

A New Species of the Gnathiid Isopod, *Gnathia teruyukiae* (Crustacea: Malacostraca), from Japan, Parasitizing Elasmobranch Fish

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Abstract A new species of gnathiid isopod, *Gnathia teruyukiae*, is described on the basis of laboratory reared material moulted from larvae, which parasitized elasmobranch fish caught from off Okinawa Island, Ryukyu Islands. Praniza larvae are also described. It is morphologically most similar to *G. meticola* Holdich and Harrison, 1980, but differs in the body length, the mandible length, and the structure of the mouthparts.

Key words: ectoparasite, gnathiids, Ryukyu Archipelago, larval morphology.

The family Gnathiidae Leach, 1814, contains over 190 species belonging to 12 genera (Hadfield *et al.*, 2008). Members of the family are distributed world-wide, and found in intertidal zone to abyssal depths of 4000 m (Camp, 1988; Cohen and Poore, 1994). From Japanese and adjacent waters, about 30 species in six genera have been recorded (Shimomura and Tanaka, 2008; Ota and Hirose, 2009b).

Gnathiid isopods exhibit great morphological differences between the larva, adult male, and adult female (Mouchet, 1928), and undergo a biphasic life cycle involving parasitic larvae and non-feeding adults. The larvae (called as praniza larvae) actively swim to attach infest teleosts and/or elasmobranch fish to suck their body fluid, whereas the adults are non-feeding and only reproduce in benthic substrata (Monod, 1926). In earlier studies, recognition of species of gnathiids had been based on the morphology of adult males only. Therefore, it is difficult to identify larvae or females alone (Smit and Davies, 2004). However, recent studies have yielded laboratory reared material grown from larvae collected from host fish, which enables description of larvae and adult females in detail (Smit and Basson, 2002; Nunomura and Honma, 2004; Hadfield *et al.*

2008; Coetzee *et al.*, 2008, 2009; Ferreira *et al.*, 2009). I also have studied gnathiid larvae ectoparasites of elasmobranchs caught by commercial fisheries in waters around the Ryukyu Archipelago, southwestern Japan (Ota and Hirose, 2009a, 2009b). In this paper, a new species, *Gnathia teruyukiae*, is described on the basis of these laboratory reared adult specimens.

Materials and Methods

Between April 2004 and September 2009, elasmobranch hosts caught in Nakagusuku Bay (26°N, 127°E), off the coast of Yomitan Village (26°21'N, 127°42'E), and off Ishigaki Island (24°28'N, 124°18'E), were investigated to collect praniza larvae. All of these host specimens were kind donations from fishermen.

Some larval gnathiids were fixed in 70% ethanol and used for description. I reared immature larvae in separated 0.5 mm mesh containers placed in a seawater tank (90×45×45 cm) with a filtration system. Some larvae metamorphosed into adults, and others died. The adults were photographed and preserved in 70% ethanol. These specimens were cleaned using a fine hair and dissected with sharpened tungsten needles. The ap-

pendages were removed from the body and then mounted in CMCP-10 high viscosity mountant (Polyscience, Warrington, PA, USA). Observations were made with a phase-contrast light microscope; drawings were made using a camera lucida. The examined materials are deposited in the National Museum of Nature and Science, Tokyo, Japan (NSMT). Descriptive terminology follows Cohen and Poore (1994). The identification of elasmobranch hosts was made according to Carpenter and Niem (1999).

Taxonomy

Family **Gnathiidae** Leach, 1814

Genus **Gnathia** Leach, 1814

Gnathia teruyukiae sp. nov.

[New Japanese name: Shimofuri-umikuwagata]

(Figs. 1–5)

Material examined. Holotype: NSMT-Cr 21451, male (total length 8.7 mm), gill chamber or oral cavity of a blotched fantail ray *Taeniura meyeni* Müller and Henle, 1841 caught by set net fishing, off Yomitan Village (26°21'N, 127°42'E), Okinawa Island, Ryukyu Archipelago, 25 August 2008.

