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Two New Species and a Further Country Record of the Caridean Shrimp Genus *Periclimenaeus* Borradaile, 1915 from Korea (Decapoda: Palaemonidae)

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Two new species of the palaemonid genus *Periclimenaeus* are described and illustrated from Korea; additionally, a third species is recorded from Korea for the first time. *Periclimenaeus karantina* sp. nov. was obtained from ascidian hosts. The species has a denticulate dactylus on both second pereiopods, considered to be typical for ascidian associates. It can be separated from related species by the combination of the following characters: the carpocerite overreaching the anterior margin of the scaphocerite; the distolateral tooth of the scaphocerite exceeding the anterior margin of the lamella; the dactylus of the minor chela exceeding the fixed finger; and the ambulatory dactyli furnished with a minute proximal tooth. *Periclimenaeus apomonosi* sp. nov. was obtained from sponge hosts, and belongs to the *P. robustus* species-group, on account of the developed anterior median lobe on the tergite of the first abdominal somite. It can be distinguished from related species by the combination of the presence of a supraorbital tooth; the presence of a pointed process on the inferior orbital angle; the distolateral tooth of the scaphocerite terminating level with the anterior margin of the lamella; the antennal carpocerite reaching about 0.6 of the scaphocerite; the first and second chelae with non-serrated cutting edges; the ischium and merus of the second pereiopods harbouring tubercles on the ventral margin; and the ambulatory dactyli with a distal accessory tooth and the corpus furnished with denticles, ventrally. The sponge associated species, *Periclimenaeus djboutensis*, relatively widespread across the Indo-Pacific, is reported for the first time from Korea in Geomundo Island. Asides from a morphological description of all three species, molecular information of two genetic markers (16S + *COI*) is provided to aid in future phylogenetic reconstructions of the genus.

Key words: Caridea, *Periclimenaeus* spp. nov., Jejudo Island, Korea, Indo-West Pacific.

BACKGROUND

Periclimenaeus Borradaile, 1915 is the fourth most species rich genus in the family Palaemonidae, with 83 species currently recorded from tropical to temperate waters (De Grave and Fransen 2011; Bruce 2013 2014a b c; Ramos-Tafur and Lemaitre 2017; Park et al. 2019a). The genus is near-cosmopolitan in distribution, with 65 species reported from the Indo-West Pacific, three species from the eastern Pacific, 14 species from the western Atlantic and one species from the eastern Atlantic.

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Although the host identity for many species remains unknown, the majority of species are known to dwell inside various sponges or ascidians, which are assumed to be excellent shelters from predators and even a source of food to the shrimps (Ďuriš et al. 2011b; Bruce 2013). Although a few species have been reported on cnidarians (*e.g.*, *P. gorgonidarum* (Balss, 1913); *P. tchesunovi* Ďuriš, 1990; *P. zarenkovi* Ďuriš, 1990), these are considered incidental associations (Ďuriš 1990; Marin 2012; Park et al. 2019a). *Periclimenaeus* has a well-developed snapping claw on the major second chela, characterized by the presence of a strong molar process on the dactylus and an opposing deep fossa on the fixed finger (Bruce 2012b). Only three species within the genus, *P. denticulodigitus* Bruce, 2014, *P. gorgonidarum*, and *P. parkeri* Bruce, 2012b, have this molar-fossa system on both second chelipeds. The structure of the minor second chela can be used to distinguish between the ascidian and sponge dwelling species. Most ascidian associated species have serrated cutting edge on the dactylus of the minor second chela, whereas sponge associates tend to have entire cutting edges. However, four sponge dwelling species are known to have serrated cutting edge: *P. fawatu* Bruce, 2006; *P. minutus* Holthuis, 1952; *P. schmitti* Holthuis, 1951; *P. spongicola* Holthuis, 1952; this makes the distinction less clear than is generally assumed. All species, for which a host is known either associate with sponges or ascidians, respectively; *Periclimenaeus spongicola* is the only species that has been reported from both host types (Holthuis 1952; Fransen 2006).

The presence of an anterior median lobe on the tergite of the first abdominal somite was used by Bruce (2005b) to establish the *Periclimenaeus robustus* species-group. Although the host affiliation of *P. robustus*, the core species of the group, itself is unknown, the majority of species in the *P. robustus* species-group have been recorded from sponge hosts. Fourteen species, including two Atlantic species, are now considered to be part of this species-group (Bruce 2005b 2011 2012b; Ďuriš et al. 2009 2011a; Ramos-Tafur and Lemaitre 2017), although its phylogenetic status remains to be proven.

In Korea, few studies have focused on the systematics of Palaemonidae, and only one species in the genus, *Periclimenaeus gorgonidarum*, has previously been reported from Korea (Kim and Kim 1985; Park et al. 2019a). During a recent sampling campaign, palaemonid shrimps were targeted in Jejudo Island from 2016 to 2020. During this, two species of *Periclimenaeus* were collected, one associated with an ascidian host and the other with a sponge. Neither species could be positively matched to any of the previously described species in the genus, and are herein described as new to science. In addition, a single specimen of *P. djiboutensis* Bruce, 1970 was discovered in the crustacean collection of Seoul National University, Seoul.

MATERIALS AND METHODS

Study sites and sample collection

Specimens of *Periclimenaeus* were collected together with host specimens by SCUBA diving at depths of 20–45 m around Munseom Islet and Seopseom Islet, Jejudo Island (Fig. 1A, B), on expeditions organized by SNU and NIBR in 2016–2020. (For examples of the diversity of marine species in Munseom and Seopseom Islets, see Cho et al. 2014; Chan et al. 2018; Lutaenko et al. 2019; Lee et al. 2019; Park et al. 2019a b 2020a b). Potential hosts were manually collected and placed in individual plastic bags. Host sponges were dissected along the osculum, whilst ascidians were dissected through the branchial and atrial siphons, with all shrimp specimens removed. Material was deposited into the National Institute of Biological Resources, Incheon and the Zoological Collections of the Oxford University Museum of Natural History, Oxford.

Morphological examination

Specimens were isolated from the host specimens and photographed using a digital camera (D850, Nikon, Japan) with high-definition lenses (Nikon AF-S VR Micro-Nikkor 105 mm f/2.8G IF-ED, Nikon, Japan). All shrimps and their hosts were preserved in 80% EtOH. Morphological characters were observed under stereo (Leica M205C and M125, Leica, Germany) and light microscopes (BX51, Olympus, Japan). Digital illustrations were done using a microscope-mounted digital camera (MC170, Leica, Germany), Helicon focus software (Helicon focus 7.5.6, Ukraine) and a drawing tablet (Wacom Intuos Pro PTH-660, China) with Adobe Illustrator software (Adobe Systems, USA) following Coleman (2006). Postorbital carapace length (in mm) was measured from the postorbital margin to the posterior dorsal margin of the carapace.

Molecular analysis and phylogenetic analysis

Total genomic DNA was extracted from eggs or pleopod tissue of shrimp specimens using the QIAamp® DNA Micro Kit (QIAGEN, Germany) following the manufacturer's instructions. Partial sequences of mitochondrial cytochrome c oxidase subunit I (*COI*)

and 16S rDNA (16S) were amplified using PCR with the primers 16S-ar and 16S-1472 (Crandall and Fitzpatrick 1996; Palumbi et al. 2002) and jgHCO2198 and jgLCO1490 (Geller et al. 2013), respectively. The PCR solution contained 50 ng of template DNA, 1 µM of each primer, distilled deionized water (ddH_2O) and AccuPower® ProFi Taq PCR PreMix (Bioneer, Korea) to a total volume of 20 µL. PCR was performed under the following conditions: 16S— 5 min at 95°C for initial denaturation, followed by 38 cycles of 20 s at 95°C, 30 s at 45°C, and 1 min 68°C and a final extension step at 68°C for 5 min; *COI*— 2.5 min at 94°C for initial denaturation, followed by 40 cycles of 30 s at 90°C, 1 min at 46°C, and 1 min at 72°C and a final extension step at 72°C for 10 min. Purification and Sanger DNA sequencing of PCR products were performed by Macrogen Inc. (Seoul, Korea). Forward and reverse strands of DNA sequences were proofread using Geneious 11.1.5 and visually screened to confirm the sequencing date.

RESULTS

TAXONOMY

Family Palaemonidae Rafinesque, 1815

Genus *Periclimenaeus* Borradaile, 1915

Periclimenaeus karantina sp. nov. Park and De Grave

(Figs. 2–9)

urn:lsid:zoobank.org:act:5157B8FA-51BE-476E-8B98-100D6ABDF592

Material examined: Holotype. 1 male (pocl 3.3); Oct. 22, 2019; Munseom Islet, Jejudo Island (33°13'30"N 126°34'13"E), 21 m, leg. JH Park (NIBRIV0000862971). Paratypes. 1 female (pocl 3.5); Aug. 08, 2016; same location, 20 m, leg. JH Park (NIBRIV0000862966, transferred from SNU KR_JH474); 1 ovig. female, 1 male (pocl 4.1, 3.5); Aug. 16, 2019; Seopseom Islet, Jejudo Island (33°13'44.37"N 126°35'43.74"E), 38 m, leg. JH Park (NIBRIV0000862967-68); 1 female, 1 male (pocl 3.8, 3.5); Aug. 16, 2019; same location, leg. JH Park (OUMNH.ZC.2018-03-027, OUMNH.ZC.2018-03-028); 1 ovig. female, 1 female, 2 males (pocl 4.5, 3.2, 3.4, 2.8); Oct. 21, 2019; same location, depth, leg. JH Park (NIBRIV0000862972-862974, NIBRIV0000877272); 1 juv., 1 ovig. female, 1 male (pocl 1.9, 3.4, 3.1); same data as holotype, leg. JH Park (NIBRIV0000862969-862970, NIBRIV0000877273); 1 ovig. female, 1 female, 2 males (pocl 4.6, 3.5, 3.8,

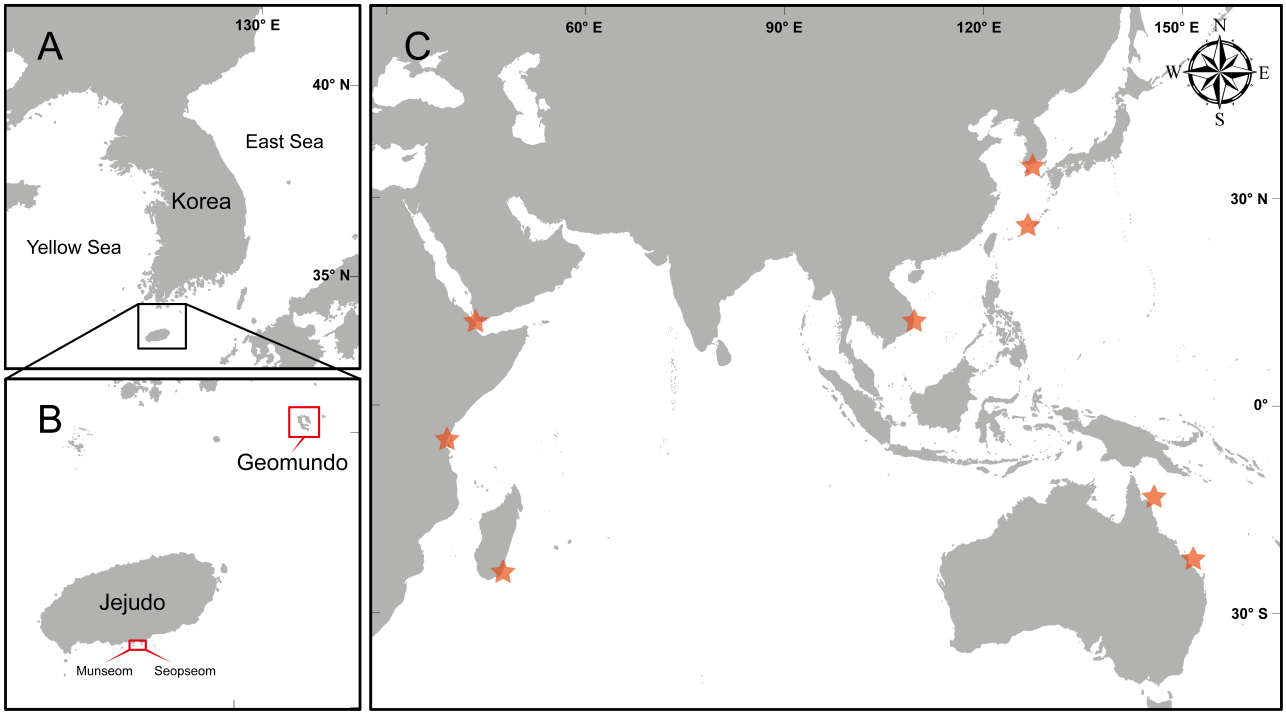

Fig. 1. Map showing (A, B) location of Jejudo Island, the type locality of both *Periclimenaeus karantina* sp. nov. and *P. apomonosi* sp. nov., and Geomundo Island, the collecting locality of *P. djboutensis* Bruce, 1970, and (C) currently known distributional records of *P. djboutensis* in the Indo-West Pacific area.

3.3); Jan. 13, 2020; Munseom Islet Jejudo Island, 32m, leg. JH Park (NIBRIV0000877274-877277); 1 ovig. female, 1 female, 2 males (pocl 4.1, 3.4, 3.7, 2.9); Jan. 14, 2020; same location, 24 m, leg. JH Park (NIBRIV0000877278-877281); 1 ovig. female, 1 male (pocl 4.4, 3.5); Jan. 14, 2020; same location, 24 m, leg. JH Park (NIBRIV0000877282-877283); 1 male (pocl 3.1); Jan. 15, 2020; same location, 21 m, leg. JH Park (JH1108). All collected from a colonial didemnid ascidian *Leptoclinides* sp. (Ascidiacea: Aplousobranchia: Didemnidae) (Fig. 9). GenBank accession numbers for DNA sequences data are presented as table 1.

Description: Body medium-sized, subcylindrical form (Fig. 2).

