastal waters of southern Japan by SCUBA and snorkel. Parasitic copepods were carefully removed from the hosts, fixed in 70% ethanol, and transferred to 99% ethanol for preservation. For morphological study, selected specimens were subsequently soaked in lactophenol for half a day,

Accepted by E. Suarez-Morales: 25 Jul. 2016; published: 28 Nov. 2016

dissected using tungsten needles and a stereomicroscope, and examined based on the wooden slide method of Humes & Gooding (1964). Drawings were made with the aid of a drawing tube. The copepod body parts were measured using an ocular micrometer and are given in millimeters, except the third endopodal segment of antennae of *Pseudanthessius imo* **n. sp.**, as the range followed by the mean and standard deviation in parentheses. Types and other examined specimens are deposited in the crustacean collection of the National Museum of Nature and Science, Tsukuba, Ibaraki Prefecture, Japan (NSMT), the Kagoshima University Museum, Kagoshima Prefecture, Japan (KAUM), the Ryukyu University Museum Fujukan, Okinawa Prefecture, Japan (RUMF), and the Natural History Museum, London, UK (NHMUK)

Results

Family Anthessiidae Humes, 1986

Genus *Panaietis* Stebbing, 1900

Panaietis incamerata Stebbing, 1900

(Figs 1–3)

Panaietis incamerata Stebbing, 1900: 666–667, Pl. LXX.
Panaietis incamerata: Monod & Dollfus, 1932, 157, 162.
Panaietis incamerata: Monod, 1934, 213–218.
Panaietis incamerata: Monod & Dollfus, 1934, 309–315.

Materials examined. 4 adult females and 3 adult males (NSMT–Cr 24619), ex *Tectus niloticus* (Linnaeus, 1767) (Vestigastropoda: Trochoidea: Tegulidae), off Saneku (28°12'N, 129°12'E), Kakeroma-jima Island, Oshima Strait, 29 April, 2015, leg. D. Uyeno, S. Yokoyama; 2 adult females (NSMT–Cr 24620), ex *T. niloticus*, off Osaki (24°25'N, 124° 4'E), Ishigaki-jima Island, East China Sea, 30 May, 2015, leg. D. Uyeno; 3 adult females and 1 adult male (NSMT–Cr 24621), ex *T. niloticus*, off Itchachi (26°20'N, 126°43'E), Kume-jima Island, East China Sea, 3 March, 2012, leg. D. Uyeno, Y. Fujita, T. Naruse; 2 adult females (RUMF-ZC-04354), ex *T. niloticus*, off Henokozaki Cape (26°31'N, 128° 4'E), Oura Bay, Okinawa-jima Island, North Pacific Ocean, 12 April, 2012, leg. D. Uyeno, S. Nishihira; 2 adult females and 1 adult male (KAUM-AT-287), ex *T. niloticus*, off Manza (26°30'N, 127°50'E), Onna, Okinawa-jima Island, East China Sea, 30 March, 2012, leg. D. Uyeno; 1 adult female (NHMUK 1934.4.20.1), off Port Blair, Andaman Islands, India; 1 adult female (NHMUK 1934.4.20.2); 1 adult female (NHMUK 1949.11.15.2), Port Blair, Andaman Islands, India.

Description of adult female. Body (Fig. 1A) cyclopiform, 5.30–7.63 (6.25 ± 0.70) long (n = 13), depressed dorso-ventrally with greatest width at cephalosome; external segmentation distinct. Cephalosome distinctly articulated from first pedigerous somite, wider than long, 0.87–1.17 (1.04 ± 0.07) × 1.11–1.62 (1.50 ± 0.13). First to fourth pedigerous somites and urosomites free. First pedigerous somite bearing pair of dorsal posterolateral lobes partially overlapping second pedigerous somite. Prosome 1.94–2.52 (2.19 ± 0.19) long. Genital somite bearing pair of posterolateral lobes with bulbous swelling on ventral side (Fig. 1A, C), 0.23–0.31 (0.25 ± 0.04) × 0.95–1.20 (1.09 ± 0.07); genital openings situated on ventral side (Fig. 1C). Abdomen progressively narrower posteriorly, composed of four free somites, 0.42–0.74 (0.55 ± 0.09) × 0.52–0.71 (0.63 ± 0.05), 0.49–0.80 (0.63 ± 0.11) × 0.52–0.64 (0.59 ± 0.03), 0.42–0.77 (0.57 ± 0.11) × 0.46–0.58 (0.52 ± 0.03), and 0.57–0.95 (0.73 ± 0.11) × 0.38–0.60 (0.48 ± 0.05), respectively. Caudal ramus (Fig. 1A, D, E) 5.07–6.56 (5.88 ± 0.48) times longer than wide, 0.88–1.36 (1.18 ± 0.13) × 0.15–0.23 (0.20 ± 0.02), with six setae. Egg sac (Fig. 1A) multiseriate, straight, sausage shaped.

Rostrum (Fig. 1B) triangular without distinct apex. Antennule (Fig. 1F) 7-segmented; armature formula 4, 15, 5, 4, 6 + 1 aesthetasc, 2 + 1 aesthetasc, 7 + 1 aesthetasc; all setae small, naked. Antenna (Fig. 1G) 3-segmented, composed of coxobasis and 2-segmented endopod; coxobasis large, bearing simple seta; first endopodal segment bearing seta on inner margin; second endopodal segment bearing four inner setae, inner fused claw, three claws, and two long distal setae. Labrum (Fig. 1H) broad, with pair of posterior lobes. Mandible (Fig. 2A) with inner lash-like serrated setiform element and apical serrated setiform element with two hyaline outer teeth at base of outer

lash. Maxillule (Fig. 2B) represented by simple lobe armed with spherical protrusion and four simple elements. Maxilla (Fig. 2C) 2-segmented; basal segment unarmed; terminal segment bearing five sharp processes and two setae. Maxilliped (Fig. 2D) 2-segmented, composed of unarmed syncoxa and rod-shaped basis bearing single apical blunt element.

Legs 1 to 4 (Fig. 2E–H) biramous, bearing 3-segmented rami. Leg armature formula as follows:

	Coxa	Basis	Exopod	Endopod
Leg 1	0-0	1-0	I-0; I-0; III, I, 3	0-0; 0-0; II, 1, 2
Leg 2	0-0	1-0	I-0; I-0; III, I, 3	0-0; 0-0; II, I, 2
Leg 3	0-0	1-0	I-0; I-0; III, I, 3	0-0; 0-0; III, I, 2
Leg 4	0-0	1-0	I-0; I-0; III, I, 3	0-0; 0-0; III, I, 1

Intercoxal sclerite (Fig. 2E–H) of legs 1 to 4 unornamented. All spines spatulate. Both rami of legs 1 to 4 bearing rows of fine spinules on base of spines. Marginal row of fine spinules present on outer margin of basal endopodal segment of legs 1 and 2 and along middle segment of legs 1 to 3. Leg 5 (Fig. 2I) consisting of dorsolateral seta on fifth pedigerous somite and free exopod; exopod elongate, rod-shaped, bearing three blunt spines and simple seta. Leg 6 (Fig. 1C) represented by two small elements at genital opening.

Description of adult male. Body (Fig. 3A) cyclopiform, 3.58–5.27 (4.60 ± 0.69) long (n = 5), depressed dorso-ventrally with greatest width at cephalosome; external segmentations distinct. Cephalosome distinctly articulated from first pedigerous somite, wider than long, 0.72–0.92 (0.83 ± 0.09) × 0.96–1.35 (1.17 ± 0.16). First to fourth pedigerous somites and urosomites free. Prosome length 1.46–1.74 (1.64 ± 0.12). Genital somite (Fig. 3A, B) wider than long, 0.15–0.28 (0.20 ± 0.05) × 0.57–0.87 (0.70 ± 0.12). Abdomen progressively narrowing posteriorly, composed of four free somites, 0.32–0.50 (0.43 ± 0.08) × 0.42–0.61 (0.51 ± 0.08), 0.29–0.59 (0.46 ± 0.12) × 0.39–0.53 (0.46 ± 0.06), 0.33–0.55 (0.45 ± 0.09) × 0.32–0.48 (0.41 ± 0.06), and 0.41–0.67 (0.56 ± 0.11) × 0.32–0.45 (0.37 ± 0.06), respectively. Caudal ramus (Fig. 3A) 4.44–6.96 (5.93 ± 1.00) times longer than wide, 0.62–1.07 (0.88 ± 0.22) × 0.11–0.19 (0.15 ± 0.03), with six setae.

Antennule, antenna, mandible, and maxilla as in female. Maxillule (Fig. 3D) as in female, except replacement of spherical protrusion by small knob-like protrusion. Maxilliped (Fig. 3E, F) 4-segmented; basal segment rod-like bearing patch of small spinules; second segment bearing two setae; third segment small, with two elements; terminal claw curved, bearing element proximally and row of spinules on inner margin. Armature formula of legs 1 to 4 as in female. Legs 1 and 2 bearing endopod with single and two pointed outer processes on middle and terminal segments, respectively. Leg 5 as in female. Leg 6 (Fig. 3B, C) represented by two simple setae on genital operculum.

Remarks. *Panaietis incamerata* was originally described from an unidentified gastropod off Louisiade Archipelago, Papua New Guinea (Stebbing 1900). Subsequently, the copepod was reported off Port Blair, Andaman Islands (Monod 1934; Monod & Dollfus 1934). Ho (1981) claimed that the leg 5 of the specimen of Andaman Islands is actually longer than that of the original description. However, he did not conclude about the conspecificity of the specimens, once Stebbing (1900) did not detail its description. Currently, three other congeners of *Panaietis* are known from marine gastropods (Sars 1918; Yamaguti 1936; Izawa 1976). My examination of *P. incamerata* based on newly collected specimens in Japanese waters and museum specimens collected from the type locality revealed some characteristics not shared with other congeners. *Panaietis incamerata* differs from *P. haliotis* Yamaguti, 1936 and *P. malleolata* (Sars, 1918) in having following characters: legs 1 and 2 bearing spatulate spines (vs. sharp spines in the other species); third segment of both rami of legs 1 and 2 bearing three and two setae (vs. four and three setae) (see Sars 1918, pl. CXII; Yamaguti, 1936). *Panaietis yamagutii* Izawa, 1976 is clearly distinguished from *P. incamerata* by the following characters: third segment of both rami of legs 1 bearing four setae in female (vs. three setae); genital openings situated on dorsal side in female (vs. ventral position with one small lobe on adjacent surface); free exopod of leg 5 small, situated on posteroventral side of pedigerous somite on both sexes (vs. elongate, situated on lateral side) (Yamaguti, 1936; Izawa, 1976; present study).

Attachment site. The pharynx and esophagus.

Newly established Japanese name for species. Takasegai-no-haramushi.