Paratypes: NSMT-Cr 21452, 2 male adults, 1 female adult, 48 immature larvae, and 14 unfed larvae from the same locality and host as the holotype; NSMT-Cr 21453, 1 male adult, 1 female adult, 7 unfed larvae, gill chamber and oral cavity of *Himantura* sp., caught during set net fishing, off the coast of Yomitan Village, 29 June 2009; NSMT-Cr 21454, 8 unfed larvae from gill chamber and oral cavity of *Himantura* sp., caught during gill net fishing, off Nakagusuku Bay (26°12'N, 127°49'E), 17 May 2005; NSMT-Cr 21455, 1 immature larva from *Nebrius ferrugineus*, caught during pole-and-line fishing, Agarizuni, off Ishigaki Island (24°28'N, 124°18'E), 12 September 2009.

Description. Male (Figs. 1, 2, 5A). Body length 6.8–8.7 mm (8.0 ± 1.0 mm; $n=3$). In life, body generally white, digestive organs black due to congealed host blood.

Cephalosome (Fig. 1A–C) sparsely covered

with tubercles and setae, almost square with posterior margin medially concave. Frontal border medially closed by 2 frontolateral processes. Anterior margin of frontal process slightly dentate. Dorsal sulcus shallow and narrow. Eyes well developed. Paraocular ornamentation present but not distinct. Supraocular lobe low, not acute.

Pereonite 1 (Fig. 1A) short, not fused, reaching lateral margin of cephalosome. Pereonites 2–4 sparsely covered with setae and tubercles. Widths of pereonites 2, 3, and 4 subequal. Pereonite 2 slightly shorter than pereonite 3. Pereonite 4 with anterior constriction and anterolateral lobe. Pereonites 5 and 6 each with areae laterales and lobi laterales. Pereonite 7 short and narrow, overlapping pleonite 1.

Lateral margins of pleonites 1–5 sparsely fringed with long setae (Fig. 1). Epimera prominent on pleonites 2–5.

Pleotelson (Fig. 1D) covered with pectinate scales, dorsal surface with 2 pairs of setae; lateral margin convex, with 9 setae; apex concave, with 2 pairs of setae.

Mandible (Fig. 1A–C) about two-thirds length of cephalosome; apex curved inward. Mandibular seta present on mid-dorsal surface near incisor. Dentate blade occupying about two-fifths of mandible length. Basal neck and erisma prominent.

Antenular peduncle (Fig. 1E) covered with pectinate scales. Distal margins of peduncular segments 1, 2, and 3 bearing 3, 4, and 1 feather-like bristles, respectively. Flagellar articles 1 and 5 each with 1 feather-like bristle; articles 3, 4, and 5 each with 1 aesthetasc; article 5 bearing 3 terminal setae.

Antennal peduncle (Fig. 1F) covered with pectinate scales. Peduncle 3 and 4 bearing 2 and 4 feather-like bristles, respectively. Flagellar articles 1–6 with few setae on distal margins; article 7 bearing 4 terminal setae.

Maxilliped with endite (Fig. 2A) reaching distal margin of palp article 1. Palp articles 1–4 bearing 5, 7, 5, and 8 plumose setae, respectively, on external margins; article 4 bearing 5 simple terminal setae.