Rostrum (Figs. 2, 3A) straight, trending

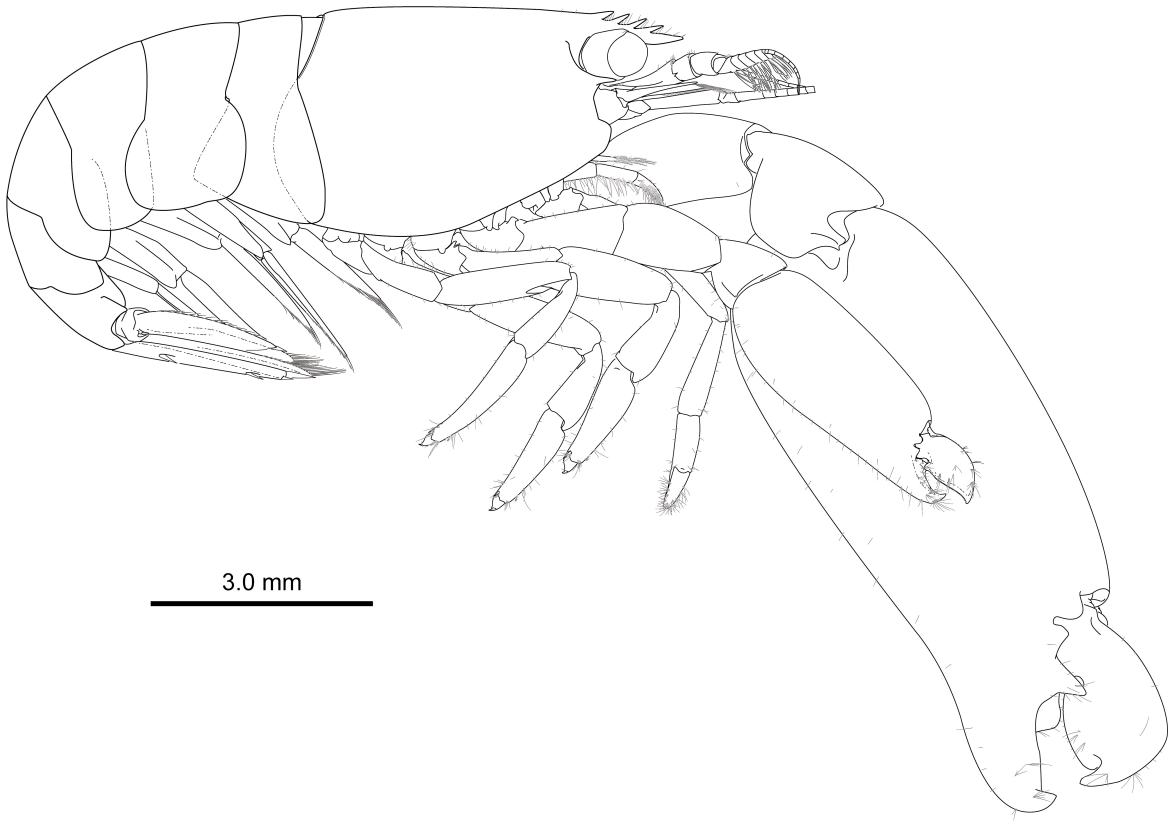

Fig. 2. *Periclimenaeus karantina* sp. nov., holotype, male (pocl 3.3 mm) from Munseom Islet, Jejudo Island, Korea (NIBRIV0000862971): whole body, lateral view.

Table 1. GenBank accession numbers for this study

Voucher number	Species	Status	*COI*	16S
NIBRIV0000862971	*Periclimenaeus karantina* sp. nov.	Holotype	MW149052	MW159109
NIBRIV0000862973	*Periclimenaeus karantina* sp. nov.	Paratype	MW149053	MW159110
NIBRIV0000862974	*Periclimenaeus karantina* sp. nov.	Paratype	MW149054	MW159111
OUMNH.ZC.2018-03-028	*Periclimenaeus karantina* sp. nov.	Paratype	MW149050	MW159107
OUMNH.ZC.2018-03-027	*Periclimenaeus karantina* sp. nov.	Paratype	MW149051	MW159108
NIBRIV0000862976	*Periclimenaeus apomonos*i sp. nov.	Holotype	MW149056	MW159113
NIBRIV0000862975	*Periclimenaeus apomonosi* sp. nov.	Paratype	MW149055	MW159112
OUMNH.ZC.2018-03-029	*Periclimenaeus apomonosi* sp. nov.	Paratype	MW149057	MW159114
N/A	* *Leptoclinides* sp.	Tissue	MW149049	N/A

Used symbols: N/A – not available; * *Leptoclinides* sp. – tissue sample of the host colonial ascidian of *Periclimenaeus karantina* sp. nov. (NIBRIV0000862967).

downwards, about 0.4 of pocl, reaching slightly beyond distal margin of basal segment of antennular peduncle, with 4 equally spaced dorsal teeth, without ventral tooth.

Carapace (Fig. 2) smooth, glabrous, without supraorbital tooth or tubercles, with feeble supraorbital ridges; antennal tooth acute; inferior orbital angle with round blunt process (Fig. 3C); pterygostomial angle produced.

Abdomen (Fig. 2) with smooth pleon, first segment without anteromedian dorsal lobe; pleura broadly rounded, sixth segment about 1.1 times length of fifth, about 0.5 of telson length, posterolateral angle rounded, posteroventral angle acute (Fig. 3D, E).

Telson (Fig. 2) about 0.7 of pocl, about 2 times longer than maximal width (Fig. 3E); two pairs of dorsal spiniform setae, subequal in size, at about 0.3 and 0.8 of telson length respectively, posterior margin with three pairs of spiniform setae, lateral posterior spiniform setae short, about 0.5 of length of intermediate pair, intermediate pair long and stout, submedian pair about 0.8 of intermediate pair length, distally setulose (Fig. 3F).

Eye (Fig. 4A, B) with hemispherical cornea, about 1.5 times longer than maximum dorsal width, about 1.2 times longer than maximum lateral width, nebenauge absent.

Antennule (Fig. 4C) with proximal segment of peduncle bearing acute distolateral tooth, with acute tooth at ventromedial margin (Fig. 4D); stylocerite broad, bearing sharp point, reaching to about 0.5 of proximal segment; intermediate segment short, about 0.3 times of proximal segment length, subequal to distal segment length; upper flagellum biramous, proximal five segments fused, short free ramus with two segments, longer free ramus with seven segment; lower flagellum with fourteen segments, filiform.

Antenna (Fig. 4E) with rounded boss proximally on coxa; basicerite without distoventral tooth, ischiocerite and merocerite unarmed; carpocerite exceeding scaphocerite; scaphocerite about 2.4 times as long as maximal width, distal lamella rounded, exceeding acute distolateral tooth situated at about 0.8 of scaphocerite length.

Mouthparts not dissected. Second maxilliped with normal endopod, exopod, oval epipod without podobranch. Third maxilliped (Fig. 5A) with ultimate segment about 0.5 times as long as antepenultimate segment, tapering distally, with dense tufts of long setae; penultimate segment about 0.6 times antepenultimate segment length, with ventromedial row of long setae; antepenultimate segment with long setae on ventromedial margin; exopod reaching middle of penultimate segment, distally with six plumose setae; coxa with rounded lateral plate, without arthrobranch.

First pereiopod (Figs. 2, 6A) with coxa and basis without special features; ischium about 0.6 of merus length, unarmed; merus subequal to carpus length, unarmed; carpus about 1.2 times as long as chela, tapering proximally; carpo-propodal cleaning brush developed; chela about 0.4 times as long as pocl, about 0.7 times as long as merus length; palm subcylindrical, smooth, non-tuberculate; fingers about 0.9 of palm length, subspatulate, with subterminal group of setae (Fig. 6B), with three terminal teeth, pair of subterminal teeth short, about 0.6 of median tooth length (Fig. 6C).

Second pereiopods (Figs. 2, 7) robust, dissimilar in shape, unequal in size.

Major second pereiopod (Fig. 2) with coxa and basis without special features; ischium about 0.8 of merus length, tapering proximally, unarmed; merus about 0.3 of palm length, with minute tubercles on ventral margin (Fig. 8E, F); carpus about 0.3 of palm length, tapering proximally, unarmed; chela about 1.7 to 2.6 times as long as pocl, about 4.3 times as long as merus length (Fig. 7A); palm subcylindrical, smooth, non-tuberculate; fingers (Fig. 7B) about 0.4 of palm length, distally curved mesially (Fig. 7C), with subterminal group of setae; fixed finger with strong subacute tip, distal cutting edge concave, entire, proximal cutting edge with deep oval fossa, mesial margin with triangular process (Fig. 7B), lateral margin with lower rounded process (Fig. 7A); dactylus with strong subacute tip, distal cutting edge with about 50 small acute teeth (Fig. 7D), proximal cutting edge with large molar process.

Minor second pereiopod (Fig. 2) with coxa and basis without special features; ischium subequal to merus length, tapering proximally, unarmed; merus about 0.4 of palm length, with minute tubercles on ventral margin (Figs. 7E, 8D); chela about 1.2 times as long as pocl, about 0.5 of major chela length, about 3 times as long as merus, with fingers unequal in size; palm subcylindrical, smooth, non-tuberculate; carpus about 0.3 of palm length, tapering proximally, unarmed; fixed finger about 0.7 of dactylus length, with strong subacute tip, cutting edge with long groove extending to 0.9 of fixed finger from apex (Fig. 8A), lateral cutting edge slightly convex, proximal margin with lower rounded process, with denticulate mesial cutting edge (Fig. 8A, C), proximal margin with triangular tuberculate process (Fig. 8A, C); dactylus (Fig. 7F) about one third of palm length, about 2.0 times as long as maximal depth in midlength, exceeding fixed finger, with broadly rounded dorsal margin, tip with blunt tooth continuous with sinuous cutting edge, distally concave, proximally convex, with about 40 small acute teeth, decreasing in size proximally (Fig. 8 A, B), proximal

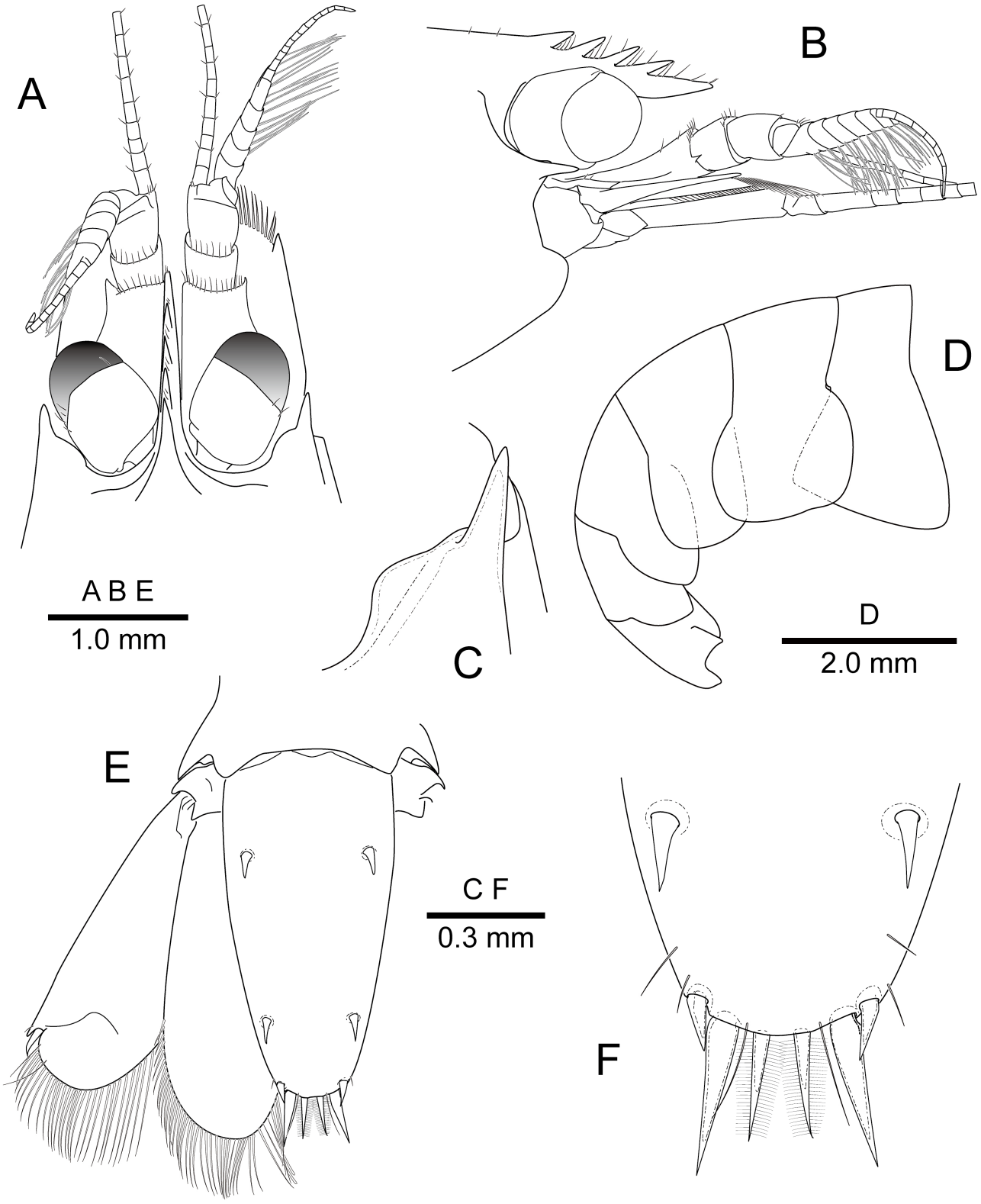

Fig. 3. *Periclimenaeus karantina* sp. nov., holotype, male (pocl 3.3 mm) from Munseom Islet, Jejudo Island, Korea (NIBRIV0000862971). A, frontal region of carapace, dorsal; B, same, lateral; C, inferior orbital angle, dorsal; D, first six abdominal segments, lateral; E, telson and uropod, dorsal; F, posterior margin of telson, dorsal.

cutting edge with right-angular obtuse process fitting to proximal end of occlusal groove on fixed finger (Fig. 8B).

Ambulatory pereiopods (Fig. 2) subequal in shape, third pereiopod strongest, fourth and fifth gradually slightly slender.