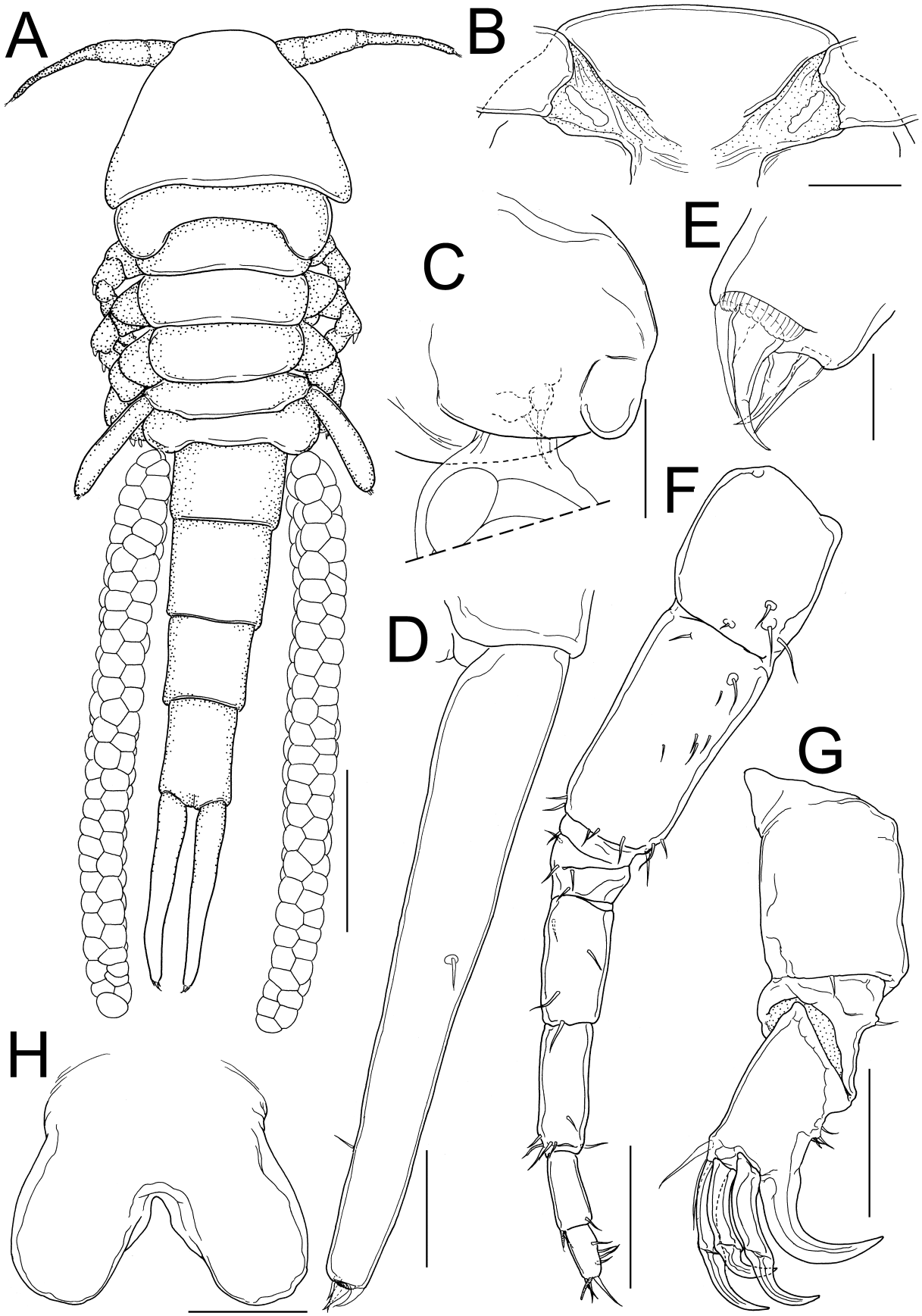

FIGURE 1. *Panaietis incamerata* Stebbing, 1900, adult female, NSMT–Cr 24619. A, habitus, dorsal; B, rostral area; C, genital aperture and leg 6, ventral; D, right caudal ramus, dorsal; E, distal tip of left caudal ramus, dorsal; F, right antennule; G, right antenna, anterior; H, labrum, anterior. Scale bars: A, 1 mm; B, D, F, G, 200 μm; C, H, 100 μm; E, 20 μm.

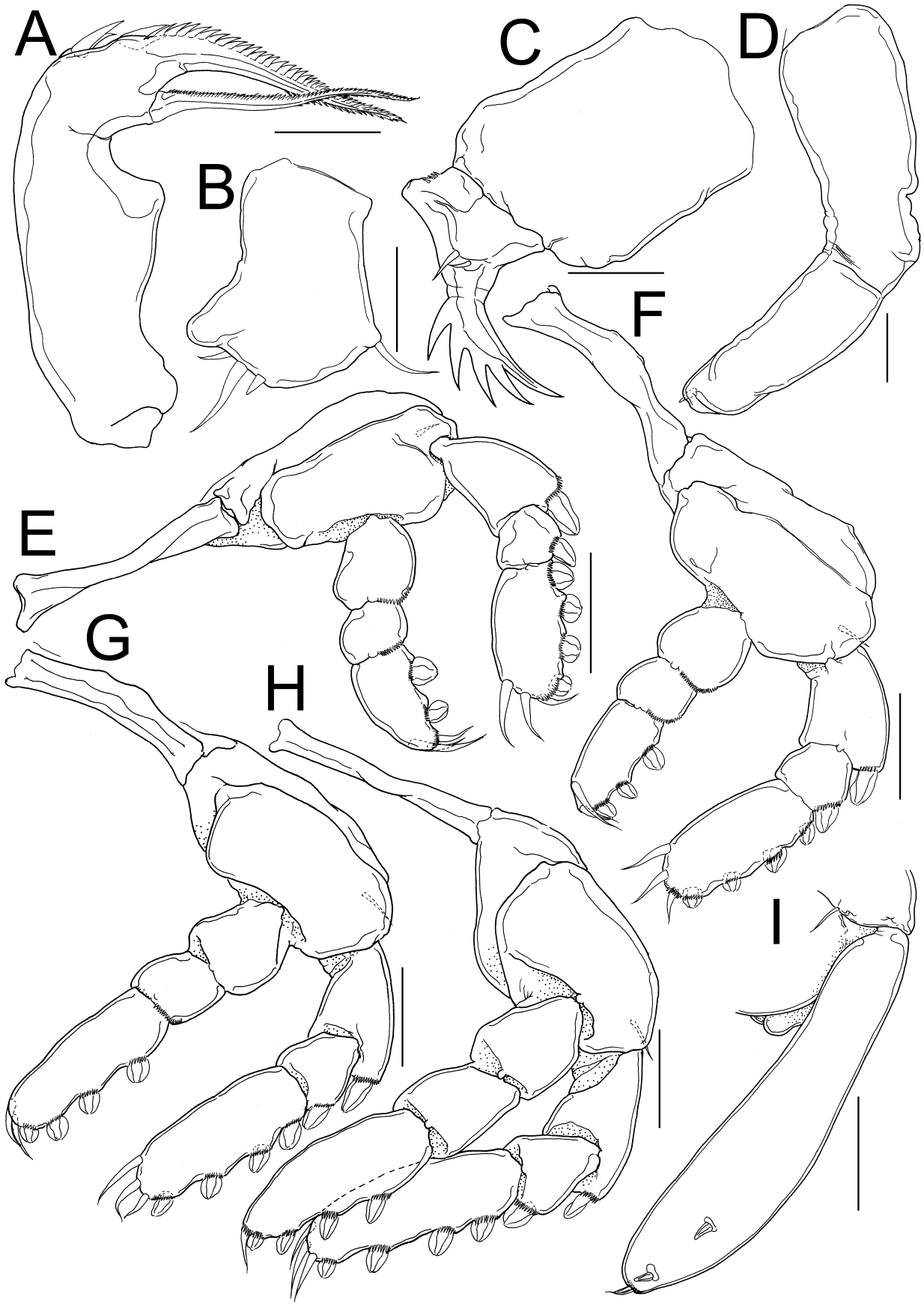

FIGURE 2. *Panaietis incamerata* Stebbing, 1900, adult female, NSMT–Cr 24619. A, left mandible, posterior; B, left maxillule, anterior; C, left maxilla, posterior; D, left maxilliped, anterior; E, left leg 1, anterior; F, left leg 2, anterior; G, left leg 3, anterior; H, left leg 4, anterior; I, right leg 5, dorsal. Scale bars: A, B, D, 50 μm; C, 30 μm; E–I, 200 μm.

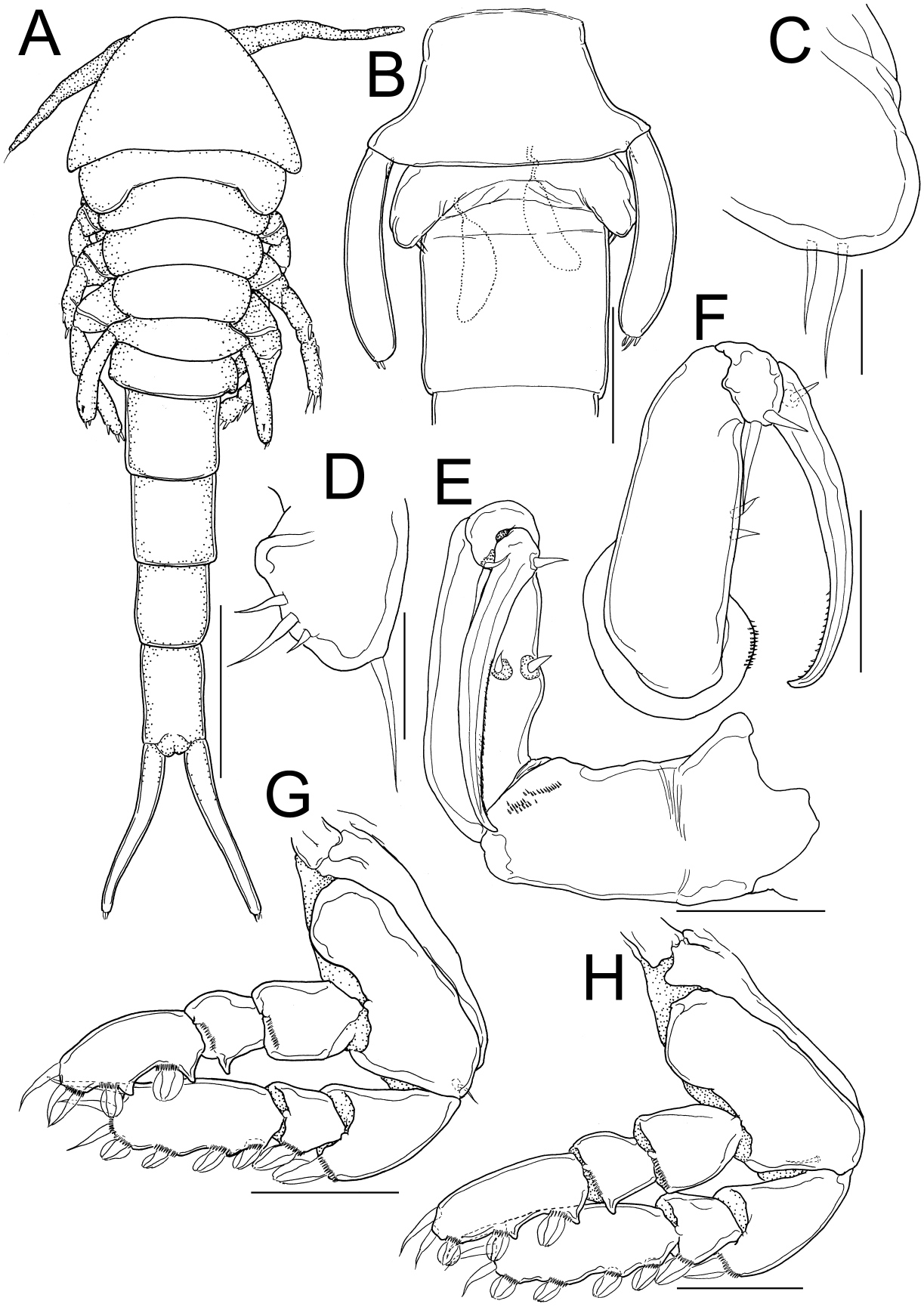

FIGURE 3. *Panaietis incamerata* Stebbing, 1900, adult male, NSMT–Cr 24619. A, habitus, dorsal; B, anterior part of urosome, ventral; C, left leg 6, ventral; D, left maxillule, anterior; E, right maxilliped, inner; F, right antennule, outer; G, left leg 1, anterior; H, left leg 2, anterior. Scale bars: A, 1 mm; B, 400 μm; C, E, F, 100 μm; D, 50 μm; G, H, 200 μm.

***Panaietis doraconis* n. sp.**
(Figs 4–6)

Type material. Holotype: adult female (NSMT–Cr 24622), ex *Tectus pyramis* (Born, 1778) (Vetigastropoda: Trochoidea: Tegulidae), off Saneku (28°12'N, 129°12'E), Kakeroma Island, Oshima Strait, 27 April, 2015, leg. D. Uyeno, S. Yokoyama. Allotype: adult male (NSMT–Cr 24633), collection data same as holotype. Paratypes: 2 adult females and 1 adult male (NSMT–Cr 24634), collection data same as holotype.

Additional material. 1 adult female and 1 adult male (KAUM-AT-288), ex *T. pyramis*, off Yoron Island (27° 1'N, 128°26'E), North Pacific Ocean, 16 May, 2015, leg. D. Uyeno; 2 adult females (RUMF–ZC-04355), ex *T. pyramis*, off Manza (26°30'N, 127°50'E), Onna, Okinawa Island, East China Sea, 30 March, 2012, leg. D. Uyeno; 3 adult females and 1 adult male (NSMT–Cr 24625), ex *T. pyramis*, off Manza (26°30'N, 127°50'E), Onna, Okinawa Island, East China Sea, 23 March, 2012, leg. D. Uyeno; 3 adult females (NSMT–Cr 24624), ex *T. pyramis*, off Hakamagoshi (31°35'N, 130°35'E), Sakurajima Island, the Kagoshima Bay, 20 September, 2015, leg. D. Uyeno.