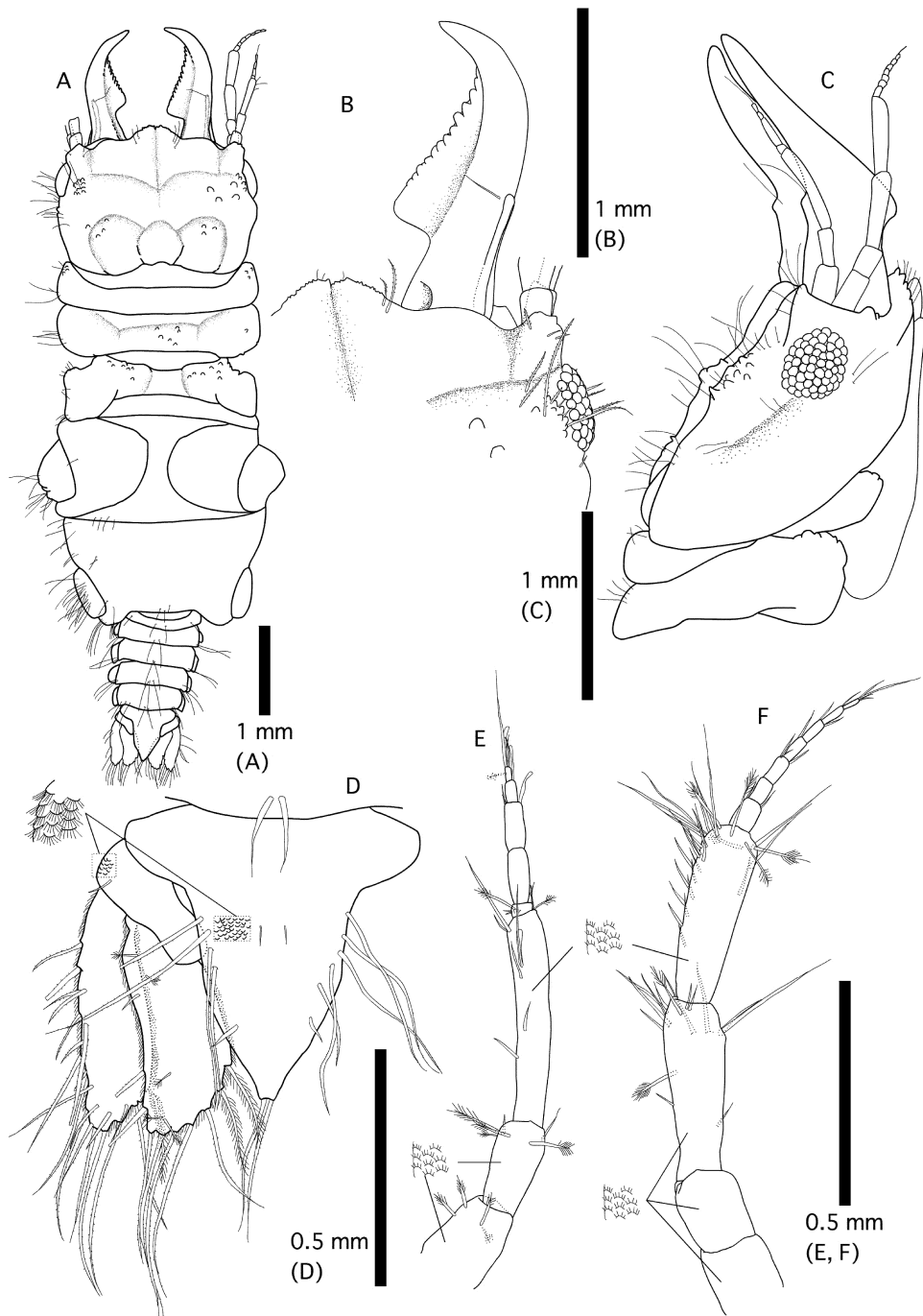


Fig. 1. *Gnathia teruyukiae* sp. nov., holotype, adult male (NSMT-Cr 21451, total length, 8.7 mm). A, body, dorsal view; B, frontal border and mandible, dorsal view; C, cephalosome, lateral view; D, pleotelson, dorsal view; E, antenna 1, medial view; F, antenna 2, medial view.