Third pereiopod (Fig. 6D) robust, sparsely setose; coxa and basis without special features; ischium about 0.7 of merus length, unarmed; merus about 1.2 of carpus length, unarmed; carpus about 0.9 of propodus length, tapering proximally, unarmed; propodus about 2.9 times longer than maximal depth, tapering distally,

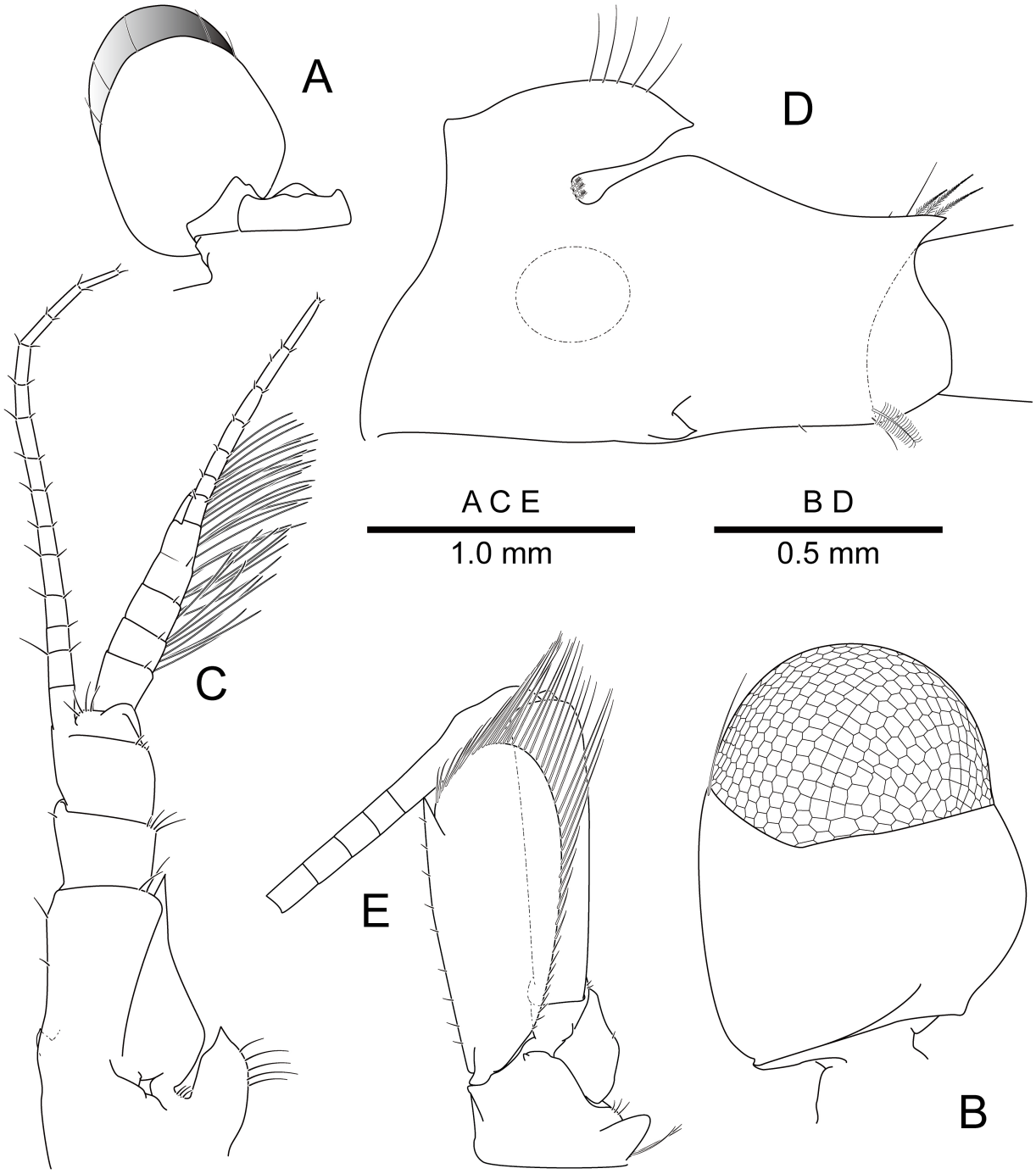

Fig. 4. *Periclimenaeus karantina* sp. nov., holotype, male (pocl 3.3 mm) from Munseom Islet, Jejudo Island, Korea (NIBRIV0000862971). A, eye, dorsal; B, same, lateral; C, antennule, dorsal; D, same, proximal segment of peduncle, ventral; E, antenna, dorsal.

with two or three stout distoventral spiniform setae (Figs. 6E, 8G); dactylus about 0.2 of propodus length, unguis distinctly demarcated, simple, curved, about 0.3 of dorsal corpus length, corpus without distal accessory tooth, slightly convex distally, with minute acute proximal tooth (Figs. 6E, 8G), with sensory setae distolaterally.

Fourth pereiopod (Fig. 6F) robust, sparsely setose; coxa and basis without special features; ischium about 0.8 of merus length, unarmed; merus about 1.2 of carpus length, unarmed; carpus about 0.9 of propodus length, tapering proximally, unarmed; propodus about 3.3 times longer than maximal depth, tapering distally, with pair of stout distoventral spiniform setae (Fig. 6G); dactylus about 0.16 of propodus length, unguis distinctly demarcated, simple, curved, about 0.4 of dorsal corpus length, corpus without distal accessory tooth, slightly convex distally, with minute acute proximal tooth (Fig. 6G), with sensory setae distolaterally.

Fifth pereiopod (Fig. 6H) robust, sparsely setose; coxa and basis without special features; ischium about 0.7 of merus length, unarmed; merus about 1.4 of carpus length, unarmed; carpus about 0.7 of propodus length, tapering proximally, unarmed; propodus about 4.7 times longer than maximal depth, tapering distally, with single stout distoventral spiniform setae, with distoventral setulose setae, with single spiniform setae distomedially (Fig 6I); dactylus about 0.13 of propodus length, unguis distinctly demarcated, simple, curved, about 0.3 of dorsal corpus length, corpus without distal accessory tooth, slightly convex distally, with minute acute proximal tooth (Fig 6I), with sensory setae distolaterally.

Second pleopod of male (Fig. 5B) with endopod with short appendix masculina in relation to appendix interna, with two long terminal setulose setae; appendix interna about 3.0 times as long as appendix masculina (Fig. 5C).

Second pleopod of female with protopod medially with two to four ovigerous setae proximally, two to three distally, proximo-laterally with single seta (Fig. 5D, E).

Uropod (Fig. 3E) reaching to telson tip; exopod slightly shorter than endopod, outer margin entire, with single spiniform setae, curved inward, about 2.3 times longer than acute distolateral tooth.

Variation: All intact 21 adult specimens have the same rostral formula (4/0) except for a single ovigerous specimen (pocl 4.6 mm, 3/0). The general morphology of both sexes is very similar, although the

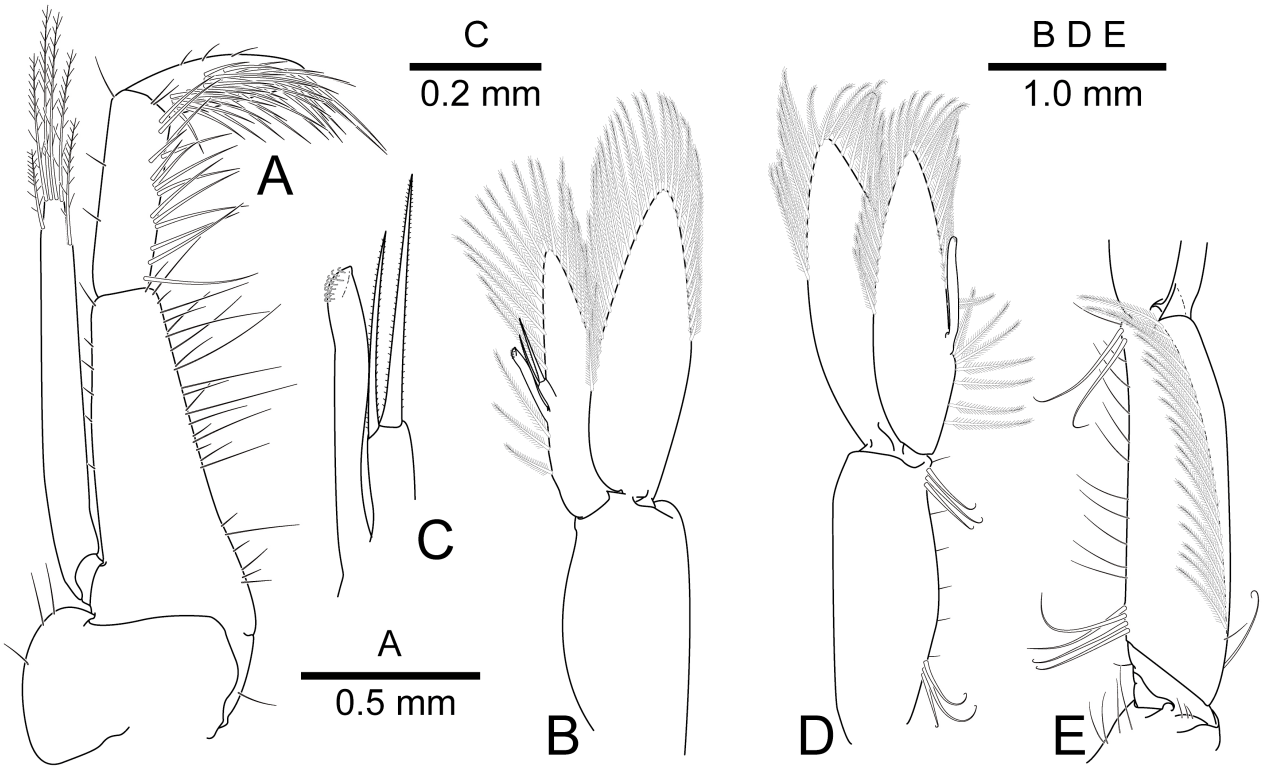

Fig. 5. *Periclimenaeus karantina* sp. nov. A–C, holotype, male (pocl 3.3 mm) from Munseom Islet, Jejudo Island, Korea (NIBRIV0000862971). D, paratype, non-ovigerous female (pocl 3.5 mm) from Seopseom Islet, Jejudo Island, Korea (NIBRIV0000862966). E, paratype, ovigerous female (pocl 4.1 mm) from Munseom Islet, Jejudo Island, Korea (NIBRIV0000877281). A, third maxilliped, lateral; B, second pleopod, lateral; C, same, detail of appendix masculine and appendix interna, lateral; D, second pleopod, mesial; E, same, protopodite, mesial.

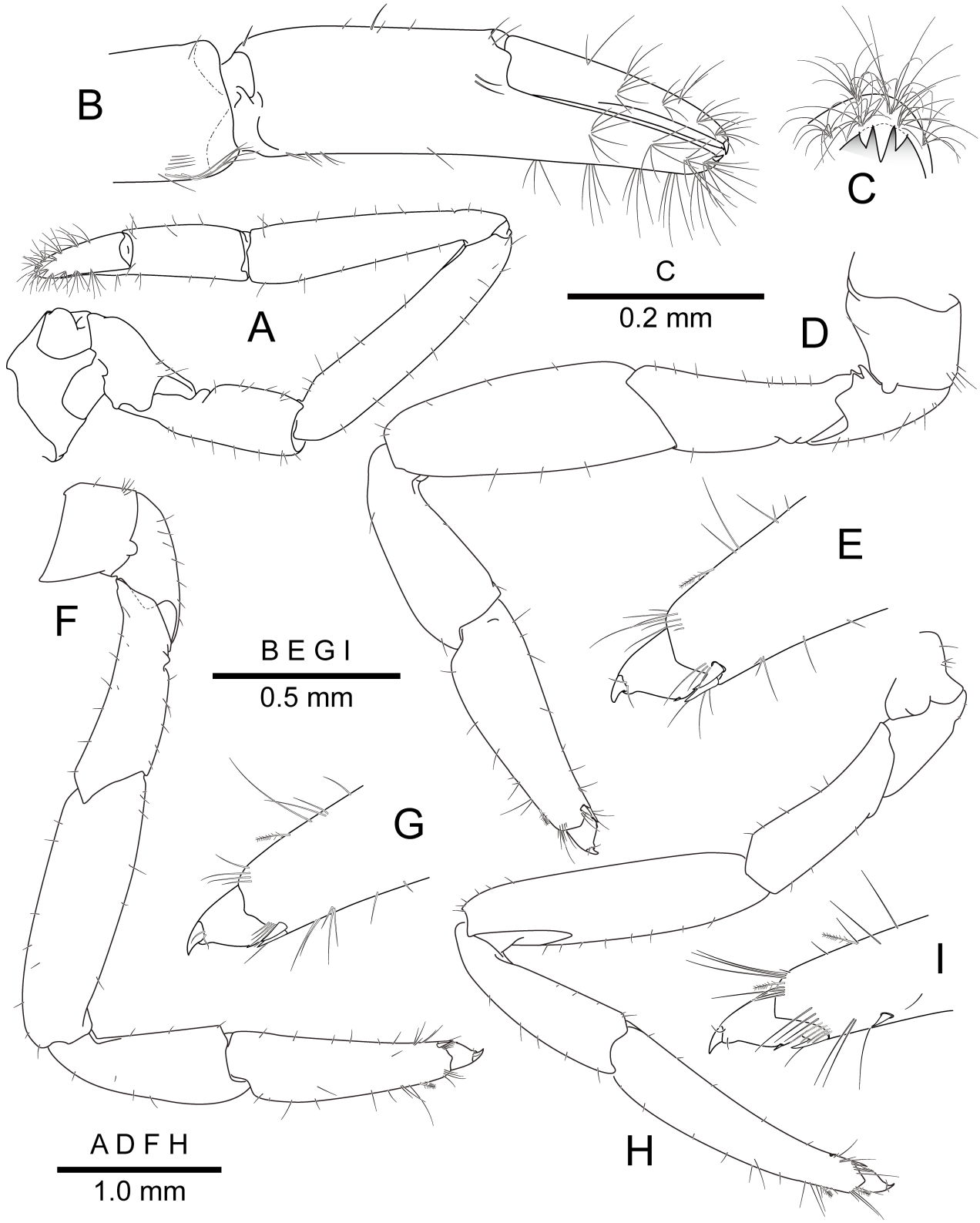

Fig. 6. *Periclimenaeus karantina* sp. nov. A, B, D–I, holotype, male (pocl 3.3 mm) from Munseom Islet, Jejudo Island, Korea (NIBRIV0000862971). C, paratype, ovigerous female (pocl 4.5 mm) from same place (NIBRIV0000862974). A, first pereiopod, lateral; B, same, chela, lateral; C, same, tip of dactylus; D, third pereiopod, lateral; E, same, distal portion of propodus and dactylus, lateral; F, fourth pereiopod, lateral; G, same, distal portion of propodus and dactylus, lateral; H, fifth pereiopod, lateral; I, same, distal portion of propodus and dactylus, lateral.

major second chela is distinctly larger in the relatively smaller male specimens. For example, the major second chela is about 2.6 times as long as the pocl in the holotype male (pocl 3.3 mm) and about 1.7 times in the largest ovigerous female paratype (pocl 4.6 mm). The dentition of the cutting edge of the fixed finger in the minor second chelae varies considerably (Fig. 8A, C) in the number of small teeth, ranging from none to 30 (holotype).