Description of holotype. Adult female. Body (Fig. 4A) cyclopiform, 7.71 long, with greatest width at cephalosome; external segmentations distinct. Cephalosome distinctly articulated from first pedigerous somite, wider than long, 0.70 × 0.75. First to fourth pedigerous somites and urosomites free. Prosome 2.14 long. Genital somite bearing one pair of lateral lobes (Fig. 4A, C), 0.52 × 0.69; genital openings situated on dorsal side. Abdomen composed of four free somites, 0.62 × 0.52, 0.76 × 0.52, 0.70 × 0.47, and 1.21 × 0.33, respectively. Caudal ramus (Fig. 4A, D) 7.24 times longer than wide, 1.13 × 0.16, with six setae.

Rostrum (Fig. 4B) triangular without distinct apex. Antennule (Fig. 4E) 7-segmented; armature formula 4, 15, 4, 4, 6 + 1 aesthetasc, 2 + 1 aesthetasc, 7 + 1 aesthetasc; all setae small and naked. Antenna (Fig. 4F) 3-segmented, composed of coxobasis and 2-segmented endopod; coxobasis large, bearing naked seta; first endopodal segment bearing small, naked seta on inner margin; second endopodal segment bearing four inner setae, inner fused claw, three claws, and two long setae. Labrum (Fig. 4G) broad, bearing pair of posterior lobes. Mandible (Fig. 5A) bearing lash-like serrated inner setiform element and apical serrated setiform element with two hyaline outer teeth at outer base. Maxillule (Fig. 5B) represented by simple lobe armed with spherical protrusion and simple elements. Maxilla (Fig. 5C) 2-segmented; basal segment unarmed; terminal segment bearing row of spinules, five sharp processes, and two small setae. Maxilliped (Fig. 5D) 2-segmented, composed of unarmed syncoxa and rod-shaped basis bearing single apical blunt element.

Legs 1 to 4 (Fig. 5E–H) biramous, with 3-segmented rami. Leg armature formula as follows:

	Coxa	Basis	Exopod	Endopod
Leg 1	0-0	1-0	I-0; I-0; III, I, 3	0-0; 0-0; II, 1, 2
Leg 2	0-0	1-0	I-0; I-0; III, I, 3	0-0; 0-0; II, I, 2
Leg 3	0-0	1-0	I-0; I-0; III, I, 3	0-0; 0-0; III, I, 2
Leg 4	0-0	1-0	I-0; I-0; III, I, 3	0-0; 0-0; III, I, 1

Intercoxal sclerite (Fig. 5E–H) of legs 1 to 4 unornamented. All spines spatulate. Both rami of legs 1 to 4 bearing rows of fine spinules present on base of spines. Leg 5 (Fig. 5I) consisting of dorsolateral seta on fifth pedigerous somite and free exopod; exopod elongate, rod-shaped, bearing three blunt spines and naked seta. Leg 6 (Fig. 4C) represented by two small elements at genital opening.

Description of allotype adult male. Body (Fig. 6A) cyclopiform, 4.06 long, depressed dorso-ventrally with greatest width at cephalosome; external segmentations distinct. Cephalosome distinctly articulated from first pedigerous somite, slightly wider than long, 0.57 × 0.61. First to fourth pedigerous somites and urosomites free. Prosome 1.70 long. Genital somite (Fig. 6A, B), 0.28 × 0.28. Abdomen progressively narrowing posteriorly, composed of four free somites, 0.32 × 0.26, 0.34 × 0.25, 0.25 × 0.24, and 0.44 × 0.23, respectively. Caudal ramus (Fig. 6A) 5.33 times longer than wide, 0.54 × 0.10, with six setae.

Antennule, antenna, mandible, maxillule, and maxilla as in female. Maxilliped (Fig. 6C) 4-segmented; basal segment rod-like; second segment bearing single seta and patches of spinules; third segment small with two elements; terminal claw curved, bearing two basal elements and row of spinules on inner margin. Armature formula of legs 1 to 4 as in female. Leg 5 as in female. Leg 6 (Fig. 6B) represented by two simple setae on genital operculum.

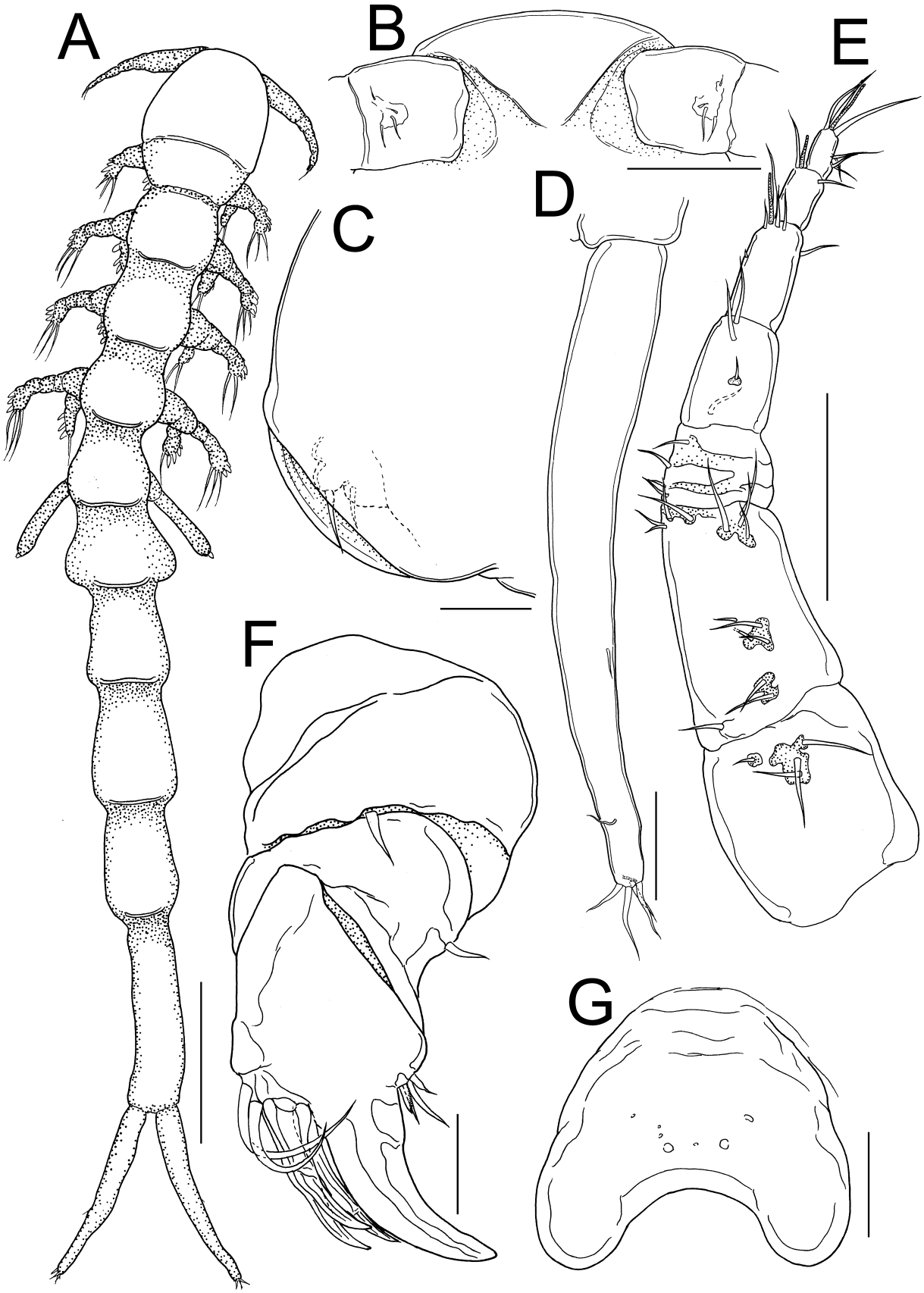

FIGURE 4. *Panaietis draconis* **n. sp.**, adult female, holotype NSMT–Cr 24622. A, habitus, dorsal; B, rostral area; C, genital aperture and leg 6, dorsal; D, right caudal ramus, dorsal; E, left antennule; F, right antenna, anterior; G, labrum, anterior. Scale bars: A, 1 mm; B, D, E, 200 μm; C, F, G, 50 μm.

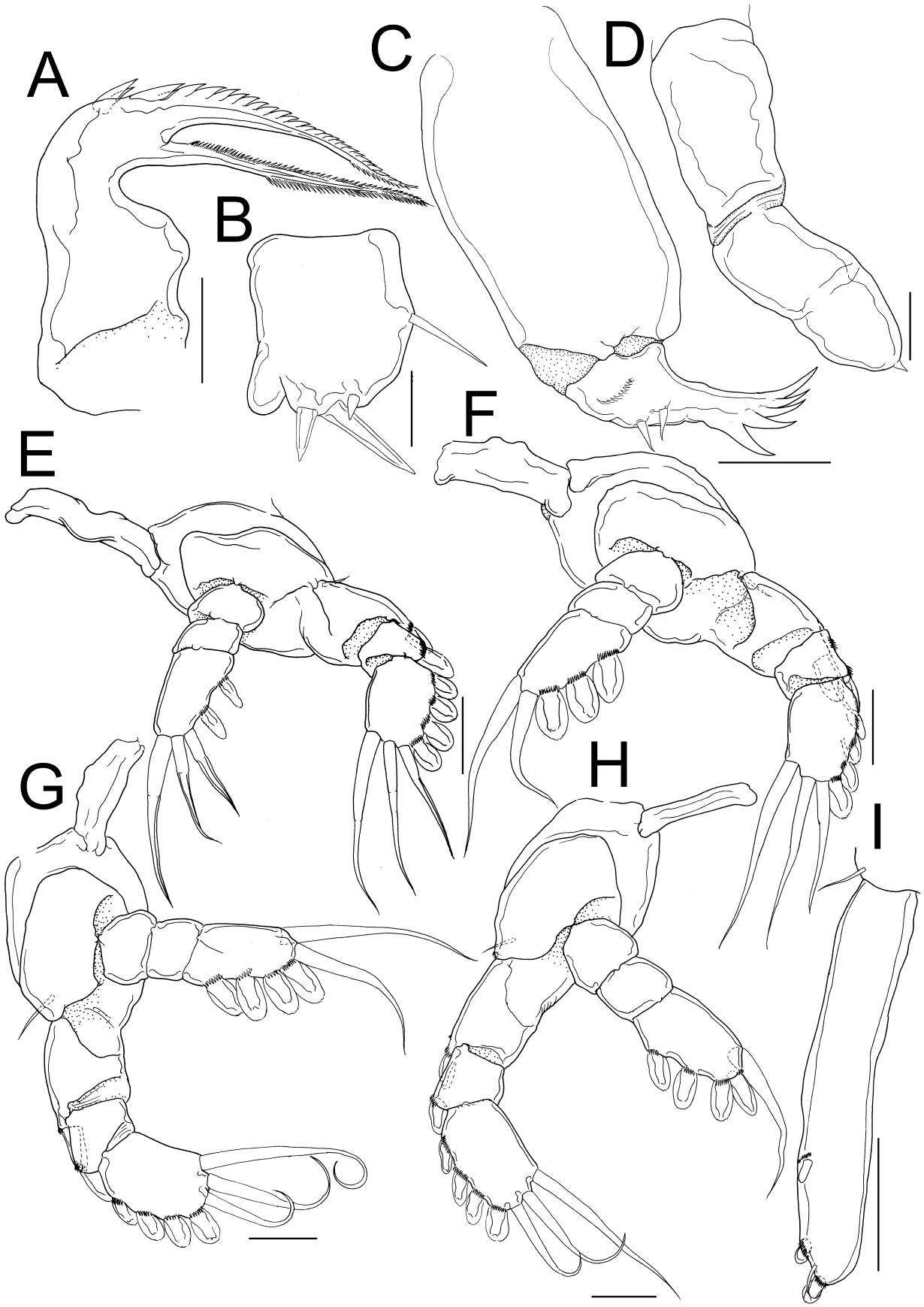

FIGURE 5. *Panaietis draconis* **n. sp.**, adult female, holotype NSMT–Cr 24622. A, right mandible, posterior; B, left maxillule, anterior; C, left maxilla, posterior; D, right maxilliped, anterior; E, left leg 1, anterior; F, left leg 2, anterior; G, right leg 3, anterior; H, right leg 4, anterior; I, left leg 5, dorsal. Scale bars: A, C, 40 μm; B, D, 20 μm; E–H, 100 μm; I, 200 μm.