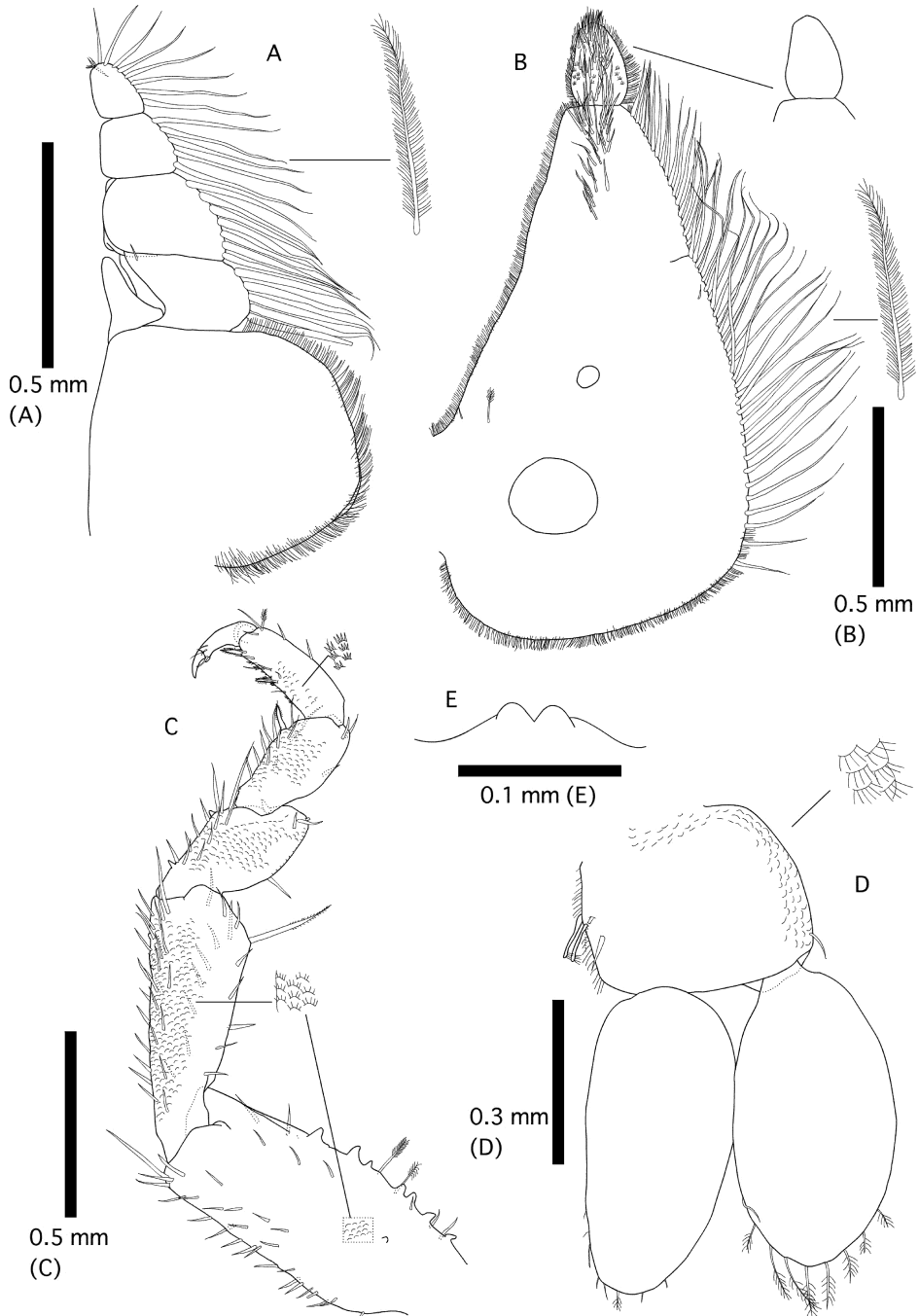


Fig. 2. *Gnathia teruyukiae* sp. nov., holotype, adult male (NSMT-Cr 21451, total length, 8.7 mm). A, maxilliped, ventral view; B, pylopod, ventral view; C, pereopod 2, medial view; D, pleopod 2, ventral view; E, penes, ventral view.

Pylopod (Fig. 2B) 2-articulated, covered with setae near distal margin of article 1 and ventral surface of article 2. Article 1 elliptical with 2 areolae bearing 49 plumose setae on internal margin and few setae and 1 feather-like bristle near external margin. Article 2 elliptical, sparsely covered with pectinate scale.

Pereopod 2 (Fig. 2C) covered with pectinate scales. Setae on outer margin longer than those on inner margin. Basis oblong, with 2 feather-like bristles and 7 processes on outer margin. Ischium subequal in length to basis, becoming wider distally. Merus about half-length of ischium. Carpus slightly smaller than merus. Propodus rectangular and as long as carpus, bearing 2 spines on inner-middle and inner-distal margins. Dactylus terminating in unguis.