Colouration: Whole body and appendages semi-

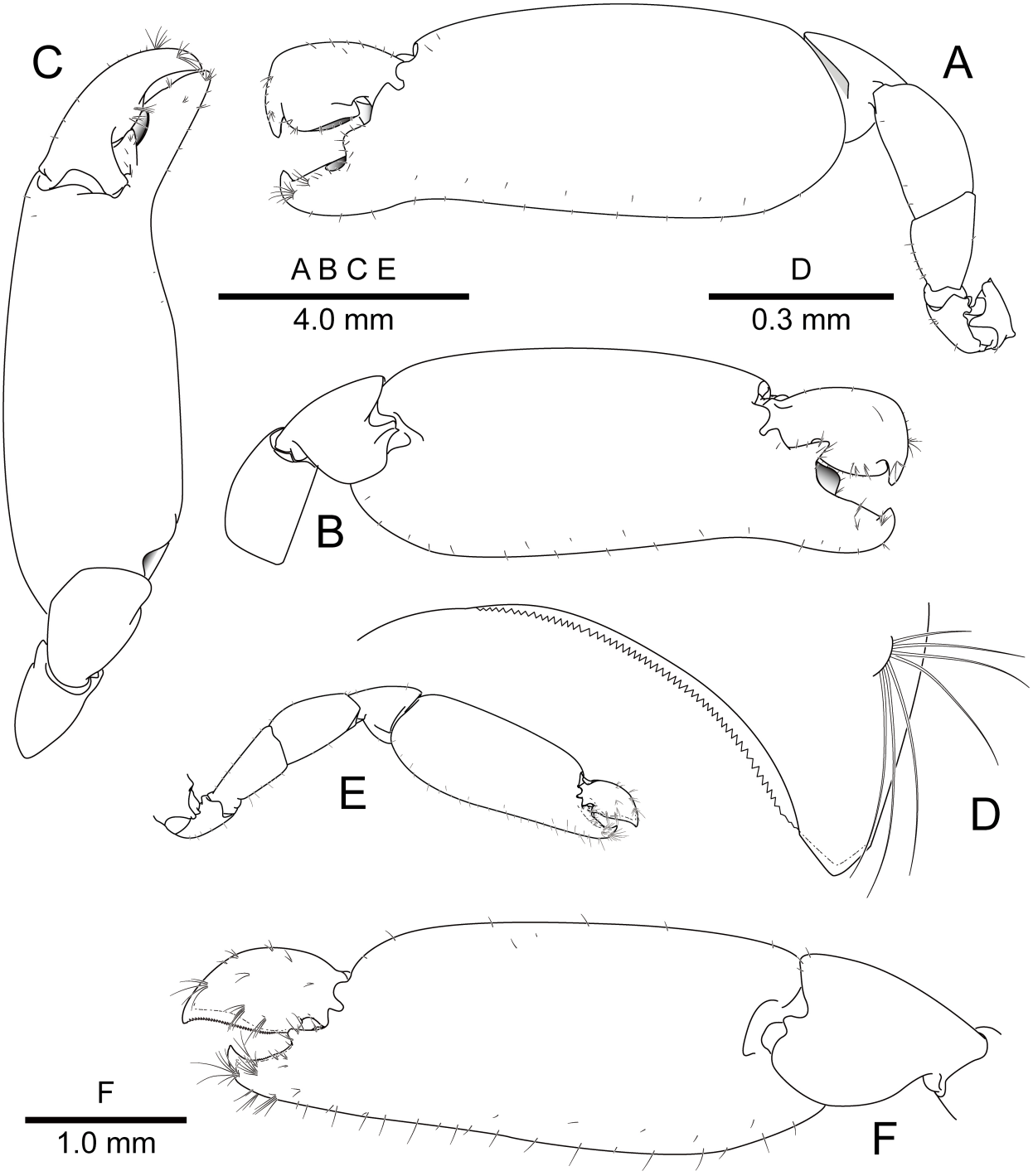

Fig. 7. *Periclimenaeus karantina* sp. nov., holotype, male (pocl 3.3 mm) from Munseom Islet, Jejudo Island, Korea (NIBRIV0000862971). A, major second pereiopod, lateral; B, same, dactylus to merus, mesial; C, same, dorsal; D, same, distal portion of dactylus, lateral; E, minor second pereiopod, lateral; F, same, chela and propodus, mesial.

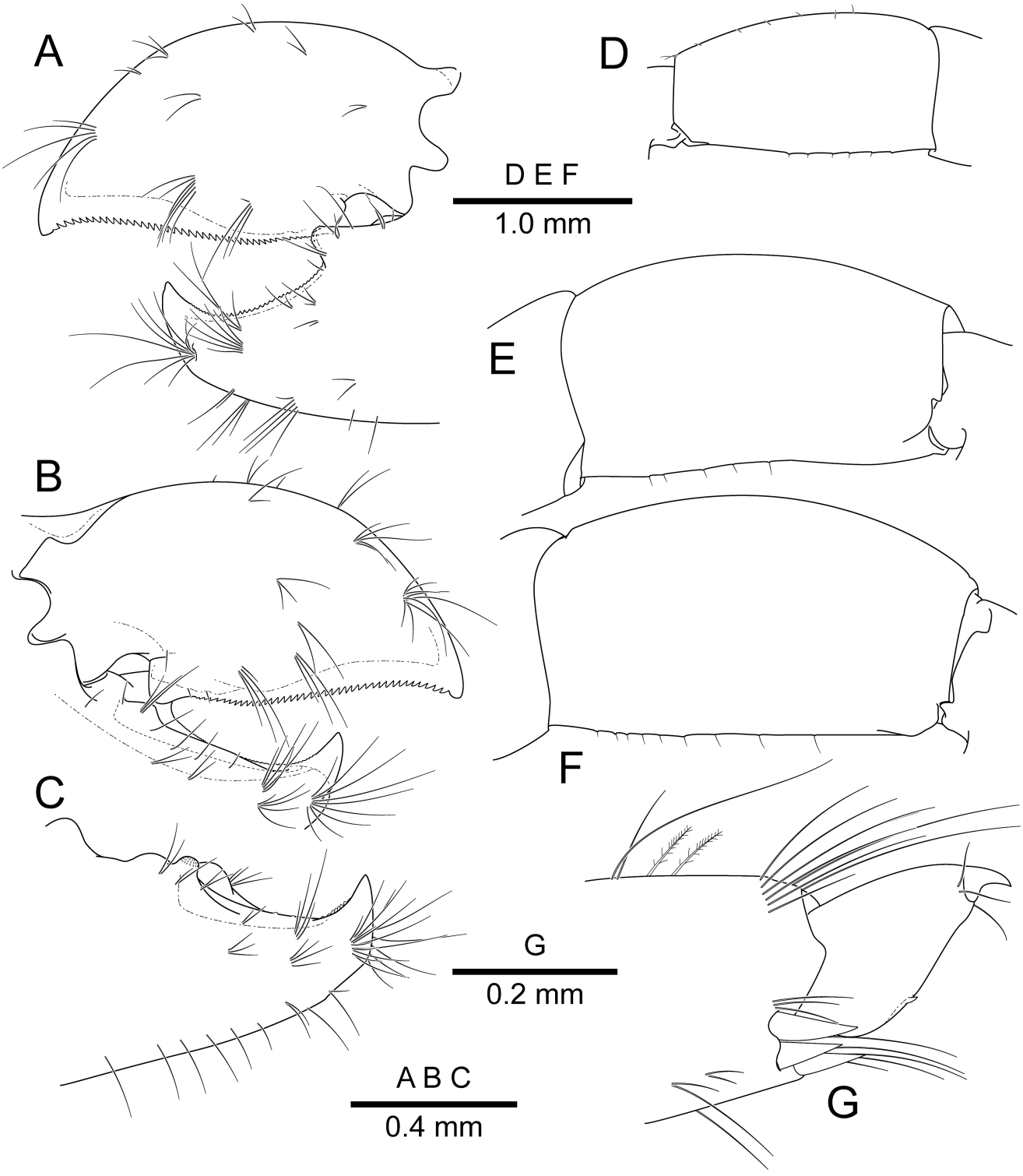

Fig. 8. *Periclimenaeus karantina* sp. nov., A, B, D, E, holotype, male (pocl 3.3 mm) from Munseom Islet, Jejudo Island, Korea (NIBRIV0000862971). C, paratype, ovigerous female (pocl 4.5 mm) from same place (NIBRIV0000862974). F, G, paratype, male (pocl 3.7 mm) from same place NIBRIV0000877280). A, distal portion of minor second chela, mesial; B, same, lateral; C, same, fixed finger, mesial; D, minor second pereiopod merus, mesial; E, F, major second pereiopod merus, mesial; G, distal portion of propodus and dactylus of third pereiopod, lateral.

transparent with a pale orange-cream background colour when alive (Fig. 9A); bright white and orange chromatophores scattered all over body and appendages (Fig. 9A, B).

Etymology: From the Greek karantina (καραντίνα, quarantine), referring to the lifestyle of the new species within the host ascidian species (Fig. 9B). It also alludes to the quarantine of human society due to the coronavirus pandemic (COVID-19), during which time this paper was written. Used as a noun in apposition.

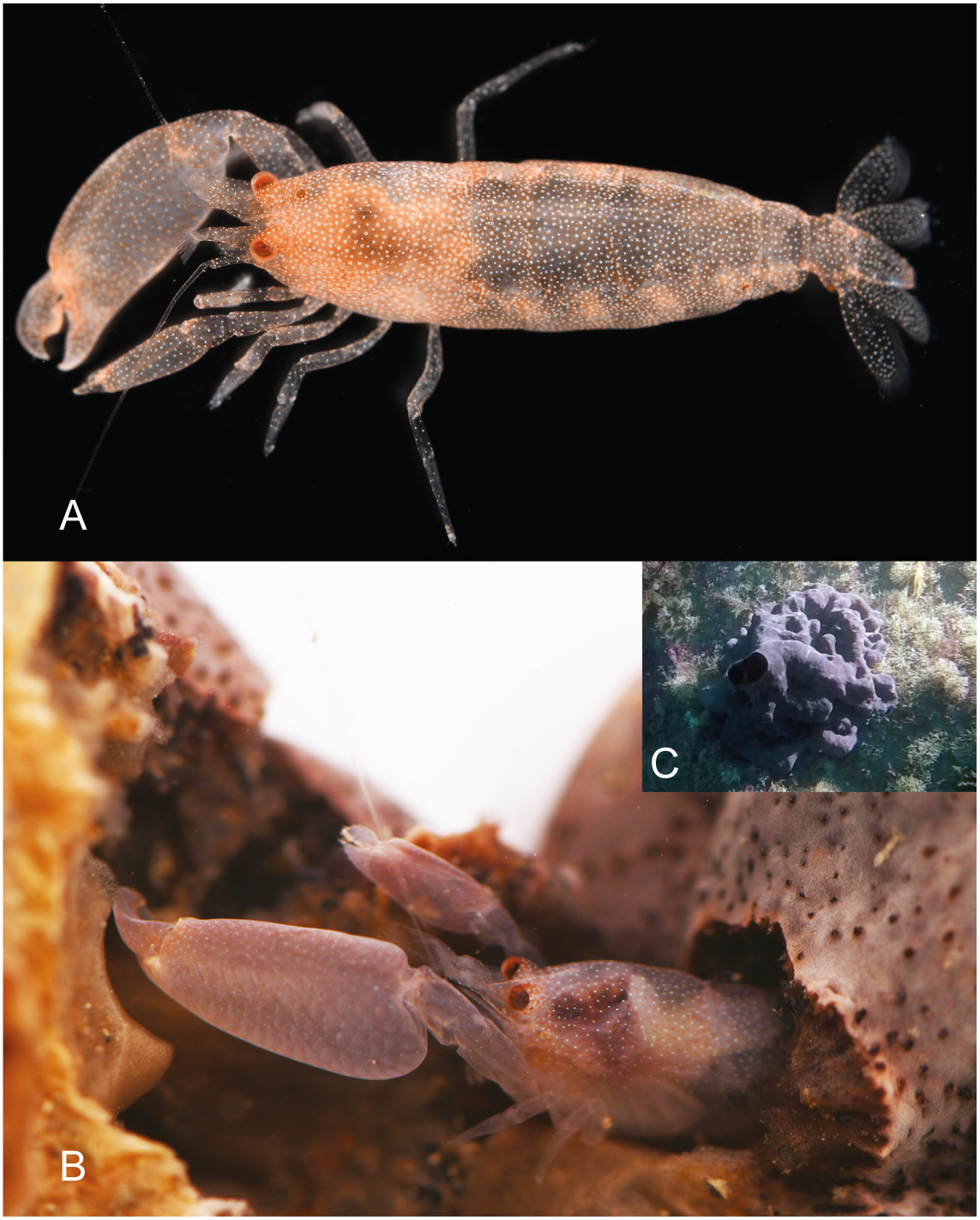

Fig. 9. *Periclimenaeus karantina* sp. nov. and host colonial didemnid ascidian *Leptoclinides* sp. A, paratype, non-ovigerous female, pocl 3.5 mm (NIBRIV0000877272), colour pattern; B, specimen (either OUMNH.ZC.2018-03-027 or 028) in the atrium of host ascidian from Museom Island; C, habitat and host ascidian of a pair of *P. karantina* sp. nov. (NIBRIV0000877282 and 877283) in Seopseom Island. Photographic Credits: JH Park.

Host: The shrimp specimens were found inside the common cloacal system of an colonial didemnid ascidian *Leptoclinides* sp. (Ascidiacea: Aplousobranchia: Didemnidae) (Fig. 9B, C).

Distribution: Presently only known from the type locality in Jejudo Island, Korea (Fig. 1A, B).

Remarks: The species is considered to be typical for ascidian associates due to the presence of a denticulate dactylus on the minor second pereiopod. *Periclimenaeus karantina* sp. nov. appears morphologically close to seven species: *P. colemani* Bruce, 2014, *P. dactylodon* Bruce, 2012a, *P. devaneyi* Bruce, 2010, *P. diplosomatis* Bruce, 1980, *P. kottae* Bruce, 2005a, *P. myora* Bruce, 1998, *P. orbitocarinatus* Fransen, 2006; and possibly *P. zarenkovi* Ďuriš, 1990. All these species share the following characters: 1) first abdominal tergite without anterodorsal medial lobe; 2) major and minor second chela with denticulate cutting edges on dactylus; and 3) the dactyli of the ambulatory pereiopods having a proximal ventral tooth, but no distoventral accessory tooth.

The new species shares with *P. devaneyi*, *P. dactylodon*, *P. kottae* and *P. orbitocarinatus* the presence of median tubercles on the ventral margin on the merus of both second pereiopods. However, *P. devaneyi* can be readily distinguished from the new species by the presence of a large spine on the distoventral angle of the carpus of the ambulatory pereiopods (vs. absent in *P. karantina* sp. nov.). *Periclimenaeus dactylodon* and *P. kottae* can also readily be distinguished from the new species by the presence of the proximal process on the corpus of the dactylus of the third pereiopod (with large rounded boss in *P. kottae* or large triangular basal tooth in *P. dactylodon* vs. with minute proximal tooth in *P. karantina* sp. nov.). *Periclimenaeus orbitocarinatus* clearly differs from the new species by the strongly pronounced postorbital ridge along the anterior margin of the carapace and the antennal carpocerite not overreaching the scaphocerite (vs. with feebly pronounced postorbital ridge and carpocerite overreaching the scaphocerite in *P. karantina* sp. nov.).

Periclimenaeus karantina sp. nov. can also be distinguished from *P. diplosomatis*, *P. myora* and *P. zarenkovi*, on the basis of the dactylus of the minor second pereiopod not exceeding the fixed finger and the ventral margin of the merus of the second pereiopods not being tuberculate (vs. dactylus exceeding fixed finger and tuberculated ventral margin in *P. karantina* sp. nov.). *Periclimenaeus diplosomatis* can be distinguished by the absence of an epipod on the second maxilliped and distolateral tooth of the scaphocerite exceeding anterior margin of the lamella (vs. with epipod and not exceeding in *P. karantina* sp. nov.). The new species also differs from *P. myora* and *P. zarenkovi* in the presence of a long carpocerite which exceeds the anterior margin of the scaphocerite (vs. not exceeding in *P. myora* and *P. zarenkovi*).