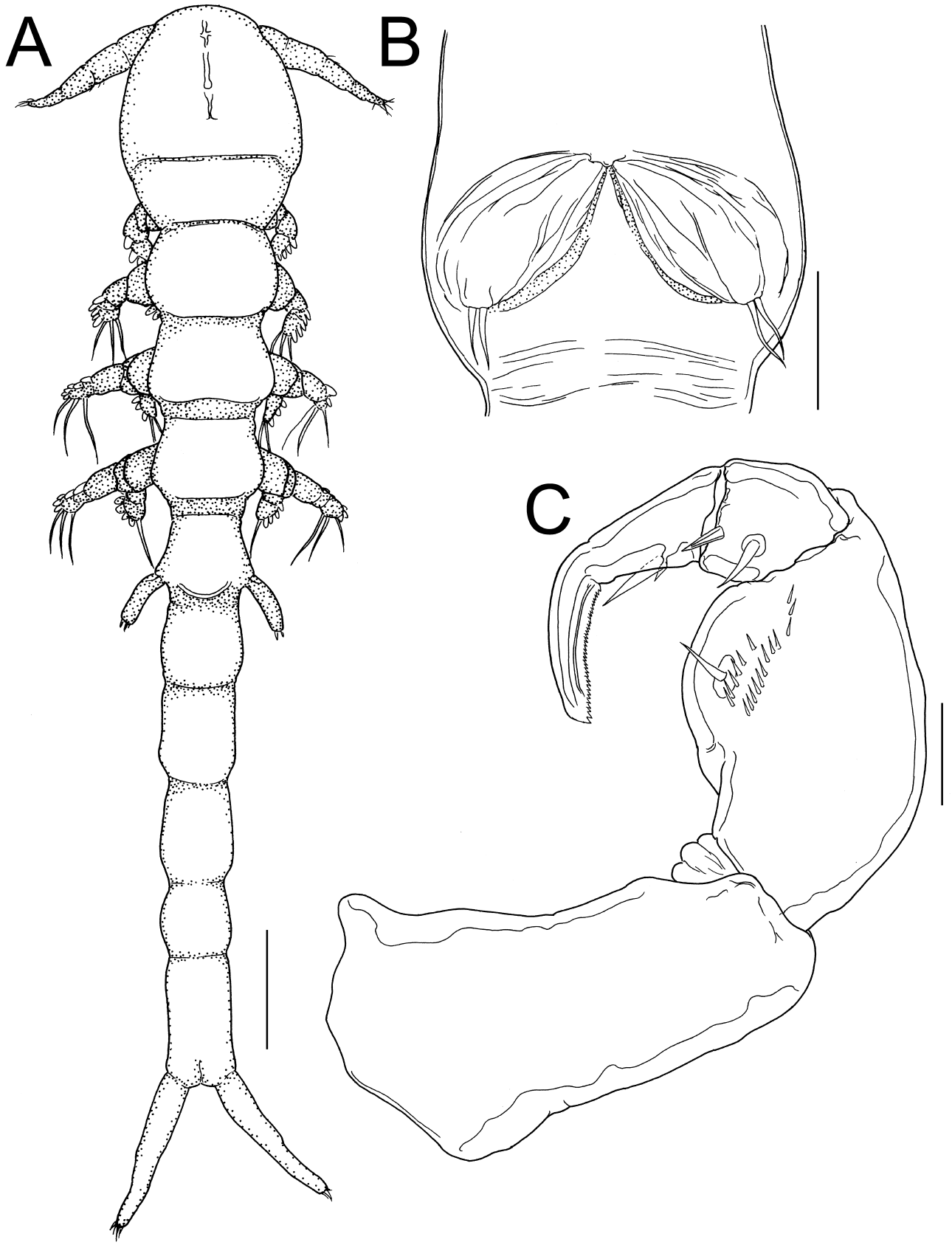

FIGURE 6. *Panaietis draconis* **n. sp.**, adult male, allotype NSMT–Cr 24623. A, habitus, dorsal; B, genital somite, ventral; C, left maxilliped, inner. Scale bars: A, 400 μm; B, 100 μm; C, 20 μm.

Variability. Morphology of paratypes and other female specimens examined as in holotype. Measurements of the body parts of paratypes and other specimens (n = 11) as follows: body length 5.88–8.97 (7.39 ± 1.09); cephalosome length 0.58–0.94 (0.73 ± 0.09); cephalosome width 0.72–1.02 (0.84 ± 0.09); prosome length 1.90–2.89 (2.33 ± 0.34); genital somite length 0.42–0.55 (0.48 ± 0.04); genital somite width 0.58–0.86 (0.70 ± 0.09); first urosomite length 0.34–0.72 (0.55 ± 0.13); first urosomite width 0.43–0.62 (0.51 ± 0.07); second urosomite length 0.49–0.83 (0.68 ± 0.12); second urosomite width 0.45–0.63 (0.52 ± 0.05); third urosomite length 0.51–0.87 (0.68 ± 0.12); third urosomite width 0.42–0.62 (0.49 ± 0.06); anal somite length 0.91–1.49 (1.15 ± 0.21); anal somite width 0.33–0.52 (0.40 ± 0.07); caudal ramus length 0.87–1.58 (1.18 ± 0.26); caudal ramus width 0.12–0.22 (0.16 ± 0.03). Caudal ramus 5.95–9.32 (7.31 ± 0.93) times longer than wide.

The morphology of paratypes and other male specimens as in allotype. The measurements of the body parts of paratypes and other specimens (n = 3) are as follows: body length 2.88–6.32 (4.22 ± 1.84); cephalosome length 0.43–0.59 (0.52 ± 0.08); cephalosome width 0.44–0.85 (0.62 ± 0.21); prosome length 1.36–2.34 (1.70 ± 0.56); genital somite length 0.18–0.43 (0.28 ± 0.13); genital somite width 0.22–0.48 (0.34 ± 0.13); first urosomite length 0.18–0.52 (0.30 ± 0.19); first urosomite width 0.18–0.43 (0.30 ± 0.12); second urosomite length 0.25–0.54 (0.35 ± 0.17); second urosomite width 0.16–0.41 (0.28 ± 0.12); third urosomite length 0.17–0.49 (0.27 ± 0.19); third urosomite width 0.15–0.45 (0.28 ± 0.16); anal somite length 0.28–0.94 (0.52 ± 0.36); anal somite width 0.17–0.39 (0.27 ± 0.11); caudal ramus length 0.35–1.12 (0.69 ± 0.39); caudal ramus width 0.07–0.16 (0.11 ± 0.05). Caudal ramus 5.11–6.95 (5.85 ± 0.97) times longer than wide.

Remarks. *Panaietis doraconis* **n. sp.** differs from *P. haliotis* and *P. malleolata* in having legs 1 to 4 with spatulate spines on both rami in the female (vs. slender and pointed spines) (see Sars 1918, pl. CXII; Yamaguti 1936, figs 21–24). The new species is distinguished from *P. yamagutii* in having the following characters in both sexes: dorsal plate on first pedigerous somite lacking posterolateral lobes in both sexes (vs. with posterolateral lobes); leg 5 situated on lateral side of pedigerous somite with one elongate rod-like free exopod (vs. leg 5 with small free exopod situated on posteroventral side of pedigerous somite) (see Izawa 1976, figs 28, 37, 39, 50). *Panaietis incamerata* differs from *P. doraconis* **n. sp.** in having the following characters: presence of posterolateral lobes on first pedigerous somite in both sexes (vs. such lobes absent); genital somite bearing pair of bulbous swellings and pair of genital openings on ventral surface in female (vs. small lobes absent; genital opening on dorsal surface) (present study).

Attachment site. Pharynx and esophagus.

Etymology. The specific name of the new species, *doraconis*, refers to the elongate body of the new species which evokes a dragon.

Newly established Japanese name for species. Gintakahama-no-haramushi.

Panaietis satsuma n. sp.

(Figs 7–9)

Type material. Holotype: adult female (NSMT–Cr 24626), ex *Tectus conus* (Gmelin, 1791) (Vetigastropoda: Trochoidea: Tegulidae), off Bonomisaki (31°15'N, 130°13'E), Bonotsu, East China Sea, 10 May, 2015, leg. D. Uyeno. Allotype: adult male (NSMT–Cr 24627), collection data same as those of holotype.

Additional material. 2 adult females and 1 adult male (NSMT–Cr 24628), ex *T. pyramis*, off Saneku (28°12'N, 129°12'E), Kakeroma Island, Oshima Strait, 29 April, 2015, leg. D. Uyeno, S. Yokoyama. 1 adult male (NSMT–Cr 24629), ex *T. pyramis*, off Cape Maeda (26°26'N, 127°46'E), Onna, Okinawa Island, East China Sea, 17 March, 2012, leg. D. Uyeno.

Description of holotype. Adult female. Body (Fig. 7A) cyclopiform, 4.81 long, with greatest width at cephalosome; external segmentations distinct. Cephalosome articulated from first pedigerous somite, wider than long, 0.73 × 1.07. First to fourth pedigerous somites and urosomites free. Prosome 2.32 long. Genital somite bearing one pair of lateral lobes (Fig. 7A, C), 0.31 × 0.64; genital openings situated on dorsal surface. Abdomen composed of four free somites, 0.38 × 0.37, 0.36 × 0.38, 0.38 × 0.35, and 0.45 × 0.33, respectively. Caudal ramus (Fig. 7A, D) 4.24 times longer than wide, 0.43 × 0.10, with six setae.

Rostrum (Fig. 7B) triangular without distinct apex. Antennule (Fig. 7E) 7-segmented; armature formula 4, 15, 4, 4, 6 + 1 aesthetasc, 2 + 1 aesthetasc, 7 + 1 aesthetasc; all setae small and naked. Antenna (Fig. 7F) 3-segmented, composed of coxobasis and 2-segmented endopod; coxobasis large, bearing small, naked seta; first endopodal

segment bearing simple seta on inner margin; second endopodal segment bearing four inner elements, inner fused claw, three claws, and two long distal setae. Labrum (Fig. 7G) broad, bearing pair of posterior lobes. Mandible (Fig. 7H) bearing inner lash-like serrated setulose element and apical serrated setulose element with two hyaline outer teeth at outer lash basis. Maxillule (Fig. 8A) represented by simple lobe armed with spherical protrusion and four simple elements. Maxilla (Fig. 8B) 2-segmented; basal segment unarmed; terminal segment bearing row of spinules, eight sharp processes, and two small setae. Maxilliped (Fig. 8C) 2-segmented, composed of unarmed syncoxa and rod-shaped basis.

Legs 1 to 4 (Fig. 8D–G) biramous, bearing 3-segmented rami. Leg armature formula as follows:

	Coxa	Basis	Exopod	Endopod
Leg 1	0-0	1-0	I-0; I-0; III, I, 3	0-0; 0-0; II, 1, 2
Leg 2	0-0	1-0	I-0; I-0; III, I, 3	0-0; 0-0; II, I, 2
Leg 3	0-0	1-0	I-0; I-0; III, I, 3	0-0; 0-0; III, I, 2
Leg 4	0-0	1-0	I-0; I-0; III, I, 3	0-0; 0-0; III, I, 1

Basis (Fig. 8D–G) of legs 1 to 4 armed with rows of fine spinules near base of endopod. Intercoxal sclerites (Fig. 8D–G) of legs 1 to 4 unornamented. All spines spatulate. Legs 1, 2, and 4 bearing distinct pointed projections on rami. Both rami of legs 1 to 4 bearing rows of fine spinules near base of setation elements. Rows of fine spinules present near distal margin of basal endopodal segment of legs 1 to 3 and of middle segment of legs 1 to 4. Leg 5 (Fig. 8H) consisting of dorsolateral seta on fifth pedigerous somite and free exopod; exopod pentagonal, bearing three spines and single naked seta. Leg 6 (Fig. 7C) represented by two small elements adjacent to genital opening.

Description of allotype. Adult male. Body (Fig. 9A) cyclopiform, 3.09 long, depressed dorso-ventrally with greatest width at cephalosome; external segmentations distinct. Cephalosome distinctly articulated from first pedigerous somite, wider than long, 0.52 × 0.71. First to fourth pedigerous somites and urosomites free. Prosome 1.51 long. Genital somite (Fig. 9A, B) 0.22 × 0.32. Abdomen progressively narrower posteriorly, composed of four free somites, 0.23 × 0.26, 0.28 × 0.24, 0.19 × 0.22, and 0.25 × 0.20, respectively. Caudal ramus (Fig. 9A) 3.27 times longer than wide, 0.24 × 0.07, with six setae.