Pleopod 2 (Fig. 2D) fringed with fine setae on inner margin of peduncle and with 1 seta on outer distal corner; inner margin with coupling hook and 2 setae; rami oval and equal in length, exopod with 11 plumose setae, endopod with 9 simple setae; appendix masculina absent. All pleopods similar in shape; exopods each with 6–11 plumose setae, endopods each with 7–9 simple setae.

Uropods (Fig. 1D) with both rami subequal in length, extending beyond apex of pleotelson. Exopod bearing 20 setae and 1 plumose seta laterally. Endopod bearing 7 setae and 2 plumose setae laterally; dorsal surface with several feather-like bristles.

Penes (Fig. 2E) composed of 2 small contiguous papillae.

Female (Figs. 3, 5B). Body length, 6.4–6.6 mm (6.5 ± 0.1 mm; $n=2$). Body entirely white in life (Fig. 5B).

Cephalosome (Fig. 3A, B) with several setae. Frontal border with horn-shaped process, covered with setae. Pereon swollen with 2 sutures between pereonite 4–6, width about two-thirds length. Pereonite 1 short, not fused to cephalosome. Pereonites 3 wider than pereonite 2, reaching lateral margins. Lateral shields of pereopods 4 and 5 not visible dorsally.

Pleonites 1–5 each with 2 or 3 setae on poste-

rior margin. Pleotelson (Fig. 3C) similar to that of adult male, but with 4 pairs of setae on lateral margin and apex.

Both antennae (Fig. 3D, E) more slender than those of adult male; setae on peduncular articles of both antennae fewer than those in adult male. No pectinate scales on peduncular articles.

Maxilliped covered with pectinate scales on inner margin of basis (Fig. 3F). Endite reaching palp article 2. Basis and articles 1–4 bearing 9, 4, 8, 7, and 8 plumose setae, respectively. Oostegite elliptical.

Pylopod (Fig. 3G) composed of 2 articles. Articles 1 and 2 covered with pectinate scales. Article 1 with suture, bearing 1 plumose setae on inner margin. Article 2 rectangular, bearing 3 setae on distal margin.

Pereopods (Fig. 3H) bearing fewer setae than in adult male.

Pleopods similar in morphology to those of male (Fig. 3I). Inner and outer margins of peduncles each with 1 seta. Exopods with 8 or 9 plumose or simple setae, and endopods with 6–8 plumose or simple setae on distal margins.

Uropodal rami (Fig. 3C) slightly extending beyond apex of pleotelson. Exopod bearing 17 or 18 simple setae laterally. Endopod bearing 9 simple setae laterally.

Praniza larva (Figs. 4, 5C–E). Body length 6.7–9.1 mm (fed larvae, 8.0 ± 0.6 mm; $n=49$; unfed larvae, 5.5 ± 1.2 mm; $n=29$). Body entirely whitish, with scattered sparse white dapples on dorsal surface of thorax (Fig. 5D, E).

Cephalosome (Fig. 4A, B) elliptical with convex posterior margin, length about two-thirds of width. Anterior margin of labrum concave. Eyes occupying length of cephalosome. Pereonite 1 (Fig. 4A) short. Pereonite 2 subequal in length to pereonite 3, with concave anterior margin. Pereonite 3 slightly wider than pereonite 2. Lateral shields of pereopods 4–6 visible in dorsal view. Setae absent on pleonites (Fig. 4A). Pleotelson (Fig. 4C) bearing 2 and 1 pairs of setae on dorsal surface and apex, respectively.