Periclimenaeus karantina sp. nov. most closely resembles *P. colemani*, with which it shares the carpocerite of the antenna exceeding the distal margin of the scaphocerite, and the scaphocerite with the lamella exceeding the distolateral tooth. The new species can be distinguished from *P. colemani* on the basis of the combination of the following characters: 1) antennule with rounded distolateral tooth (vs. sharp distolateral tooth in *P. karantina* sp. nov.); 2) dactylus of the minor chela being about 2.8 times greater than the maximal depth (vs. about 2 times in *P. karantina* sp. nov.); 3) dactylus of minor second pereiopod not exceeding fixed finger (vs. exceeding in *P. karantina* sp. nov.); 4) major and minor second pereiopods with cutting edge of dactyli with about 20 and 25 teeth, respectively (vs. with about 50 and 40 teeth in *P. karantina* sp. nov.); 5) fifth pereiopod propodus without distoventral spiniform setae (vs. single stout distoventral and single subdistal spiniform seta in *P. karantina* sp. nov.); 6) non-tuberculate ventral margin of merus of second pereiopods (vs. tuberculate ventral margin in *P. karantina* sp. nov.); 7) sixth pleuron with acutely produced posterolaterally (vs. posterolateral angle rounded in *P. karantina* sp. nov.).

Periclimenaeus apomonosi sp. nov. Park and De Grave

(Figs. 10–15)

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Material examined: Holotype. 1 female (pocl 3.4); Jun. 20, 2018; Munseom Islet, Jejudo Island (33°13'37"N 126°34'8"E), 45m, inside of unidentified sponge host, leg. JH Park (NIBRIV0000862976). Paratypes. 1 female (pocl 2.4); Mar. 31, 2018; same location, 45 m, leg. JH Park (OUMNH.ZC.2018-03-029), 1 male (pocl 2.6); Mar. 31, 2018; same location, 30 m, inside of same unidentified sponge host, leg. JH Park (NIBRIV0000862975). GenBank accession numbers for DNA sequences data are presented in table 1.

Description: Body medium-sized, subcylindrical form (Figs. 10, 15A). Rostrum (Fig. 11B) straight, slightly inclined downwards, about 0.4 of pocl, overreaching end of basal segment of antennular peduncle, 7–8 dorsal teeth along entire length, without ventral tooth.

Carapace (Fig. 11A, B) smooth, glabrous, with small acute supraorbital tooth, with feeble supraorbital ridge; antennal tooth acute; inferior orbital angle with

pointed process (Fig. 11C); pterygostomial angle rounded, not produced anteriorly.

Abdomen smooth (Fig. 11D), first segment with anteromedian dorsal lobe; pleura broadly rounded, sixth segment about 1.2 times length of fifth, about 0.5 of telson length, posterolateral angle sharply pointed, posteroventral angle acute.

Telson (Fig. 11E) about 0.6 of pocl, about 2.2 times longer than maximum width; two pairs of dorsal subequal spiniform setae at about 0.1 and 0.6 of telson length respectively, posterior margin (Fig. 11F) with three pairs of spiniform setae, lateral posterior spiniform setae short, about one third of length of intermediate pair, intermediate pair long and stout, submedian pair about 0.8 of intermediate pair length, setulose.

Eye (Fig. 12A) with hemispherical cornea, about 1.3 times longer than maximum dorsal and lateral width, without nebenauge.

Antennule (Figs. 11A, 12B) with proximal segment of peduncle bearing acute distolateral tooth, with small acute tooth at ventromedial margin; stylocerite bearing sharp point, reaching to about 0.5 of proximal segment; intermediate segment short, about 0.25 times of proximal segment length, subequal in length to distal segment; upper flagellum biramous, proximal five segments fused, short free ramus with three segments, longer free ramus with eleven segments; lower flagellum filiform.

Antenna (Fig. 12C, D) with rounded medial boss proximally; basicerite with distinct teeth distolaterally and distomedially (Fig. 12C), ischiocerite and merocerite unarmed; carpocerite reaching about 0.6 of scaphocerite; scaphocerite about 2.0 times as long as maximum width, rounded distal end of lamella almost in line with distolateral tooth.

Mouthparts not dissected, typical for genus in external observation. Third maxilliped (Fig. 12E) with ultimate segment length about 0.4 times antepenultimate segment, tapering distally, with dense tufts of long setae; penultimate segment length about 0.6 times antepenultimate segment, with ventral row of long setae; antepenultimate segment with long setae on ventromedial margin; exopod reaching 0.9 of antepenultimate segment, with four plumose distal setae; coxa with rounded lateral plate. Arthrobranch absent.

First pereiopod (Figs. 10, 13A) with coxa and basis without special features; ischium about 0.7 of merus length, unarmed; merus about 1.2 times as long as carpus length, unarmed; carpus about 1.1 times as

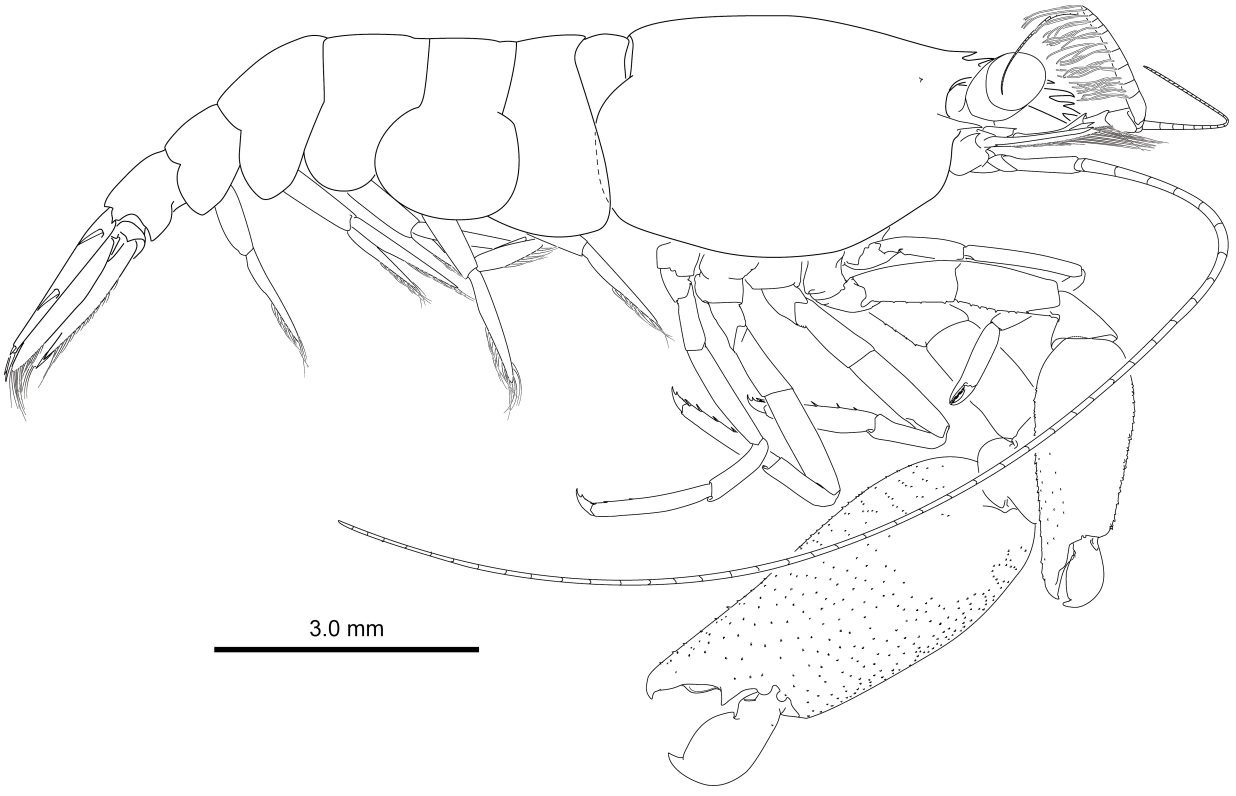

Fig. 10. *Periclimenaeus apomonosi* sp. nov., lateral aspect. Holotype, non-ovigerous female (pocl 3.4 mm) from Munseom Islet, Jejudo Island, Korea (NIBRIV0000862976).

long as chela length; carpo-propodal cleaning setae developed; chela about 0.3 times as long as pocl; palm subcylindrical, smooth, non-tuberculate; fingers (Fig. 13B) similar in shape, about 0.4 of palm length, with group of setae, subspatulate, with elongate apices of fingers, cutting edges medial, entire.

Second pereiopods (Figs. 10, 13C, E) robust, dissimilar in shape, unequal in size.

Major second pereiopod (Figs. 10, 13C) with coxa and basis without special features; ischium subequal to merus length, tuberculate ventrally; merus about 0.4 of palm length, tuberculate ventrally; carpus one third of palm length, tapering proximally, unarmed; chela (Fig. 13D) about 1.4 times as long as pocl, about 3.4 times as long as merus length; palm subcylindrical, tuberculate; fingers unequal in size, slightly curved mesially; fixed finger with strong subacute tip, distal cutting edge entire, proximal cutting edge with deep oval fossa,

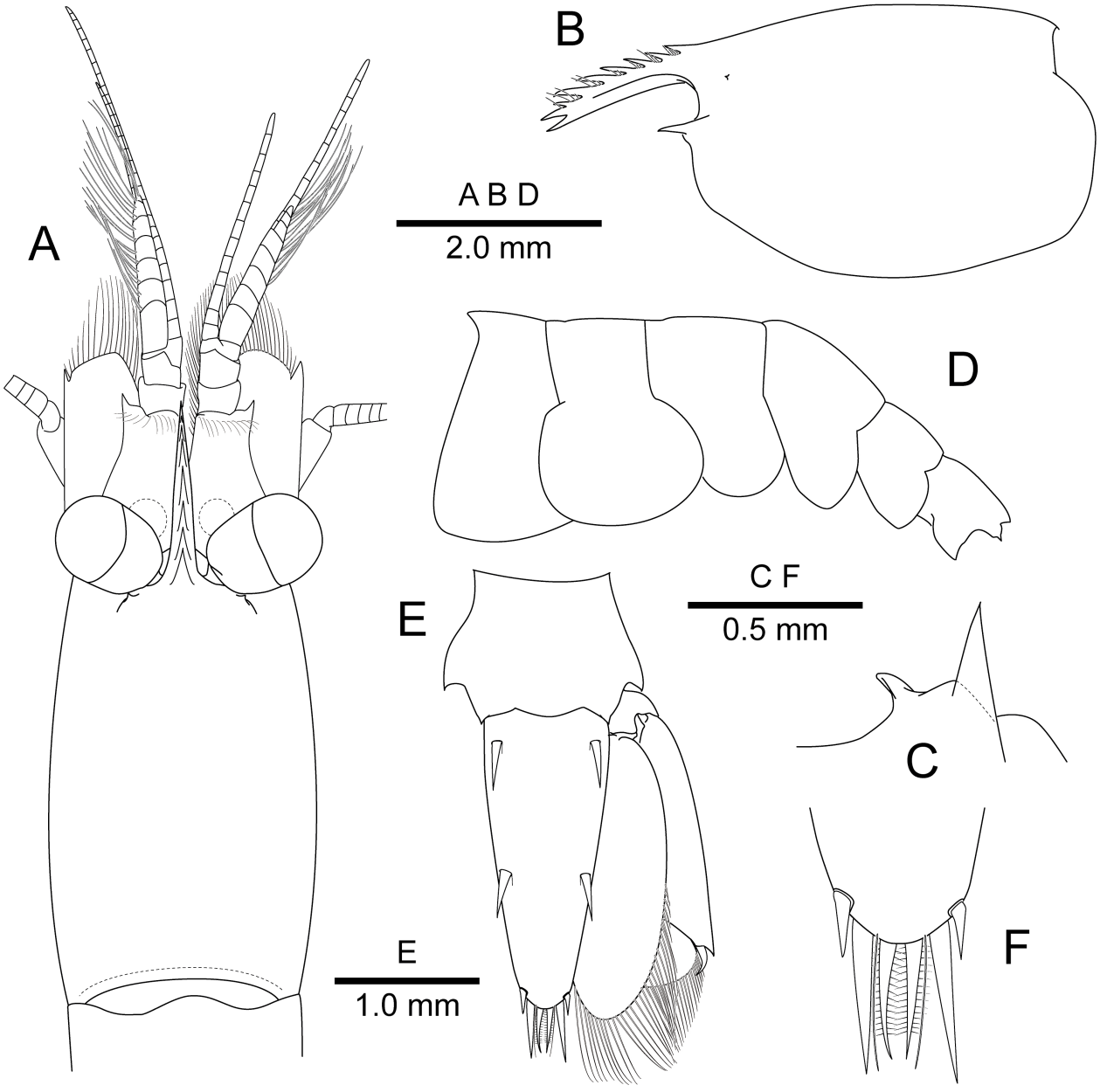

Fig. 11. *Periclimenaeus apomonosi* sp. nov. A, paratype, male (pocl 2.6 mm) from Jejudo Island, Korea (NIBRIV0000862975). B–F, holotype, non-ovigerous female (pocl 3.59 mm) from same place (NIBRIV0000862976). A, Carapace with appendages and first abdominal tergite, dorsal; B, carapace, lateral; C, inferior orbital angle, dorsal; D, first six abdominal segments, lateral; E, sixth abdominal segment, telson and uropod, dorsal; F, posterior end of telson, dorsal.