Antennule, antenna, mandible, maxillule, and maxilla as in female. Maxilliped (Fig. 9C) 4-segmented; basal segment rod-like; second segment bearing two setae and row of spinules; third segment small with single element; terminal claw curved, bearing two basal elements and row of spinules on inner margin. Armature formula of legs 1 to 4 as in female. Leg 5 as in female. Leg 6 (Fig. 9B) represented by two simple setae on genital operculum.

Variability. The morphology of other female specimens as in the holotype. Measurements of body parts (n = 2) as follows: body length 4.18–4.26 (4.22 ± 0.06); cephalosome length 0.72–0.88 (0.80 ± 0.11); cephalosome width 1.05–1.15 (1.10 ± 0.07); prosome length 1.75; genital somite length 0.22–0.30 (0.26 ± 0.05); genital somite width 0.70–0.85 (0.77 ± 0.10); first urosomite length 0.29; first urosomite width 0.43–0.56 (0.50 ± 0.09); second urosomite length 0.44–0.50 (0.47 ± 0.04); second urosomite width 0.39–0.49 (0.44 ± 0.07); third urosomite length 0.35–0.45 (0.40 ± 0.07); third urosomite width 0.35–0.47 (0.41 ± 0.08); anal somite length 0.44–0.51 (0.47 ± 0.05); anal somite width 0.32–0.41 (0.36 ± 0.07); caudal ramus length 0.46–0.55 (0.50 ± 0.06); caudal ramus width 0.12–0.15 (0.13 ± 0.03). Caudal ramus 3.55–4.00 (3.78 ± 0.32) times longer than wide.

Morphology of the other male specimens as in allotype. Measurements of body parts of other male specimens (n = 2) as follows: body length 3.22–3.38 (3.30 ± 0.11); cephalosome length 0.55–0.61 (0.58 ± 0.04); cephalosome width 0.82–0.85 (0.83 ± 0.02); prosome length 1.38–1.58 (1.48 ± 0.14); genital somite length 0.22–0.24 (0.23 ± 0.01); genital somite width 0.36–0.38 (0.37 ± 0.02); first urosomite length 0.25–0.28 (0.27 ± 0.02); first urosomite width 0.29–0.31 (0.30 ± 0.01); second urosomite length 0.32; second urosomite width 0.27–0.29 (0.28 ± 0.02); third urosomite length 0.23–0.29 (0.26 ± 0.04); third urosomite width 0.24–0.27 (0.25 ± 0.02); anal somite length 0.33–0.36 (0.35 ± 0.02); anal somite width 0.22–0.23 (0.22 ± 0.01); caudal ramus length 0.32–0.34 (0.33 ± 0.01); caudal ramus width 0.08. Caudal ramus 3.82–4.00 (3.91 ± 0.13) times longer than wide.

Remarks. *Panaietis satsuma* **n. sp.** differs from *P. haliotis* and *P. malleolata* in both rami of legs 1 to 4 bearing spatulate spines in female (vs. slender pointed spines) (see Sars 1918, pl. CXII; Yamaguti 1936, figs 21–24). The new species is distinguished from *P. yamagutii* by having the free exopod of leg 5 situated on the lateral surface of the pedigerous somite in both sexes (vs. located posteroventrally on pedigerous somite) (see Izawa 1976, fig. 37, 50). *Panaietis satsuma* **n. sp.** is distinguished from *P. incamerata* and *P. doraconis* **n. sp.** by having a pentagonal free exopod on leg 5 (vs. rod-like shaped) (present study).

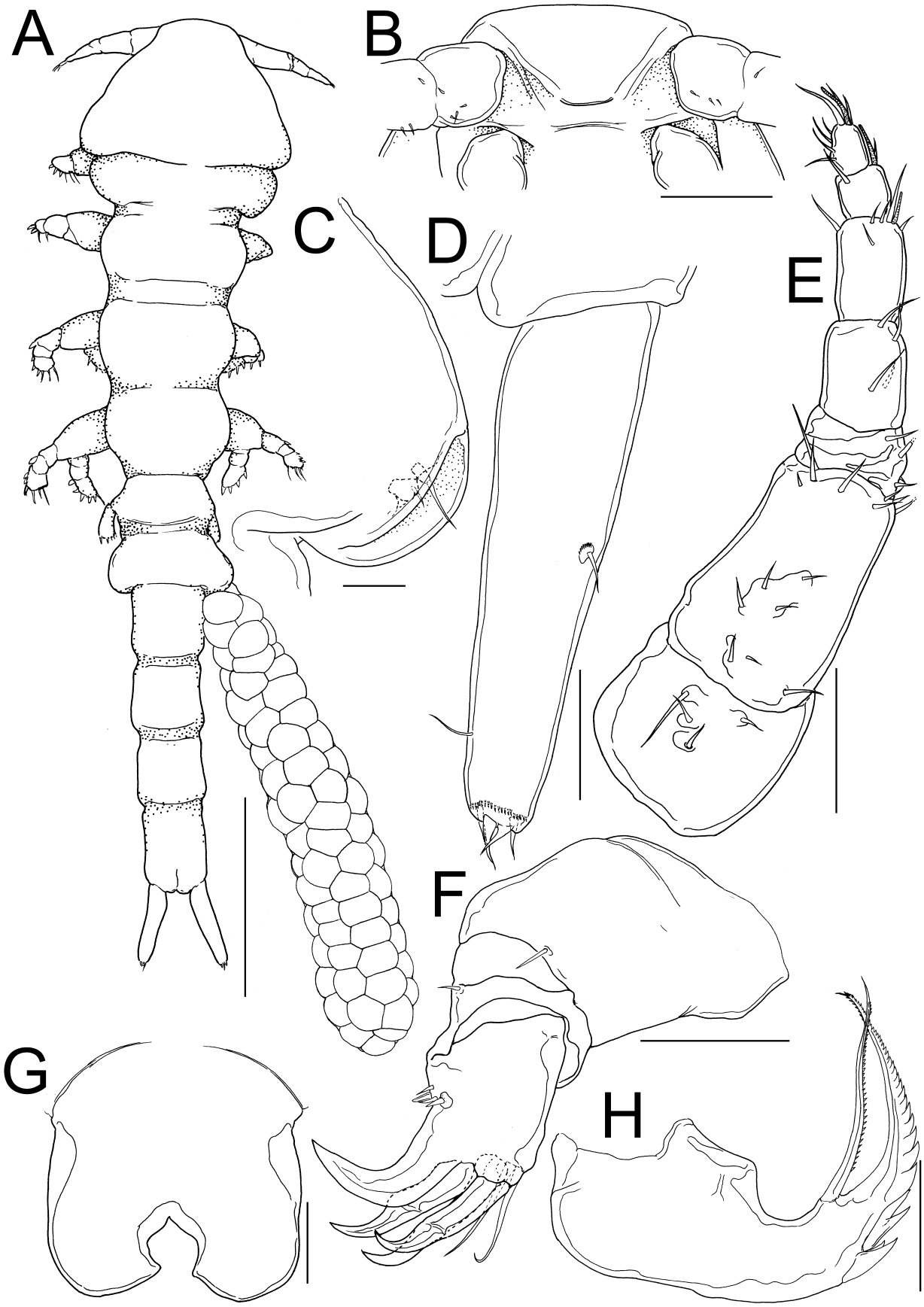

FIGURE 7. *Panaietis satsuma* **n. sp.**, adult female, holotype NSMT–Cr 24626. A, habitus, dorsal; B, rostral area; C, genital aperture and leg 6, dorsal; D, right caudal ramus, dorsal; E, right antennule; F, left antenna, anterior; G, labrum, anterior; H, right mandible, anterior. Scale bars: A, 1 mm; B, 200 µm; C, G, H, 50 µm; D–F, 100 µm.

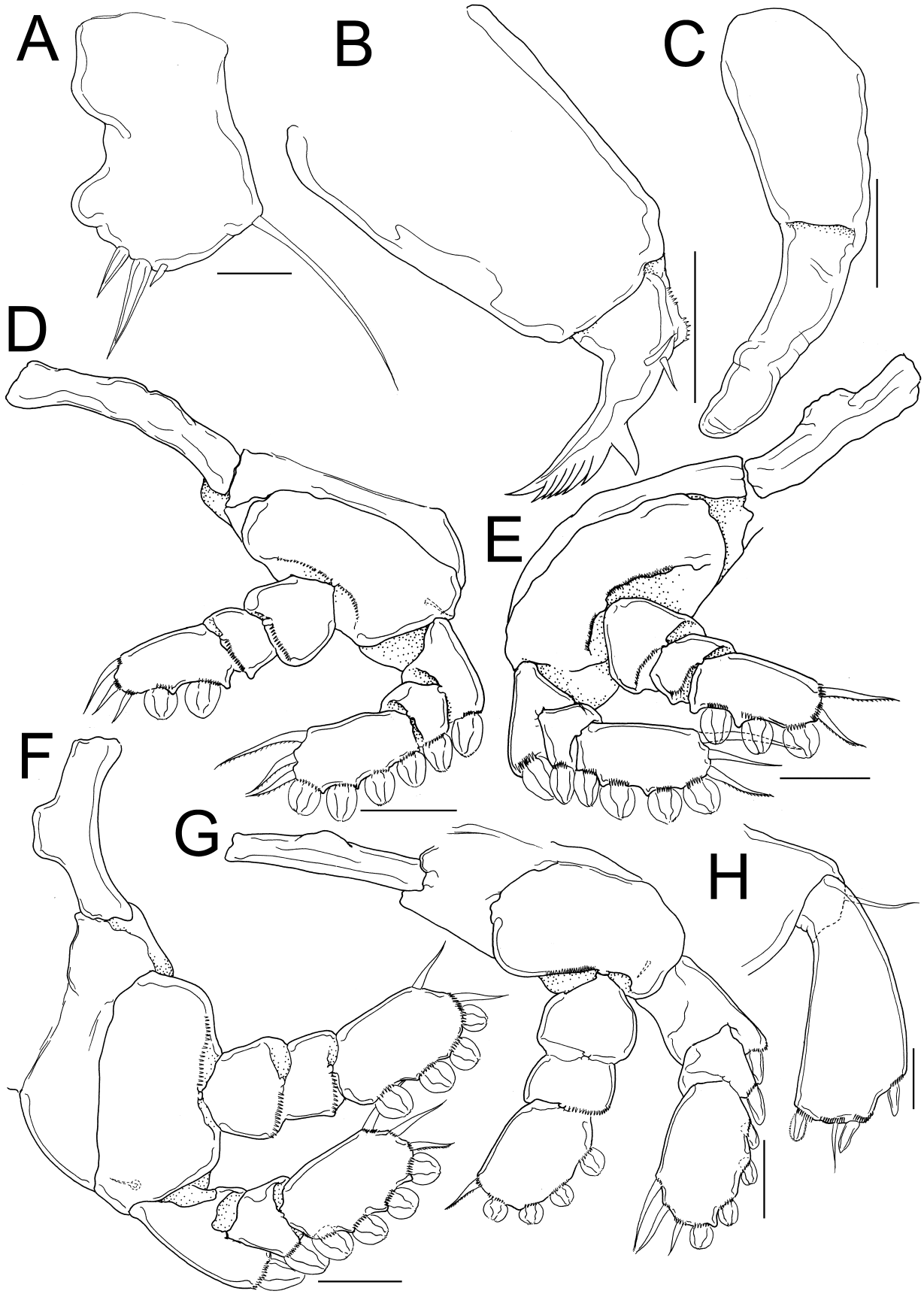

FIGURE 8. *Panaietis satsuma* **n. sp.**, adult female, holotype NSMT–Cr 24626. A, left maxillule, anterior; B, right maxilla, posterior; C, left maxilliped, anterior; D, left leg 1, anterior; E, right leg 2, anterior; F, right leg 3, anterior; G, left leg 4, anterior; H, left leg 5, ventral. Scale bars: A, 20 μm; B, C, H, 50 μm; D–G, 100 μm.