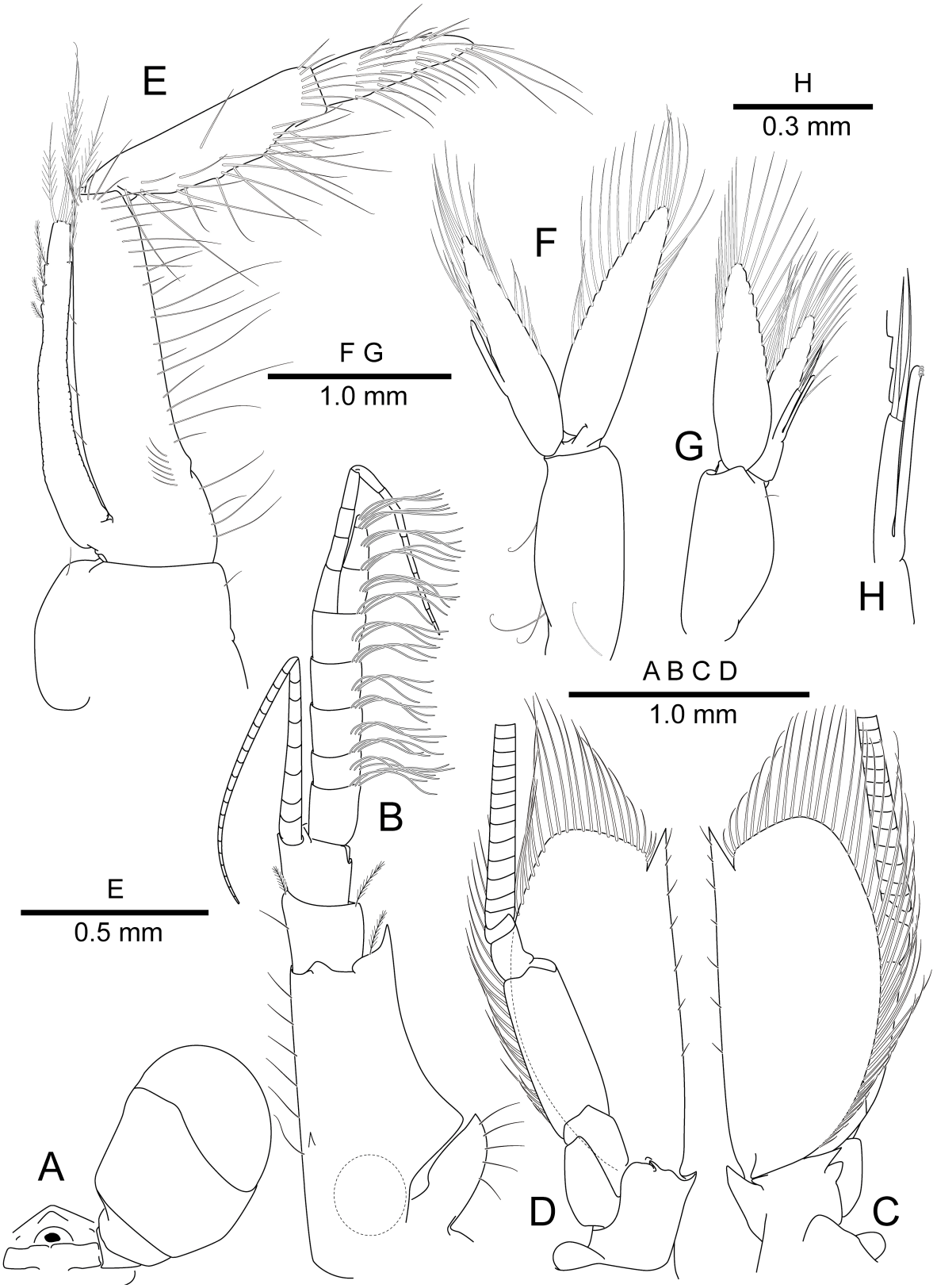

Fig. 12. *Periclimenaeus apomonosi* sp. nov. A–E, holotype, non-ovigerous female (pocl 3.4 mm) from same place (NIBRIV0000862976). G, H, paratype, male (pocl 2.6 mm) from Jejudo Island, Korea (NIBRIV0000862975). A, eye, dorsal; B, antennule, ventral; C, antenna, dorsal; D, same, ventral; E, third maxilliped, lateral; F, second pleopod, mesial; G, same lateral; H, appendix masculine and appendix interna, lateral.

mesial margin with triangular process; dactylus slightly exceeding fixed finger, about 0.4 of palm length, with strong subacute tip, distal cutting edge entire, proximal cutting edge with large molar process.

Minor second pereiopod (Figs. 10, 13E) with coxa and basis without special features; ischium subequal to merus length, tuberculate ventrally; merus about 0.5 of palm length, tuberculate ventrally; carpus about 0.3

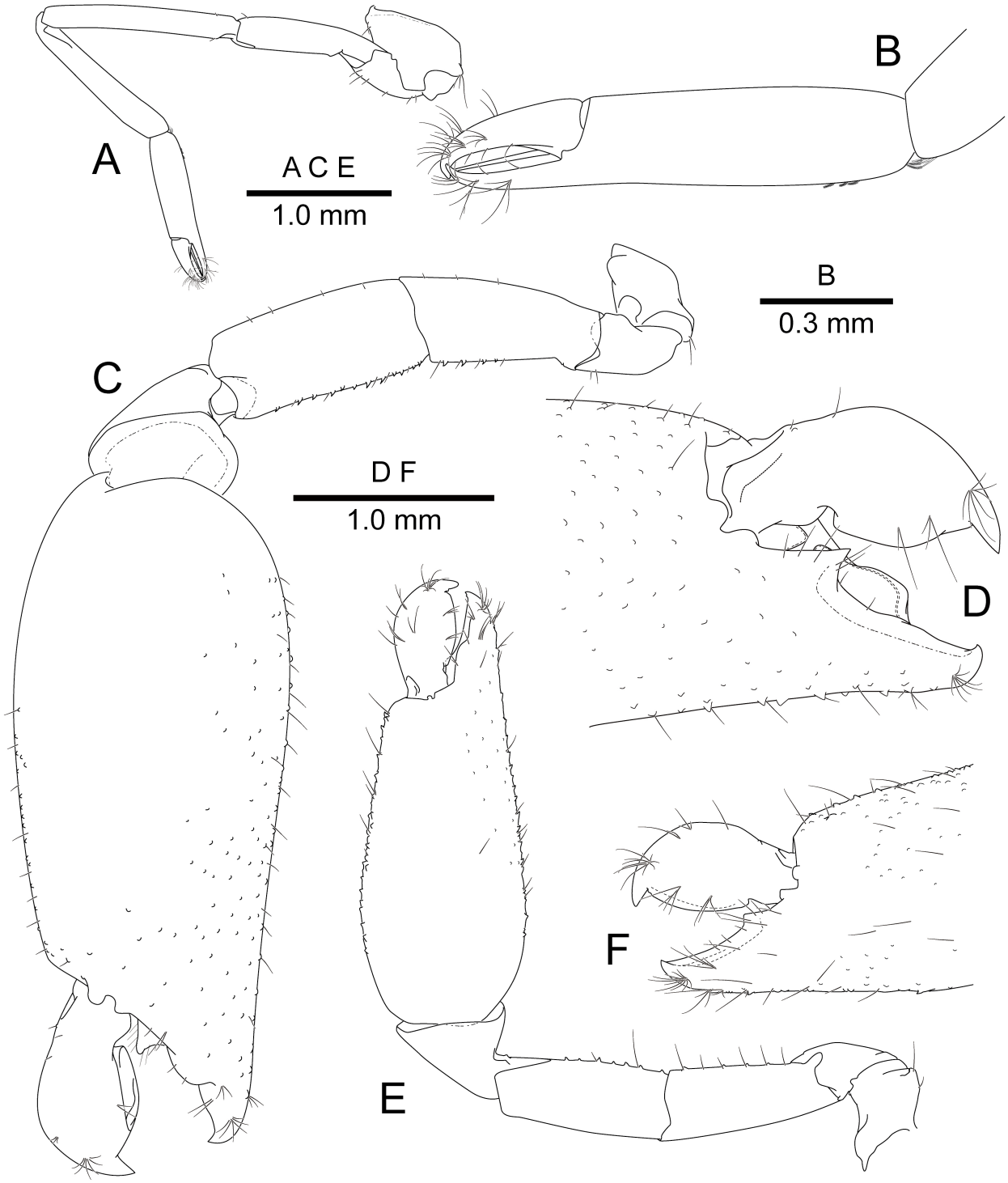

Fig. 13. *Periclimenaeus apomonosi* sp. nov., holotype, non-ovigerous female (pocl 3.4 mm) from Jejudo Island, Korea (NIBRIV0000862976). A, first pereiopod, lateral; B, same, chela and distal carpus, lateral; C, major second pereiopod, lateral; D, same, distal palm and fingers, mesial; E, right minor second pereiopod, mesial; F, same, distal palm and fingers, lateral.

of palm length, tapering proximally, unarmed; chela (Fig. 13F) about 0.85 times as long as pocl, about 0.6 of major chela length, about 2.6 times as long as merus; palm subcylindrical, tuberculate; fingers unequal in size; fixed finger about 0.85 of dactylus length, with strong subacute tip, cutting edge with groove extending to 0.9 of fixed finger, cutting edge slightly concave, proximal margin with lower triangular process; dactylus about one third of palm length, about 1.7 times as long as maximal depth, slightly exceeding fixed finger, with broadly rounded dorsal margin, tip with large tooth, cutting edge entire, convex, proximal cutting edge angular.

Ambulatory pereiopods subequal (Figs. 10, 14) in shape, fifth pereiopod slightly more slender than third and fourth.

Third pereiopod (Fig. 14A, B) with coxa and basis without special features; ischium about 0.8 of merus length, unarmed; merus about 1.5 of carpus length, unarmed; carpus about 0.7 of propodus length, unarmed; propodus about 4.6 times as long as maximal depth, sparsely setose, with pair of stout distoventral spiniform setae, five or six spiniform setae along whole ventral border; dactylus about 0.2 of propodus length, biunguiculate; unguis demarcated, curved, corpus compressed, tapering distally, dorsal margin slightly convex, ventral margin slightly concave with distinct acute distal accessory tooth about 0.4 of unguis length, distal two thirds with five acute denticles, sensory setae distolaterally.

Fourth pereiopod (Fig. 14C, D) with coxa and basis without special features; ischium about 0.7 of merus length, unarmed; merus about 1.5 of carpus length, unarmed; carpus about 0.7 of propodus length, unarmed; propodus about 5.5 times as long as maximal depth, sparsely setose, with pair of stout distoventral spiniform setae, five spiniform setae on ventral border; dactylus about 0.2 of propodus length, biunguiculate; unguis demarcated, curved, corpus compressed, tapering distally, dorsal margin slightly convex, ventral margin slightly concave with distinct acute distal accessory tooth, distal two thirds with four acute denticles, sensory setae distolaterally.

Fifth pereiopod (Fig. 14E, F) with coxa and basis without special features; ischium about 0.6 of merus length, unarmed; merus about 1.3 of carpus length, unarmed; carpus about 0.7 of propodus length, unarmed; propodus about 7.6 times as long as maximal depth, with two rows of distolateral setae, with single stout distoventral spiniform setae, two spiniform setae distomedially; dactylus about 0.2 of propodus length, biunguiculate; unguis demarcated, curved, corpus compressed, tapering distally, dorsal margin slightly convex, ventral margin slightly concave with distinct acute distal accessory tooth, with five acute denticles, sensory setae distolaterally.

Second pleopod of male (Fig. 12G) with endopod with long appendix masculina in relation to appendix interna, with two long terminal setulose setae; appendix interna about 1.3 times longer than appendix masculina (Fig. 12H).

Second pleopod of female (Fig. 12F) with endopod with appendix interna, protopod medially two ovigerous setae proximally, one distally, laterally with single seta proximally.

Uropodal exopod (Fig. 11E) shorter than endopod, outer margin entire, slightly convex, with single spiniform setae, curved inward, about 2.0 times as long as acute distolateral tooth.

Variation: The general morphology is very similar between both sexes, even in the relative sizes of the major and minor second chela.

Host: The specimens were collected from an unidentified sponge (Fig. 15B).

Etymology: From the Greek apomonosi (απομόνωση, isolation and seclusion), referring to the lifestyle of the new species within the host sponge species. It also alludes to the seclusion of human society due to the coronavirus pandemic (COVID-19), during which time this paper was written. Used as a noun in apposition.

Distribution: Presently only known from the type locality in Jejudo Island, Korea (Fig. 1A, B).

Remarks: *Periclimenaeus apomonosi* sp. nov. appears morphologically close to *P. hebedactylus* Bruce, 1970 and *P. nufu* Ďuriš, Horká & Hoc, 2009, sharing with those species the presence of a supraorbital tooth or ridge, the non-denticulate cutting edges of the dactyli of the first and second pereiopods, and a distal accessory tooth as well as the corpus with ventral denticles on the ambulatory dactyli. *Periclimenaeus tuamotae* Bruce, 1969 and *P. bidentatus* Bruce, 1970 also resemble the species in having a supraorbital tubercle and non-tuberculate cutting edges. However, the presence of the anterodorsal medial lobe of the first abdominal tergite is not clear in the type (and only) descriptions (Bruce 1969 1970).

Periclimenaeus hebedactylus is readily distinguished from *P. apomonosi* by the position of the dorsal spiniform setae on the telson (both pairs at 0.2 of telson length in *P. hebedactylus* vs. proximal pair at about 0.2 and distal pair at 0.6 in *P. apomonosi* sp. nov.). *Periclimenaeus nufu* is also readily separated from the new species by the presence of serrations on the uropodal exopod (vs. non-serrated in *P. apomonosi* sp. nov.). *Periclimenaeus bidentatus* clearly differs from the new species by the bidentate distal dactylus of the minor second pereiopod (vs. single tooth in *P.*

apomonosi sp. nov.).

Bruce (1969) provided a detailed, but unillustrated description of *P. tuamotae*. Based on his description, *P. tuamotae* and the new species share several characters: 1) carpocerite not exceeding the distal margin of the scaphocerite, 2) a finely tuberculate ventral margin of the second pereiopod chelae, and 3) the presence of tubercles along the ventral margin on the merus and ischium of both second pereiopods. However, *P. tuamotae* differs from *P. apomonosi* as follows: 1)

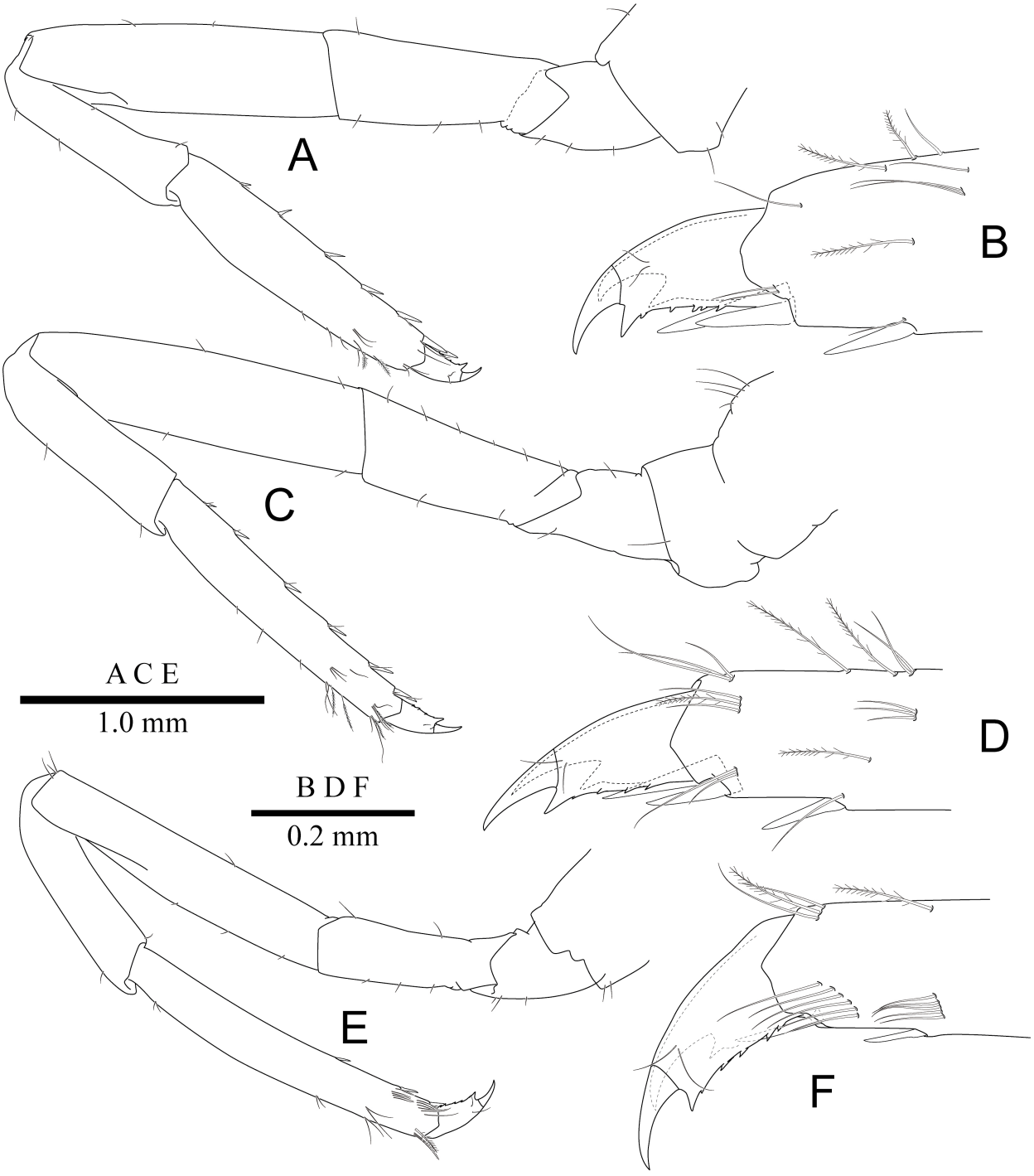

Fig. 14. *Periclimenaeus apomonosi* sp. nov., holotype, non-ovigerous female (pocl 3.4 mm) from Jejudo Island, Korea (NIBRIV0000862976). A, third pereiopod, lateral; B same, distal portion of propodus and dactylus, lateral; C, fourth pereiopod, lateral; D, same, distal portion of propodus and dactylus, lateral; E, fifth pereiopod, lateral; F, same, distal portion of propodus and dactylus, lateral.

inferior orbital angle obsolete (vs. with pointed process in *P. apomonosi* sp. nov.), 2) basicerite of antenna unarmed (vs. with distinct teeth distolaterally and distomedially on dorsal margin in *P. apomonosi* sp. nov.), 3) scaphocerite not exceeding second segment of antennular peduncle (vs. exceeding distal margin of antennular peduncle in *P. apomonosi* sp. nov.), 4) distolateral tooth of scaphocerite extending beyond

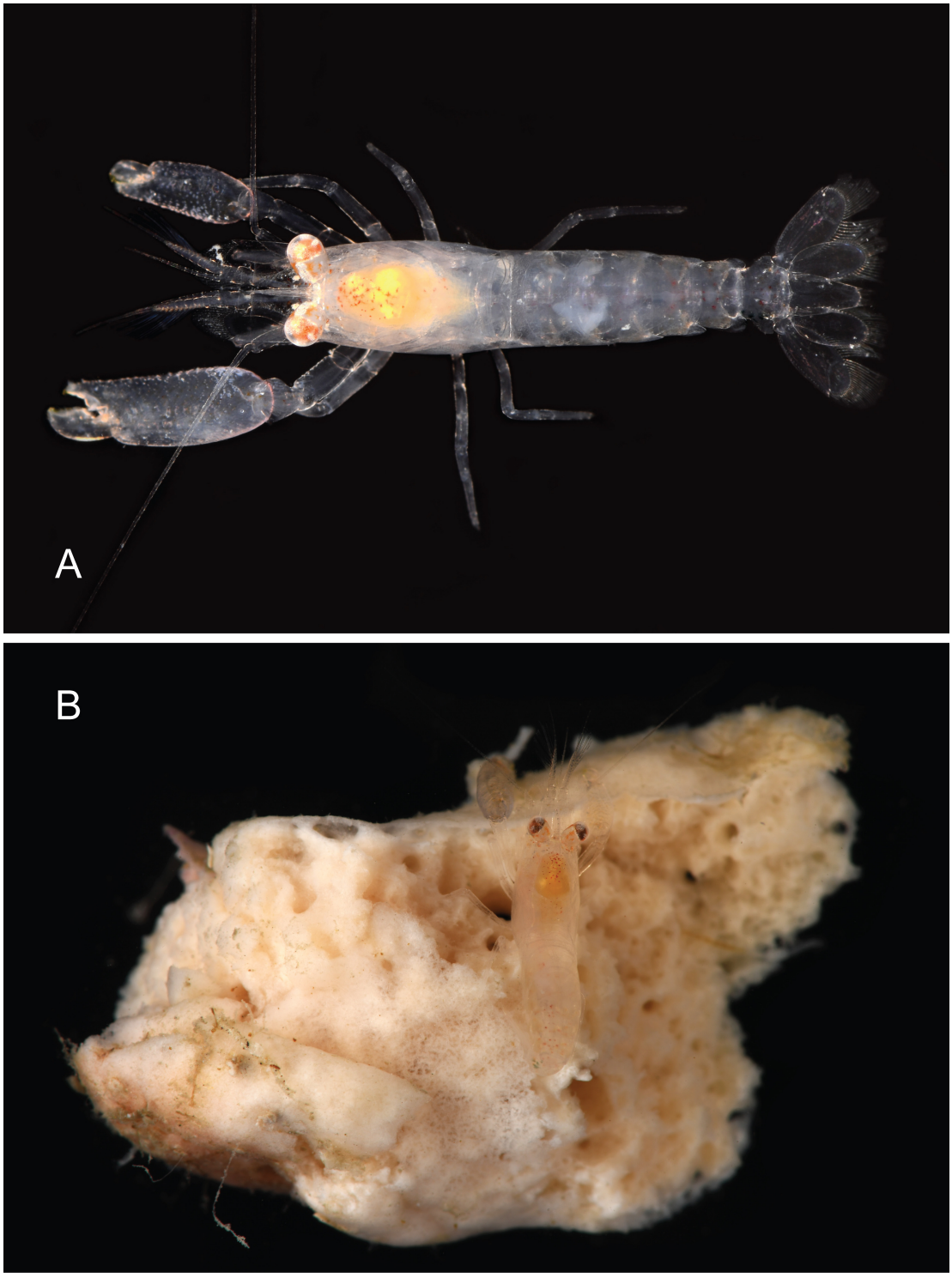

Fig. 15. *Periclimenaeus apomonosi* sp. nov., paratype, male (pocl 2.6 mm) from Jejudo Island, Korea (NIBRIV0000862975). A, dorsal view of specimen; B, specimen on dissected host sponge. Photograph credit: JH Park.

the lamella (vs. slightly exceeding or almost in line in *P. apomonosi* sp. nov.), 5) eye exceeding the rostrum (vs. not in *P. apomonosi* sp. nov.), 6) fingers of first pereiopod 0.6 of length of palm (vs. 0.4 in *P. apomonosi* sp. nov.), 7) carpus of first pereiopod about 1.5 times the length of the chela (vs. about 1.1 times in *P. apomonosi* sp. nov.), 8) two to three spiniform setae along ventral border of fourth pereiopod and none on fifth pereiopod (vs. five and two respectively in *P. apomonosi* sp. nov.).

***Periclimenaeus djiboutensis* Bruce, 1970**

(Figs. 16–18)

Periclimenaeus djiboutensis Bruce, 1970: 307 (type locality: Djibouti); 1975: 1568, figs. 3G, H, 8, 9, 13A-D; 1976: 472; 1978: 256, figs. 28, 29; 1981: 11; 1984: 205; Nomura et al., 1996: 10; Marin, 2007: 227, fig. 10; Marin and Caley, 2011, 7.

Material examined: 1 ovig. female (pocl 3.7); Oct. 15, 2001; Geomundo Island, Dadohaehaesang National Park, Korea (34°2'60"N 127°19'43"E), inside of unidentified sponge host, leg. SNU staff (Laboratory of Systematics and Molecular Evolution) (NIBRIV0000877271).

Description of Korean specimen: Body medium-sized, subcylindrical form (Fig. 16). Rostrum (Fig. 17A) straight, downward, about 0.3 of pocl, reaching 0.9 of basal segment of antennular peduncle, 7 dorsal teeth along entire length, without ventral tooth.

Carapace (Fig. 16) smooth, glabrous, with feeble supraorbital ridge, without supraorbital tooth or tubercle; antennal tooth acute; inferior orbital angle (Fig. 17B) with pointed process; pterygostomial angle rounded, produced anteriorly, with simple setae.

Abdomen (Fig. 16) smooth, first segment with anteromedian dorsal lobe; pleura broadly rounded, sixth segment as long as fifth length, about 0.6 of telson length, posterolateral angle rounded without tooth, porsteroventral angle rounded.

Telson (Fig. 17G) about 0.6 of pocl, about 2.5 times maximum width; two pairs of dorsal spiniform subequal setae at about 0.05 and 0.1 of telson length respectively, posterior margin (Fig. 17H) with three pairs of spiniform setae, lateral posterior spiniform setae short, about 0.2 of length of intermediate pair, intermediate pair long and stout, submedian pair about 0.9 of intermediate pair length, reaching distal margin of intermediate pair, setulose.

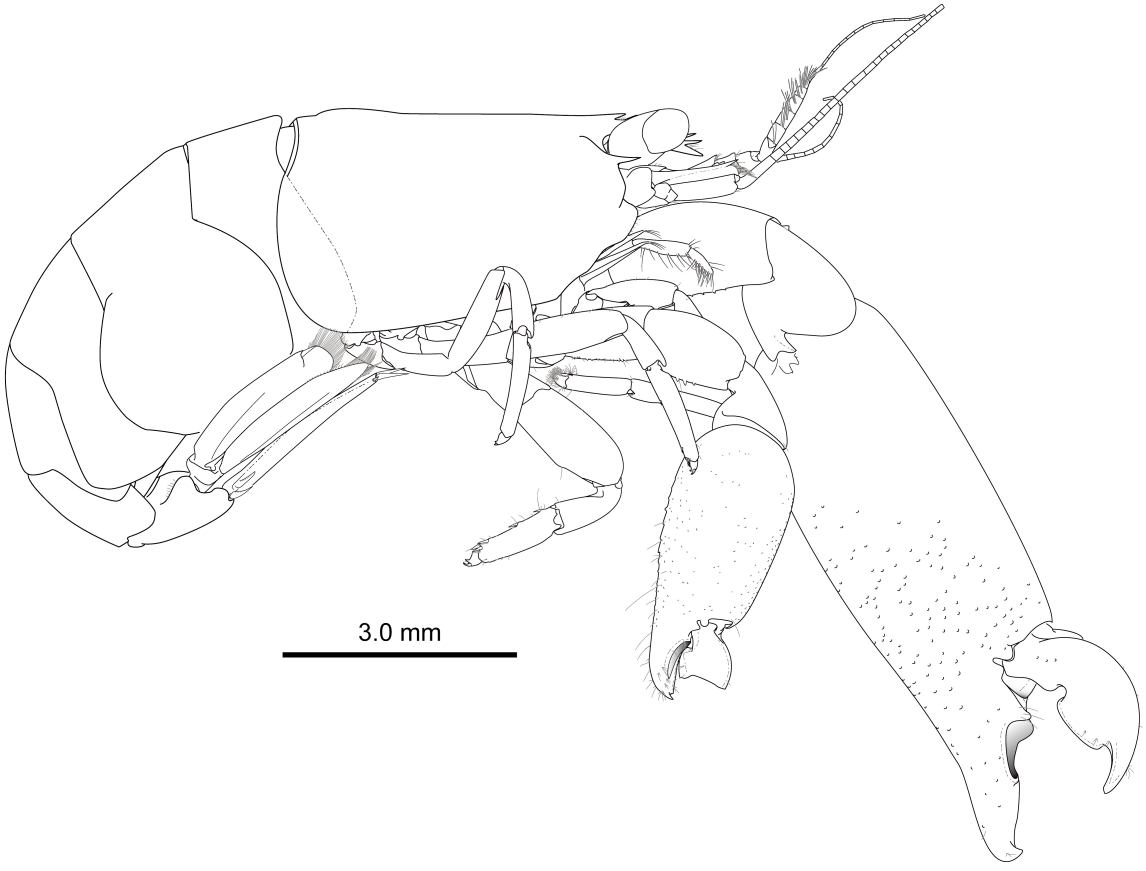

Fig. 16. *Periclimenaeus djiboutensis* Bruce, 1970, ovigerous female specimen pocl 3.7 mm from Geomundo Island (NIBRIV0000877283).