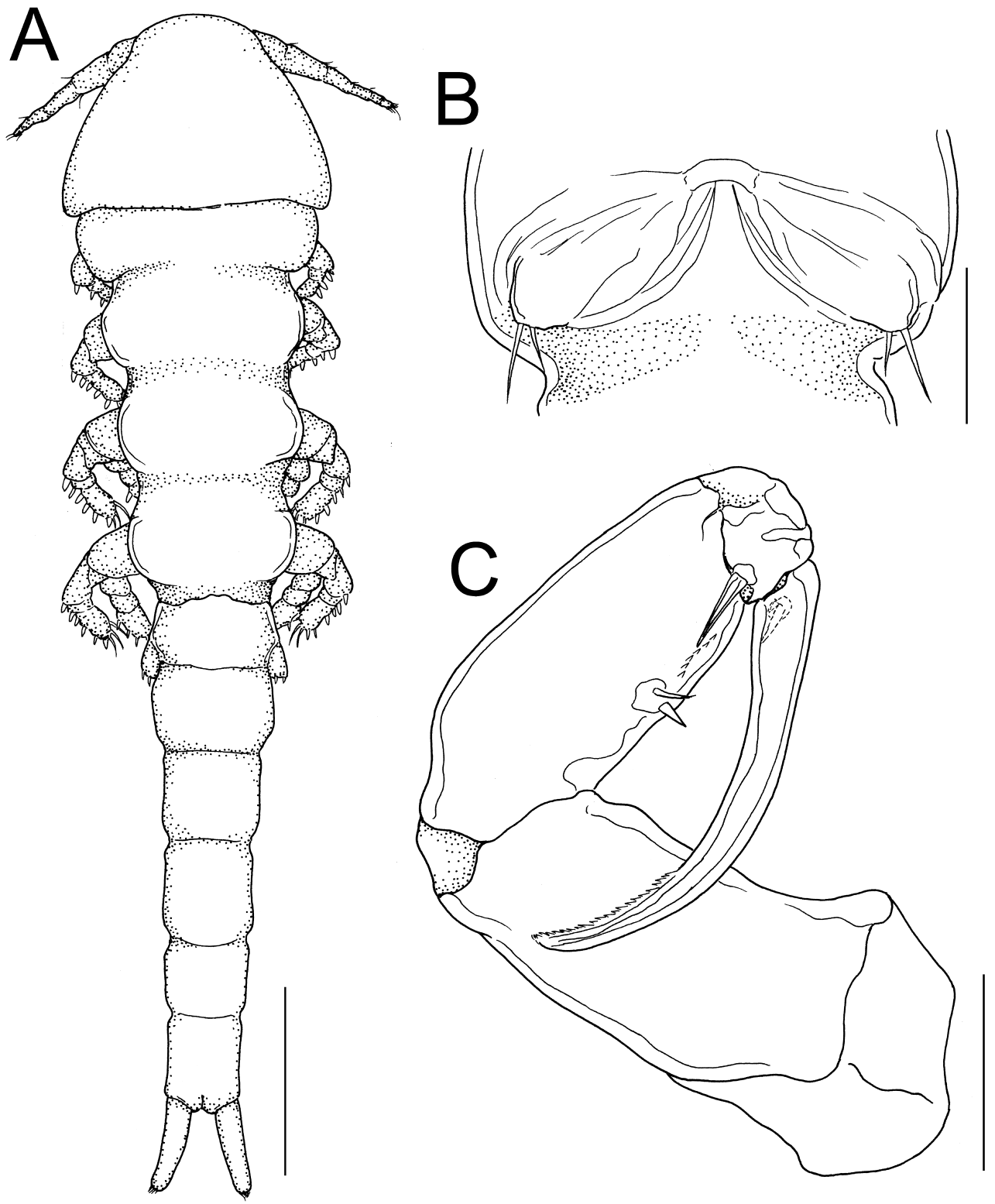

FIGURE 9. *Panaietis satsuma* **n. sp.**, adult male, allotype NSMT–Cr 24627. A, habitus, dorsal; B, genital somite, ventral; C, right maxilliped, inner. Scale bars: A, 500 μm; B, 100 μm; C, 50 μm.

Attachment site. The pharynx and esophagus.

Etymology. The specific name, *satsuma*, is derived from the old name of the type locality, Kagoshima prefecture. The name is used as a noun in apposition.

Newly established Japanese name for species. Benishiridaka-no-haramushi.

Family Pseudanthessiidae Humes & Stock, 1972

Genus *Pseudanthessius* Claus, 1889

***Pseudanthessius imo* n. sp.**
(Figs 10–12)

Type material. Holotype: adult female (NSMT–Cr 24630), ex *Tectus niloticus* (Linnaeus, 1767) (Vestigastropoda: Trochoidea: Tegulidae), off Saneku (28°12'N, 129°12'E), Kakeroma Island, Oshima Strait, 29 April, 2015, leg. D. Uyeno, S. Yokoyama. Allotype: adult male (NSMT–Cr 24631), collection data same as those of holotype. Paratypes: 2 adult females and 2 adult males (NSMT–Cr 24632), collection data same as those of holotype

Additional material. 1 adult female and 1 adult male (NSMT–Cr 24633), (NSMT–Cr 24633), ex *T. niloticus*, off Itchachi (26°20'N, 126°43'E), Kume Island, East China Sea, 3 March, 2012, leg. D. Uyeno, Y. Fujita, T. Naruse.

Description of holotype. Adult female. Body (Fig. 10A) cyclopiform, 2.94 long, depressed dorso-ventrally with greatest width at cephalosome; external segmentation distinct. Cephalosome distinctly articulated from first pedigerous somite, wider than long, 0.63 × 0.93. First to fourth pedigerous somites and urosomites free. Prosome 1.50 long. Genital double somite wider than long (Fig. 10A), 0.47 × 0.32. Abdomen progressively narrower posteriorly, composed of three free somites, 0.25 × 0.26, 0.18 × 0.21, and 0.19 × 0.20, respectively. Caudal ramus (Fig. 10A, D) 2.85 times longer than wide, 0.23 × 0.08, with six setae.

Rostrum (Fig. 10B) triangular, bearing distinct apex with round margin. Post-rostral process situated between bases of antennae (Fig. 10B). Antennule (Fig. 10E) 7-segmented; armature formula 4, 14, 6, 3, 4 + 1 aesthetasc, 2 + 1 aesthetasc, 7 + 1 aesthetasc; all setae naked. Antenna (Fig. 10F) 4-segmented, composed of coxobasis and 3-segmented endopod; coxobasis large, bearing single naked seta; first endopodal segment bearing simple seta on inner margin; second endopodal segment bearing three inner setae; third endopodal segment 1.44 times longer than wide, 61 × 43 μm, bearing four claws, one of them being elongate and three setae on distal part. Labrum (Fig. 10G) broad, bearing pair of posterior lobes. Mandible (Fig. 10H) bearing serrated blade with single hyaline tooth at base of convex margin of blade. Maxillule (Fig. 11A) represented by simple lobe armed with single inner and three distal setae. Maxilla (Fig.11B) 2-segmented; basal segment unarmed; terminal segment bearing serrated blade and three setae; inner seta large and spinulose. Maxilliped (Fig. 11C) 3-segmented, composed of unarmed syncoxa, basis bearing two simple setae, and conical endopodal segment with two simple elements.

Legs 1 to 4 (Fig. 11D–G) biramous, with 3-segmented rami. Leg 4 endopod unsegmented, almost as long as exopod, and with sinuous margins. Leg armature formula as follows:

	Coxa	Basis	Exopod	Endopod
Leg 1	0-1	1-0	I-0; I-1; III, I, 4	0-1; 0-1; I, 2, 3
Leg 2	0-1	1-0	I-0; I-1; III, I, 5	0-1; 0-2; II, I, 3
Leg 3	0-1	1-0	I-0; I-1; III, I, 5	0-1; 0-2; II, I, 2
Leg 4	0-1	1-0	I-0; I-1; III, I, 5	II

Intercoxal sclerites (Fig. 11D–G) of legs 1 to 4 unornamented. Leg 1 bearing basis with row of hair-like setules on inner margin. All spines spatulate with serrated margins and terminal flagellum. Both rami of legs 1 to 4 bearing rows of hair-like setules on outer and inner margins, except inner margin of basal segment of endopods on legs 1 to 3. Basal and middle endopodal segments of legs 1 to 3 each bearing row of fine spinules along distal margin and distal pointed projection on outer margin. Terminal endopodal segments of legs 1 and 2 each bearing single pointed projection on outer margin. Leg 5 (Fig. 11H) represented by simple spine and two naked setae. Leg 6 (Fig. 10C) represented by two small elements at genital opening.

Description of allotype. Adult male. Body (Fig. 12A) cyclopiform, 2.43 long, depressed dorso-ventrally with greatest width at cephalosome; external segmentations distinct. Cephalosome distinctly articulated from first pedigerous somite, wider than long, 0.55 × 0.80. First to fourth pedigerous somite and urosomites free. Prosome 1.14 long. Genital somite (Fig. 12A, B), 0.23 × 0.35. Abdomen progressively narrower posteriorly, composed of four free somites, 0.23 × 0.28, 0.20 × 0.24, 0.16 × 0.20, and 0.16 × 0.18, respectively. Caudal ramus (Fig. 12A) 3.77 times longer than wide, 0.22 × 0.06, with six setae.

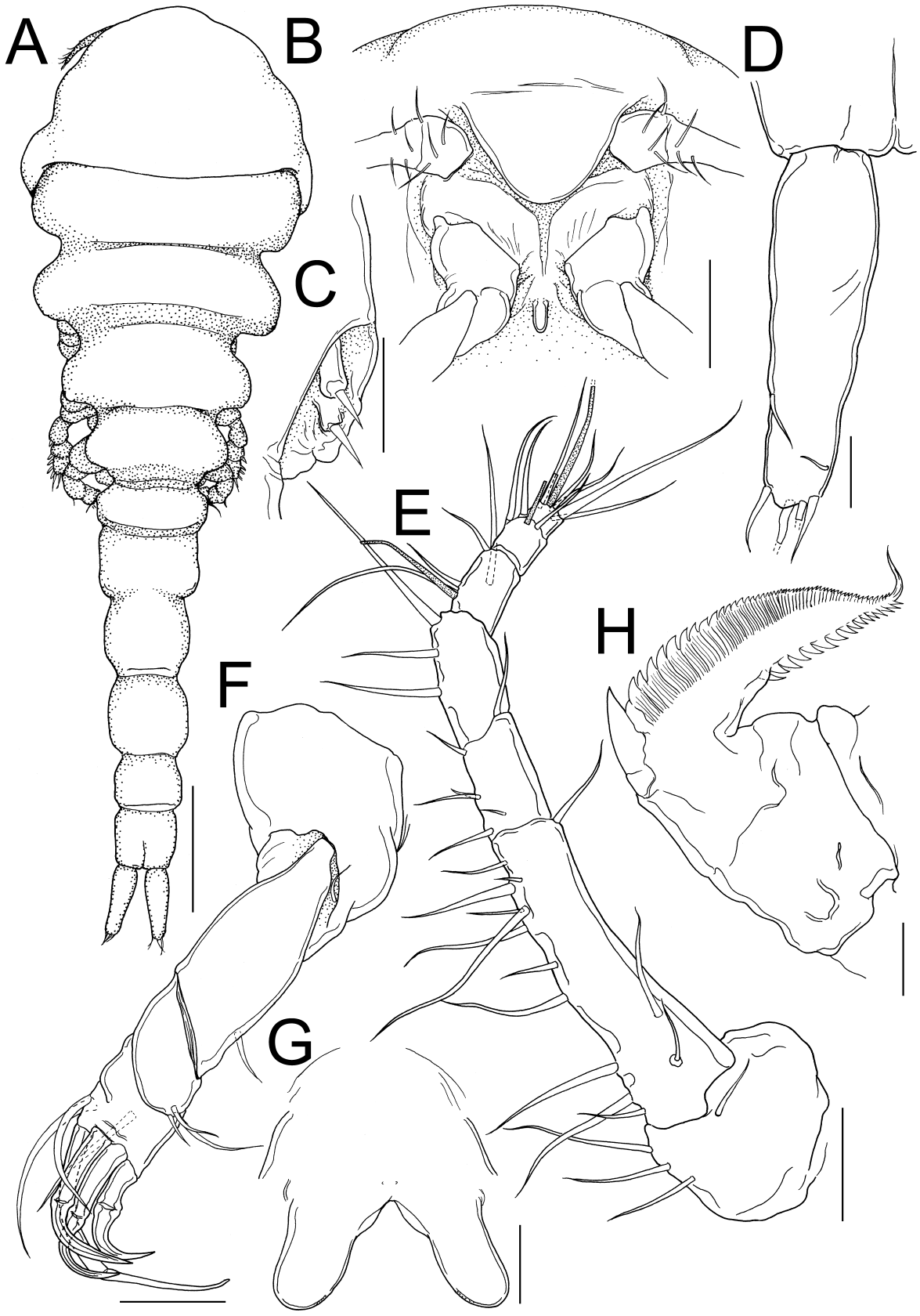

FIGURE 10. *Pseudanthessius imo* **n. sp.**, adult female, holotype NSMT–Cr 24630. A, habitus, dorsal; B, rostral area; C, genital aperture and leg 6, dorsal; D, left caudal ramus, dorsal; E, right antennule; F, right antenna, anterior; G, labrum, anterior; H, left mandible, anterior. Scale bars: A, 400 μm; B, 100 μm; C, D, F, G, 50 μm; E, 40 μm; H, 20 μm.

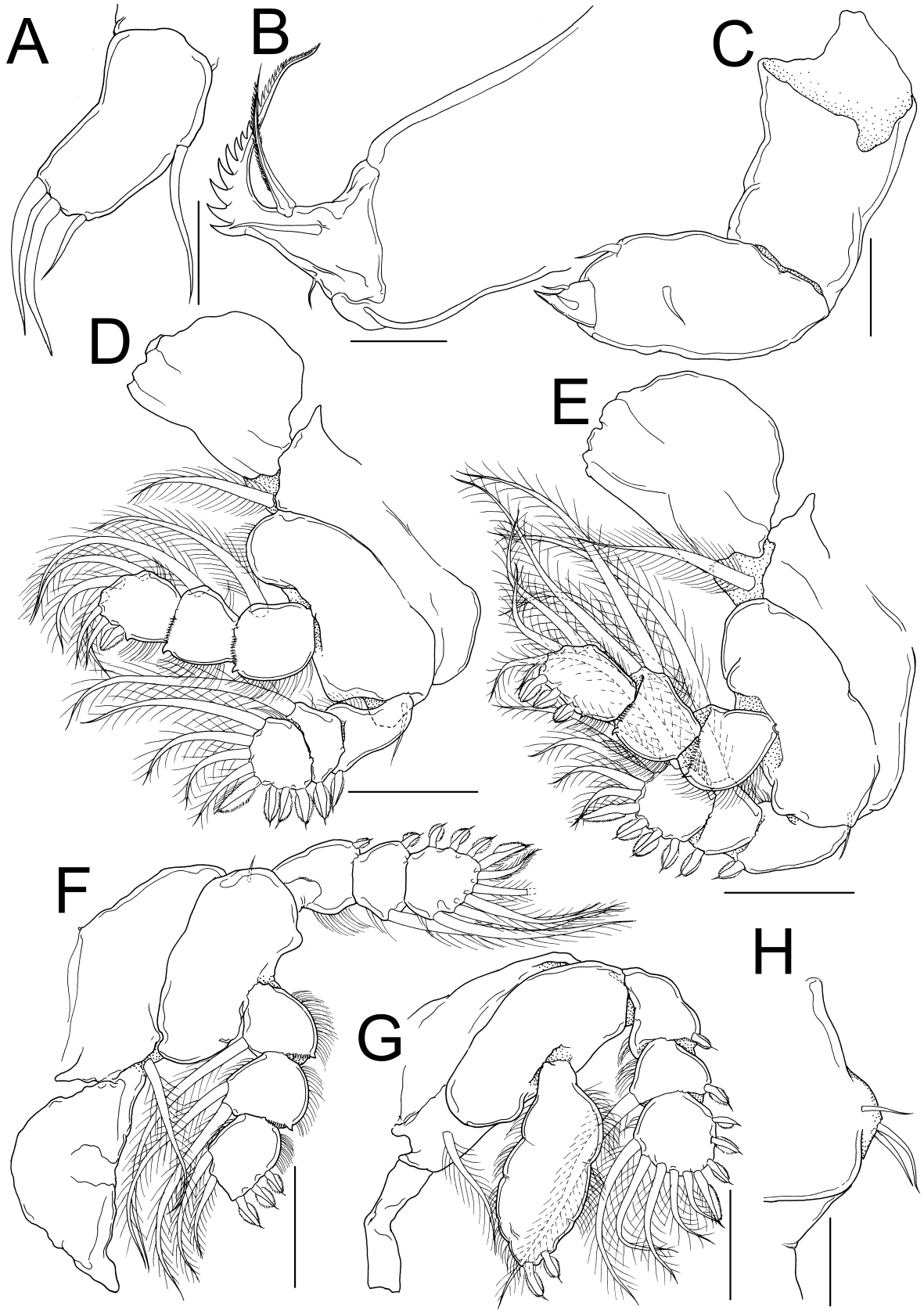

FIGURE 11. *Pseudanthessius imo* **n. sp.**, adult female, holotype NSMT–Cr 24630. A, right maxillule, anterior; B, right maxilla, posterior; C, right maxilliped, posterior; D, left leg 1, anterior; E, left leg 2, anterior; F, left leg 3, anterior; G, left leg 4, anterior; H, right leg 5, dorsal. Scale bars: A, 20 μm; B, C, 40 μm; D–G, 100 μm; H, 50 μm.

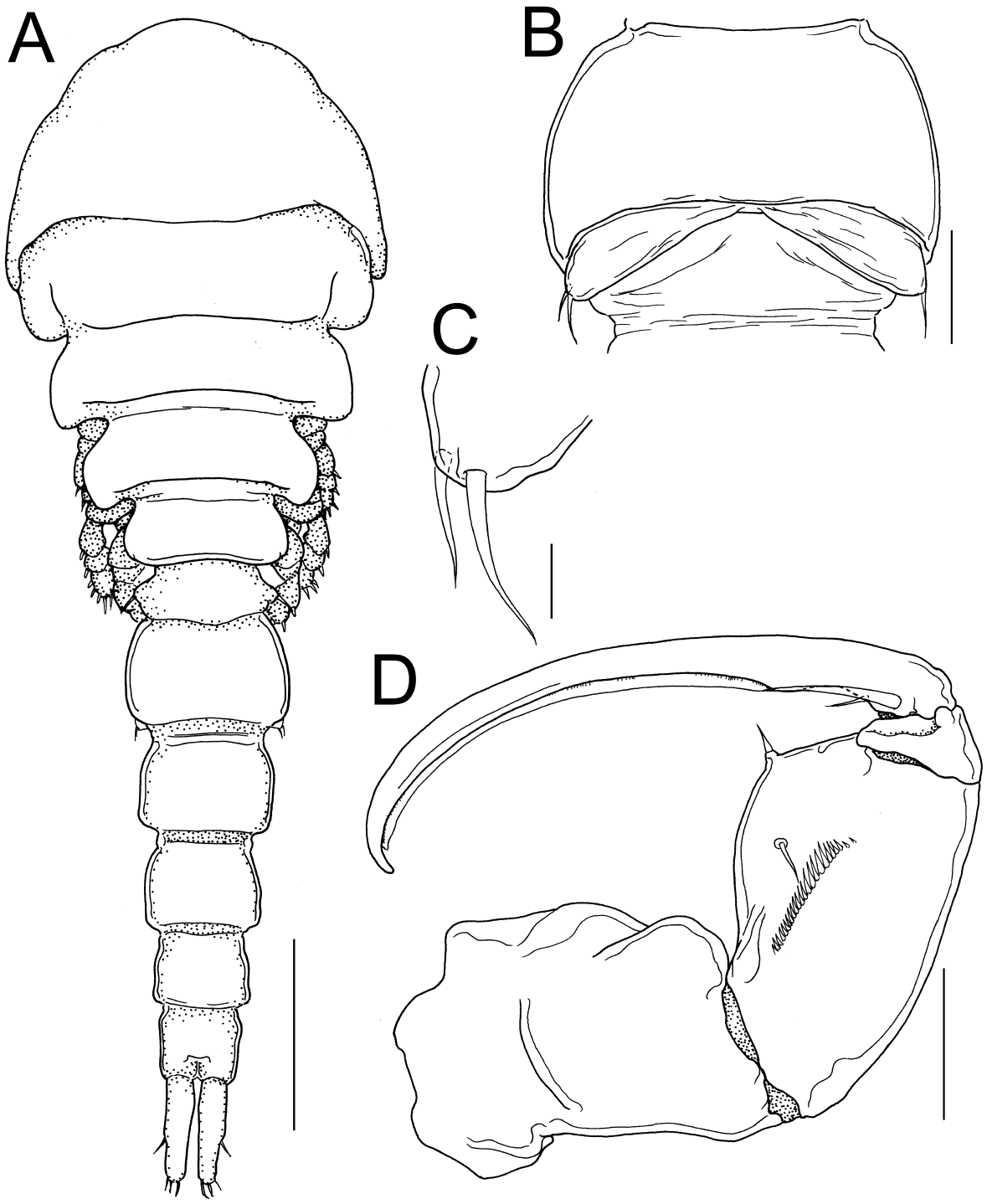

FIGURE 12. *Pseudanthessius imo* **n. sp.**, adult male, allotype NSMT–Cr 2463. A, habitus, dorsal; B, genital somite, ventral; C, right leg 6, ventral; D, left maxilliped, inner. Scale bars: A, 400 μm; B, 100 μm; C, 20 μm; D, 40 μm.

Antennule, antenna, mandible, maxillule, and maxilla as in female. Antenna bearing third endopodal segment 1.48 times longer than wide, 57 × 38 μm. Maxilliped (Fig. 12D) 4-segmented; basal segment unarmed; second segment bearing two setae and row of fine spinules; third segment small without armature; terminal claw curved bearing two basal setae. Armature formula of legs 1 to 5 as in female. Leg 6 (Fig. 12B, C) represented by two simple setae on genital operculum.

Variability. Morphology of paratypes and other female specimens as in holotype. Measurements of the paratypes and other specimens (n = 3) as follows: body length 2.08–2.51 (2.31 ± 0.22); cephalosome length

0.58–0.65 (0.63 ± 0.04); cephalosome width 0.82–0.98 (0.90 ± 0.08); prosome length 1.05–1.33 (1.23 ± 0.15); genital double somite length 0.30–0.36 (0.33 ± 0.03); genital double somite width 0.29–0.37 (0.34 ± 0.04); first urosomite length 0.15–0.21 (0.19 ± 0.04); first urosomite width 0.27–0.30 (0.29 ± 0.02); second urosomite length 0.12–0.17 (0.14 ± 0.03); second urosomite width 0.22–0.28 (0.25 ± 0.03); anal somite length 0.17–0.19 (0.18 ± 0.01); anal somite width 0.20–0.23 (0.22 ± 0.01); caudal ramus length 0.21–0.26 (0.24 ± 0.02); caudal ramus width 0.07; length of third endopodal segment of antenna 57–74 (65 ± 8) μm; width of third endopodal segment of antenna 38–61 (46 ± 13) μm. Caudal ramus 3.00–3.56 (3.35 ± 0.31) times longer than wide. Third endopodal segment of antenna 1.21–1.65 (1.46 ± 0.23) times longer than wide.

Morphology of paratypes and other male specimens as in allotype. Measurements of male paratypes and additional specimens (n = 3) as follows: body length 2.08–2.30 (2.15 ± 0.13); cephalosome length 0.51–0.63 (0.58 ± 0.06); cephalosome width 0.68–0.85 (0.75 ± 0.09); prosome length 0.96–1.14 (1.03 ± 0.10); genital somite length 0.18–0.26 (0.22 ± 0.04); genital somite width 0.31–0.43 (0.37 ± 0.06); first urosomite length 0.17; first urosomite width 0.25–0.31 (0.28 ± 0.03); second urosomite length 0.18–0.20 (0.19 ± 0.01); second urosomite width 0.23–0.28 (0.25 ± 0.02); third urosomite length 0.13–0.16 (0.14 ± 0.02); third urosomite width 0.18–0.23 (0.20 ± 0.03); anal somite length 0.12–0.15 (0.14 ± 0.01); anal somite width 0.17–0.19 (0.18 ± 0.01); caudal ramus length 0.18–0.24 (0.21 ± 0.03); caudal ramus width 0.06–0.07 (0.07 ± 0.00); length of third endopodal segment of antenna 49–71 (61 ± 11) μm; width of third endopodal segment of antenna 36–42 (38 ± 3) μm. Caudal ramus 2.74–3.69 (3.24 ± 0.48) times longer than wide. Third endopodal segment of antenna 1.33–1.73 (1.59 ± 0.22) times longer than wide.