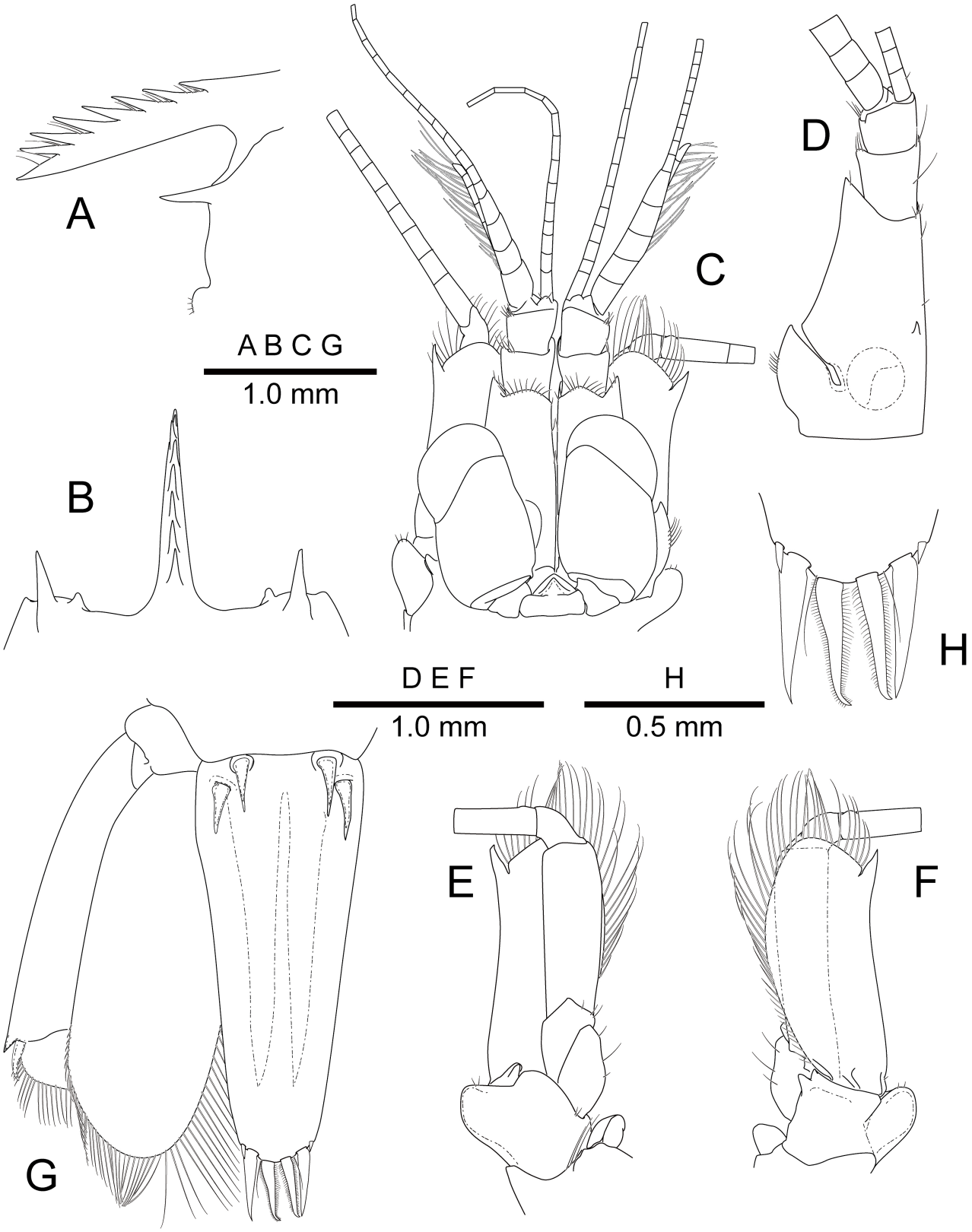

Fig. 17. *Periclimenaeus djiboutensis* Bruce, 1970, ovigerous female specimen pocl 3.7 mm from Geomundo Island (NIBRIV0000877283). A, frontal region of carapace, lateral; B, same, dorsal; C, eye, antennule and antenna, dorsal; D, antennule, ventral; E, antenna, ventral; F, same, dorsal; G, telson and uropod, dorsal; H, posterior end of telson, dorsal.

Eye (Figs. 16, 17C) with hemispherical cornea, about 1.8 times longer than maximum dorsal width, without nebenauge.

Antennule (Figs. 16, 17C) with proximal segment of peduncle bearing acute distolateral tooth, with acute ventromedial tooth at about 0.5 of proximal segment of peduncle (Fig. 17D); stylocerite bearing sharp point, reaching to about 0.5 of proximal segment; intermediate segment about 0.3 times of proximal segment length; distal segment about 0.7 times of proximal segment length; upper flagellum biramous, lower flagellum filiform.

Antenna (Fig. 17E, F) with basicerite with distinct rounded lobe laterally, with distomedial tooth; ischiocerite and merocerite unarmed; carpocerite extending to distal end of scaphocerite; scaphocerite about 2.3 times as long as maximum width, rounded distal margin of lamella exceeding acute distolateral tooth.

Mouthparts not dissected, typical for the genus in external observation.

First pereiopod (Figs. 16, 18A) with coxa and basis without special features; ischium about 0.6 of merus length, unarmed; merus about 1.1 times as long as carpus length, unarmed; carpus about 1.6 times as long as chela length; chela about 0.3 times of pocl; palm subcylindrical, smooth, non-tuberculate; fingers (Fig. 18B) about 0.2 of palm length, with group of terminal setae, with three terminal teeth.

Second pereiopods (Figs. 16, 18C, D) robust, dissimilar in shape, unequal in size.

Major second pereiopod (Figs. 16, 18C) with coxa and basis without special features; ischium about 0.8 of merus length, tuberculate ventrally; merus about 0.4 of palm length, tuberculate ventrally; carpus about 0.3 of palm length, tapering proximally, unarmed; chela about 1.9 times as long as pocl; chela about 3.6 times as long as merus length; palm subcylindrical, tuberculate; fingers unequal in size, slightly curved mesially; fixed finger with strong subacute tip, distal cutting edge entire, proximal cutting edge with deep oval fossa, mesial margin with triangular process, lateral margin with angular process; dactylus slightly exceeding fixed finger, about 0.4 of palm length, with strong subacute tip, distal cutting edge entire, proximal cutting edge with large molar process.

Minor second pereiopod (Figs. 16, 18D) with coxa and basis without special features; ischium and merus subequal in length, tuberculate ventrally; carpus about 0.3 of palm length, tapering proximally, unarmed; chela about 0.9 times as long as pocl, about 0.5 of major chela length, about 2.7 times as long as merus; palm subcylindrical, tuberculate; fixed finger about 0.4 of palm length, with acute tip, cutting edge with groove, concave, entire; dactylus incomplete, with rounded dorsal margin, cutting edge entire, proximal cutting edge angular.

Ambulatory pereiopods (Figs. 16, 18E, I, G) subequal in shape, third pereiopod longer and more robust than fourth and fifth; fourth slightly longer and more robust than fifth.

Third pereiopod (Fig. 18E, F) with coxa and basis without special features; ischium about 0.7 of merus length, unarmed; merus about 1.5 of carpus length, about 2.0 times as long as maximal depth, unarmed; carpus about 0.9 of propodus length, about 2.6 times as long as maximal depth, unarmed; propodus about 3.2 times as long as maximal depth, sparsely setose, with pair of stout distoventral spiniform setae, three spiniform setae on ventral border; dactylus about 0.2 of propodus length, biunguiculate; unguis demarcated, curved, corpus ventrally with distinct acute distal accessory tooth, distoventral tubercles obsolescent, entire proximally, sinuous, concave distally, convex proximally, sensory setae distolaterally.

Fourth pereiopod (Fig. 18G, H) with coxa and basis without special features; ischium about 0.8 of merus length, unarmed; merus about 1.5 of carpus length, about 3.1 times as long as maximal depth, unarmed; carpus about 0.8 of propodus length, about 3.3 times as long as maximal depth, unarmed; propodus about 4.9 times as long as maximal depth, sparsely setose, with pair of stout distoventral spiniform setae, two spiniform setae on ventral border; dactylus about 0.16 of propodus length, biunguiculate; unguis demarcated, curved, corpus ventrally with distinct acute distal accessory tooth, entire, sinuous, concave distally, convex proximally, sensory setae distolaterally.

Fifth pereiopod (Fig. 18I, J) with coxa and basis without special features; ischium about 0.7 of merus length, unarmed; merus about 1.2 of carpus length, about 3.7 times as long as maximal depth, unarmed; carpus about 0.8 of propodus length, about 3.6 times as long as maximal depth, unarmed; propodus about 5.3 times as long as maximal depth, with row of distolateral setae, with single stout distoventral spiniform setae, one spiniform setae distomedially; dactylus about 0.2 of propodus length, biunguiculate; unguis demarcated, curved, corpus ventrally with distinct acute distal accessory tooth, entire, sinuous, concave distally, convex proximally, sensory setae distolaterally.

Uropodal exopod (Fig. 17G) shorter than endopod, outer margin entire, with single spiniform setae, curved inward, about 2.5 times longer than acute distolateral tooth.

Host: The specimens were collected from an unidentified sponge.

Distribution: *Periclimenaeus djiboutensis* was

described from Djibouti (Bruce 1970) and has since been reported from Tanzania (Bruce 1976), Madagascar (Bruce 1978), Vietnam (Marin 2007), Queensland, Australia (Bruce 1981; Marin and Caley 2011), and the Ryukyus, Japan (Nomura et al. 1996) (Fig. 1C). The record from Eilat, Israel (Fishelson 1974) was considered to be erroneous by Ďuriš et al. (2011a). The present record is the first for Korea (Fig. 1).

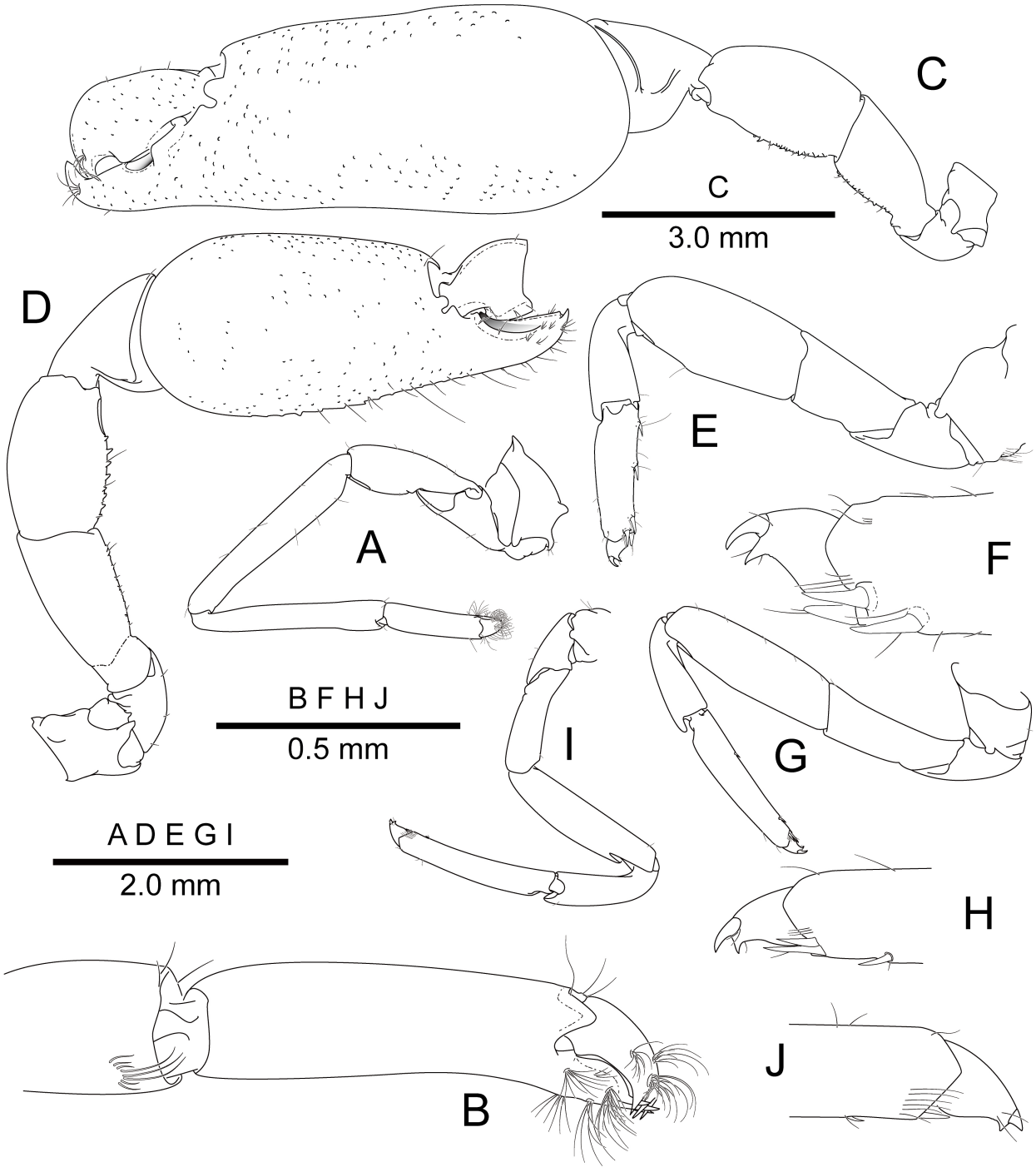

Fig. 18. *Periclimenaeus djiboutensis* Bruce, 1970, ovigerous female specimen pocl 3.7 mm from Geomundo Island (NIBRIV0000877283). A, first pereiopod, lateral; B, same, chela and distal portion of propodus, lateral; C, major second pereiopod, lateral; D, minor second pereiopod, lateral; E, third pereiopod, lateral; F, same, distal portion of propodus and dactylus, lateral; G, fourth pereiopod, lateral; H, same, distal portion of propodus and dactylus, lateral; I, fifth pereiopod, lateral; J, same, distal portion of propodus and dactylus, lateral.

Remark: Although the distal margin of the dactylus of the minor second pereiopod is incomplete, the present specimen agrees well with previous descriptions of *Periclimenaeus djboutensis* by having a rounded lateral lobe on the antennal basicerite, the shape of the chela of the first pereiopod and the characteristic, dorsal spiniform setae situated on the proximal part of the telson (Bruce 1970 1975 1978). These morphological affinities easily distinguish the species from other sponge associated *Periclimenaeus* species. However, the Korean specimen exhibits the following differences compared with previous descriptions: 1) inferior orbital angle with dentate process in Korean specimen (Fig. 17B), versus absent in the type description (Bruce 1970), 2) corpus of the ambulatory dactyli without distoventral tubercles in Korean (Fig. 18F, H, J) and Vietnamese specimens (see Fig. 10L in Marin 2007), versus blunt tubercles present on the corpus in Madagascan specimens (see Fig. 29G in Bruce 1978), and 3) the antennal basicerite with distomedial dorsal process in Korean (Fig. 17F) and Djibouti specimens (see Fig. 9B in Bruce 1975), but absent in Vietnamese specimens (see Fig. 10B in Marin, 2007). Further, Bruce (1975 1978) illustrated a strongly hooked bidentate tip on the dactylus of the minor second pereiopod. However, Marin (2007) illustrated only a single acute tip in a Vietnamese specimen. It is presently unclear if these differences are intraspecific morphological variation or potentially could reveal further undescribed species.

CONCLUSIONS

Two new symbiotic species in the palaemonid genus *Periclimenaeus* are described and illustrated from Korea. *Periclimenaeus karantin*a sp. nov. and *P. apomonosi* sp. nov. were obtained from ascidian and sponge hosts, respectively. In addition, the sponge associated species, *Periclimenaeus djiboutensis*, relatively widespread across the Indo-Pacific, is reported for the first time from Korea. Along with a morphological description of all three species, molecular information from two genetic markers (16S + *COI*) is provided to aid in future phylogenetic reconstructions of the genus.

List of abbreviations

DZMB, Deutsches Zentrum für Marine Biodiversitätsforschung, Senckenberg Research Institute, Wilhelmshaven, Germany.
leg., Legit (Latin) from Latin, meaning ‘collector’.
MABIK, Marine Biodiversity Institute of Korea.
NIBR, National Institute of Biological Resources, Incheon, Korea.
OUMNH.ZC, Zoological Collections of the Oxford University Museum of Natural History, Oxford, United Kingdom.
PCR, polymerase chain reaction.
pocl, postorbital carapace length.
SNU, Seoul National University, Seoul, Korea.
sp. nov., species nova (Latin): from Latin, meaning ‘new species’.

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Competing interests: The authors declare that they have no competing interests.

Availability of data and materials: GenBank accession numbers for DNA sequences data are presented in table 1. And type series were deposited in National Institute of Biological Resources, Incheon, Korea and Zoological Collections of the Oxford University Museum of Natural History, Oxford, United Kingdom.

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