Remarks. *Pseudanthessius imo* **n. sp.** has four spines on the third exopodal segment of leg 4, a character shared with *P. spinosus* Shin & Kim, 2004 (Shin & Kim, 2004). The new species differs from *P. spinosus* by having the following characters: caudal ramus 2.5 to 4 times longer than wide (vs. less than 2 times); presence of post-rostral process between bases of antenna (vs. process absent); third endopodal segment of antenna less than 2 times longer than wide, with four claws and three setae (vs. about 3 times longer than wide, bearing two claws, one claw-like seta, and three setae); bearing mandible with single hyaline tooth on convex margin (vs. with four small spinules); leg 4 bearing unsegmented endopod with sinuous both lateral margins (vs. with straight margins and two conical distal processes) (see Shin & Kim, 2004).

Attachment site. Mantle cavity.

Etymology. The specific name means "sweet potato" in Japanese. It alludes to shape of the irregularly constricted endopod of leg 4. The name is used as a noun in apposition.

Newly established Japanese name for species. *Imo-ashi-kenmijinko*.

Discussion

Panaietis was established by Stebbing (1900) based on *P. incamerata* collected from an unidentified gastropod in Papua New Guinea. The second species, *P. malleolata*, was originally described by Sars (1918) as *Conchocheres malleolatus* from *Cuspidaria obesa* (Lovén, 1846) (as *Neaera obesa*) (Bivalvia: Anomalodesmata: Cuspidariidae) caught off the western coast of Norway, and was later transferred to its current genus (Monod & Dollfus 1932). Subsequently, *P. haliotis* was described from *Haliotis gigantea* Gmelin (Vestigastropoda: Haliotidae) [as *Haliotis* (*Sulculus*) *gigantea*] from the Pacific coast of Japan (Yamaguti, 1936). Yamaguti (1936) also redescribed *P. incamerata* based on specimens of both sexes collected from *Turbo cornutus* Lightfoot [as *Turbo* (*Batillus*) *cornutus*] in Japanese waters, but Izawa (1976) mentioned that this copepod was not conspecific with *P. incamerata* and described it as *P. yamagutii*, based on newly collected specimens from Japanese waters. A total of six species are now recognized in the genus, including *P. doraconis* **n. sp.** and *P. satsuma* **n. sp**. described from *Tectus* spp. in the present study. All these species were found from molluscs, and the hosts of five of these species are vestigastropods (e.g., Sars 1918; Yamaguti 1936; Izawa 1976; Ho 1981; present study).

Since the establishment of the genus *Pseudanthessius*, based on *P. gracilis* Claus, 1889, numerous species have been described (e.g., Stock et al. 1964; Humes & Ho 1970). Although Humes & Stock (1973) enumerated 34 species as valid within the genus, Humes (1977) later established two genera (*Mecomerinx* Humes, 1977 and *Senariellus* Humes, 1977) and transferred species into each of them. Another 16 species have been subsequently added to the genus, and currently the total has increased to 46 species (Humes 1972, 1977, 1978, 1997; Stock 1995;

Stock & Humes 1995; Kim 2000, 2007, 2009, 2014; Shin & Kim 2004; present study). Species of *Pseudanthessius* have been found on various hosts (e.g., Turbellaria, Nemertea, Bivalvia, Polychaeta) but the major hosts are echinoderms belonging to the Crinoidea, Asteroidea, Ophiuroidea, Echinoidea, and Holothuroidea (e.g., Humes & Stock 1973). Three species are known from molluscan hosts, *P. gracilis*, *P. thorellii* (Brady & Robertson, 1875), and *P. dimorphus* Stock, 1995 but they are known to be restricted to the Bivalvia (Humes & Stock 1973; Stock 1995). Thus the discovery of *P. imo* **n. sp.** on *Tectus niloticus* represents the first record of a species of *Pseudanthessius* from a gastropod mollusc.

In this study, part of the copepod fauna utilizing the rich diversity of marine gastropods distributed around the Ryukyu Islands and southern Kyushu was revealed. Although the author examined both *Tectus pyramis* and *T. conus*, hosts of *Panaietis doraconis* **n. sp.** and *P. satsuma* **n. sp.**, off Kochi prefecture, Shikoku, western Japan, no copepods have been found. Further surveys to reveal the geographic distribution ranges of these copepods are required because gastropods are known to be widely distributed in the Indo-Pacific.

Acknowledgements

The author thanks Dr. Yoshihisa Fujita (Okinawa Prefectural University of Arts), Mr. Isamu Nakayoshi, and Ms. Arisa Izeki (Kumejima Fishery Cooperative), Mr. Sadao Yokoyama (Diver's Lodge Orenchi), Dr. Takuma Fujii and Ms. Midori Matsuoka (Kagoshima University), Dr. Tohru Naruse and Dr. James Davis Reimer (University of the Ryukyus), Mr, Masayoshi Kondo (Okinawa Institute of Science and Underwater Technology), Mrs. Hiroko Uyeno and Mr. Tomohiro Yoshida (The Kagoshima University Museum) for help with sampling, and Dr. Kunihiko Izawa (Izawa Marine Biological Laboratory) for providing valuable references. Finally, the author greatly thanks Prof. Geoff A. Boxshall (Natural History Museum) for his curating work on specimens registered in the crustacean collection of NHMUK and for his kind pre-review of the manuscript. Part of this work was supported by JSPS KAKENHI Grant Number JP15H06517, the "Kume Island Project" funded by the Mitsui & Co. Ltd. Environment Fund, and the "Establishment of Research and Education Network on Biodiversity and Its Conservation in the Satsunan Islands" project of Kagoshima University adopted by the Ministry of Education, Culture, Sports, Science and Technology, Japan.

References

Boxshall, G.A. & Halsey, S.H. (2004) *An Introduction to Copepod Diversity*. The Ray Society, London, 966 pp.

Ho, J.-S. (1981) Parasitic Copepoda of gastropods from the Sea of Japan. *Report of the Sado Marine Biological Station, Niigata University*, 11, 23–41.

Humes, A.G. (1972) *Pseudanthessius comanthi* n. sp. (Copepoda, Cyclopoida) associated with a crinoid at Eniwetok Atoll. *Pacific Science*, 26, 373–380.

Humes, A.G. (1977) Pseudanthessiid copepods (Cyclopoida) associated with crinoids and echinoids (Echinodermata) in the tropical western Pacific Ocean. *Smithsonian Contributions to Zoology*, 243, 1–43. http://dx.doi.org/10.5479/si.00810282.243

Humes, A.G. (1978) A new cyclopoid copepod, *Pseudanthessius limatus*, associated with an ophiuroid in Panama (Atlantic side). *Proceedings of the Biological Society of Washington*, 91, 242–249.

Humes, A.G. (1997) *Pseudanthessius newmanae*, new species (Copepoda: Poecilostomatoida: Pseudanthessiidae) from marine turbellarians in Australia. *Memoirs of the Queensland Museum*, 42, 227–231.

Humes, A.G. & Gooding, R.U. (1964) A method for studying the external anatomy of copepods. *Crustaceana*, 6, 238–240. http://dx.doi.org/10.1163/156854064X00650

Humes, A.G. & Ho, J.-S. (1970) Cyclopoid copepods of the genus *Pseudanthessius* associated with crinoids in Madagascar. *Smithsonian Contributions to Zoology*, 54, 1–20. http://dx.doi.org/10.5479/si.00810282.54

Humes, A.G. & Stock, J.H. (1973) A revision of the family Lichomolgidae Kossman, 1877, cyclopoid copepods mainly associated with marine invertebrates. *Smithsonian Contributions to Zoology*, 127, 1–368. http://dx.doi.org/10.5479/si.00810282.127

Izawa, K. (1976) Two new parasitic copepods (Cyclopoida: Myicolidae) from Japanese gastropod molluscs. *Publications of the Seto Marine Biological Laboratory*, 23, 213–227.

Kim, I.-H. (2000) Poecilostomatoid copepods from an intertidal mud flat in the Yellow Sea. *Journal of Natural History*, 34, 367–432.

http://dx.doi.org/10.1080/002229300299543
Kim, I.-H. (2007) Copepods (Crustacea) associated with marine invertebrates from the Moluccas. *Korean Journal of Systematic Zoology*, Special Issue 6, 1–126.
Kim, I.-H. (2009) Poecilostome copepods (Crustacea: Cyclopoida) associated with marine invertebrates from tropical waters. *The Korean Journal of Systematic Zoology*, Special Issue 7, 1–90.
http://dx.doi.org/10.5635/KJSZ.2009.25.1.001
Kim, I.-H. (2014) Six new species of Copepoda (Clausiidae, Pseudanthessiidae, Polyankyliidae) associated with polychaetes from Korea. *Journal of Species Research*, 3, 95–122.
http://dx.doi.org/10.12651/JSR.2014.3.2.095
Monod, T. (1934) Notes on the bionomics of *Trochus niloticus* Linn. 3. Sur un Copépode parasite de *Trochus niloticus*. *Records of the Indian Museum*, 36, 213–218.
Monod, T. & Dollfus, R.P. (1932) Les copépodes parasites de mollusques. *Annales de Parasitologie Humaine et Comparée*, 10, 129–204.
Monod, T. & Dollfus, R.P. (1934) Des Copépodes parasites de mollusques (deuxième supplément). *Annales de Parasitologie Humaine et Comparée*, 12, 309–321.
Palomares, M.L.D. & Pauly, D. (Eds.) (2015) SeaLifeBase. Available from: http:// www.sealifebase.org/ (accessed 27December 2015)
Poutires, J.M. (1998) Gastropods. *In*: Carpenter, K.E. & Niem, V.H. (Eds.), *FAO Species Identification Guide for Fishery Purposes. The Living Marine Resources of the Western Central Pacific. Vol. 1. Seaweeds, corals, bivalves and gastropods*. FAO, Rome, pp. 363–648.
Sars, G.O. (1918) Copepoda Cyclopoida. Parts XIII & XIV. Lichomolgidae (concluded), Oncaeidae, Corycaeidae, Ergasilidae, Clausiidae, Eunicicolidae, Supplement. *An Account of the Crustacea of Norway, with short descriptions and figures of all the species. Bergen Museum, Bergen*, 6, 173–225.
Stebbing, T.R.R. (1900) On Crustacea brought by Dr. Willey from the South Seas, *Zoological Results Based on Material from New Britain, New Guinea, Loyalty Islands and Elsewhere Collected during the Years 1895, 1896 and 1897*, 5, 605–690.
Shin, S. & Kim, I.-H. (2004) *Pseudanthessius spinosus*, a new species of Copepoda (Poecilostomatoida, Pseudanthessiidae) associated with the echinoid *Clypeaster japonicus* from Korea. *Korean Journal of Biological Sciences*, 8, 13–18.
http://dx.doi.org/10.1080/12265071.2004.9647728
Stock, J.H. (1995) Copepoda Poecilostomatoida associated with Bivalvia from New Guinea. *Hydrobiologia*, 312, 37–45.
http://dx.doi.org/10.1007/BF00018885
Stock, J.H. & Humes, A.G. (1995) Copepoda associated with Echinoidea from the West Indies. *Studies on the Natural History of the Caribbean Region*, 72, 25–46.
Stock, J.H., Humes, A.G. & Gooding, R.U. (1964) Copepoda associated with West Indian invertebrates. IV. The genera *Octopicola*, *Pseudanthessius* and *Meomicola* (Cyclopoida, Lichomolgidae). *Studies on the Fauna of Curaçao*, 18, 1–74.
Uyeno, D. & Nagasawa, K. (2012a) Four new species of splanchnotrophid copepods (Poecilostomatoida) parasitic on doridacean nudibranchs (Gastropoda, Opisthobranchia) from Japan, with proposition of one new genus. *ZooKeys*, 247, 1–29.
http://dx.doi.org/10.3897/zookeys.247.3698
Uyeno, D. & Nagasawa, K. (2012b) New species of the copepod genus *Anthessius* Della Valle, 1880 (Poecilostomatoida: Anthessiidae) from *Turbo marmoratus* Linnaeus (Gastropoda: Turbinidae) collected during the KUMEJIMA 2009 Expedition. *Zootaxa*, 3367, 60–68.
Yamaguti, S. (1936) 6. Parasitic copepods from mollusks of Japan, I. *Japanese Journal of Zoology*, 7, 113–127.