Antennular peduncle with article 3 bearing pectinate scales but not distinct (Fig. 4D). All an-

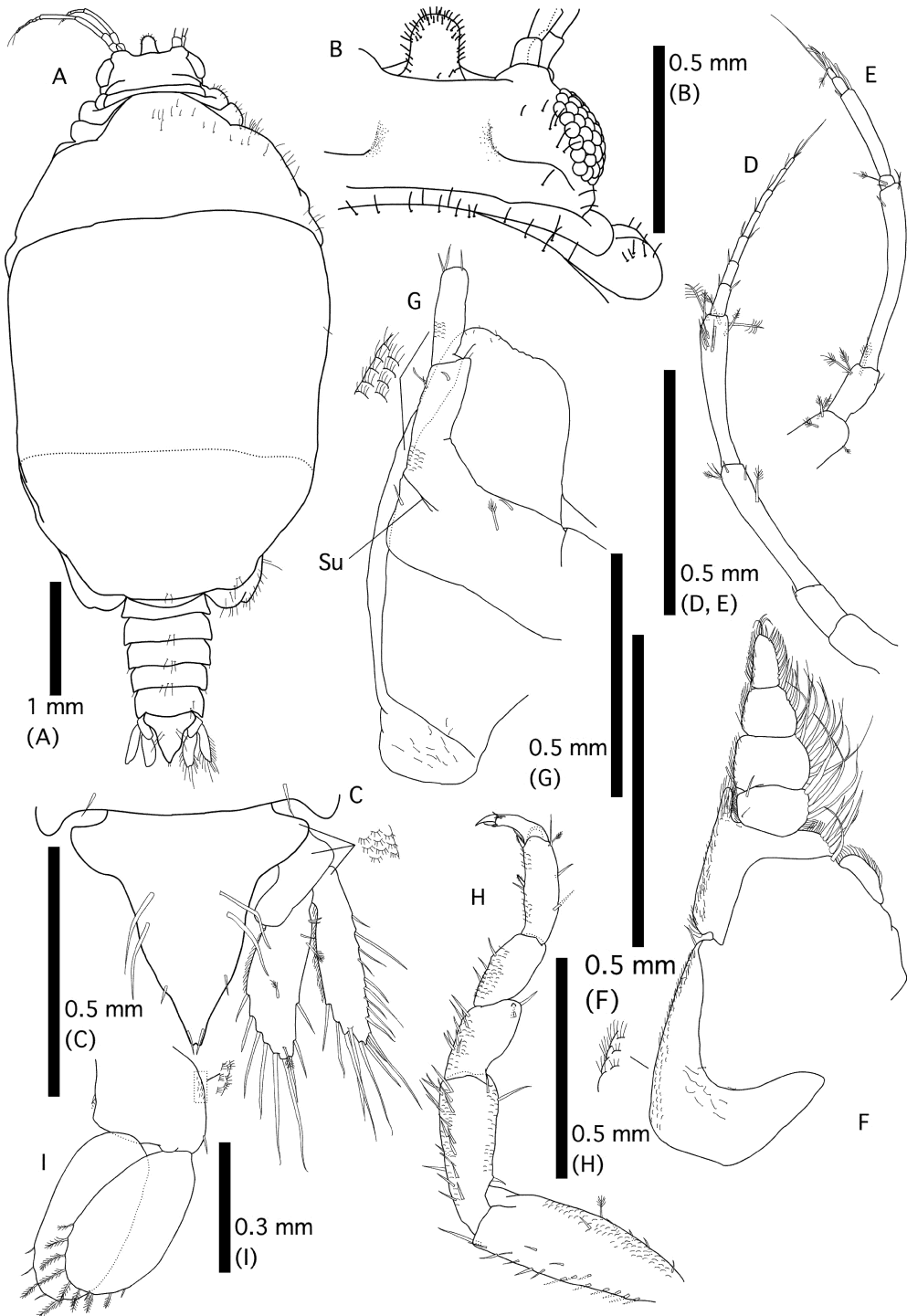


Fig. 3. *Gnathia teruyukiae* sp. nov., paratype, adult female (NSMT-Cr 21452, total length, 6.6 mm). A, body, dorsal view; B, eye and frontal border, dorsal view; C, pleotelson, dorsal view; D, antenna 1, medial view; E, antenna 2, medial view; F, maxilliped, ventral view; G, pylopod, ventral view; Su, suture of article 1; H, pereopod 2, medial view; I, pleopod 2, ventral view.

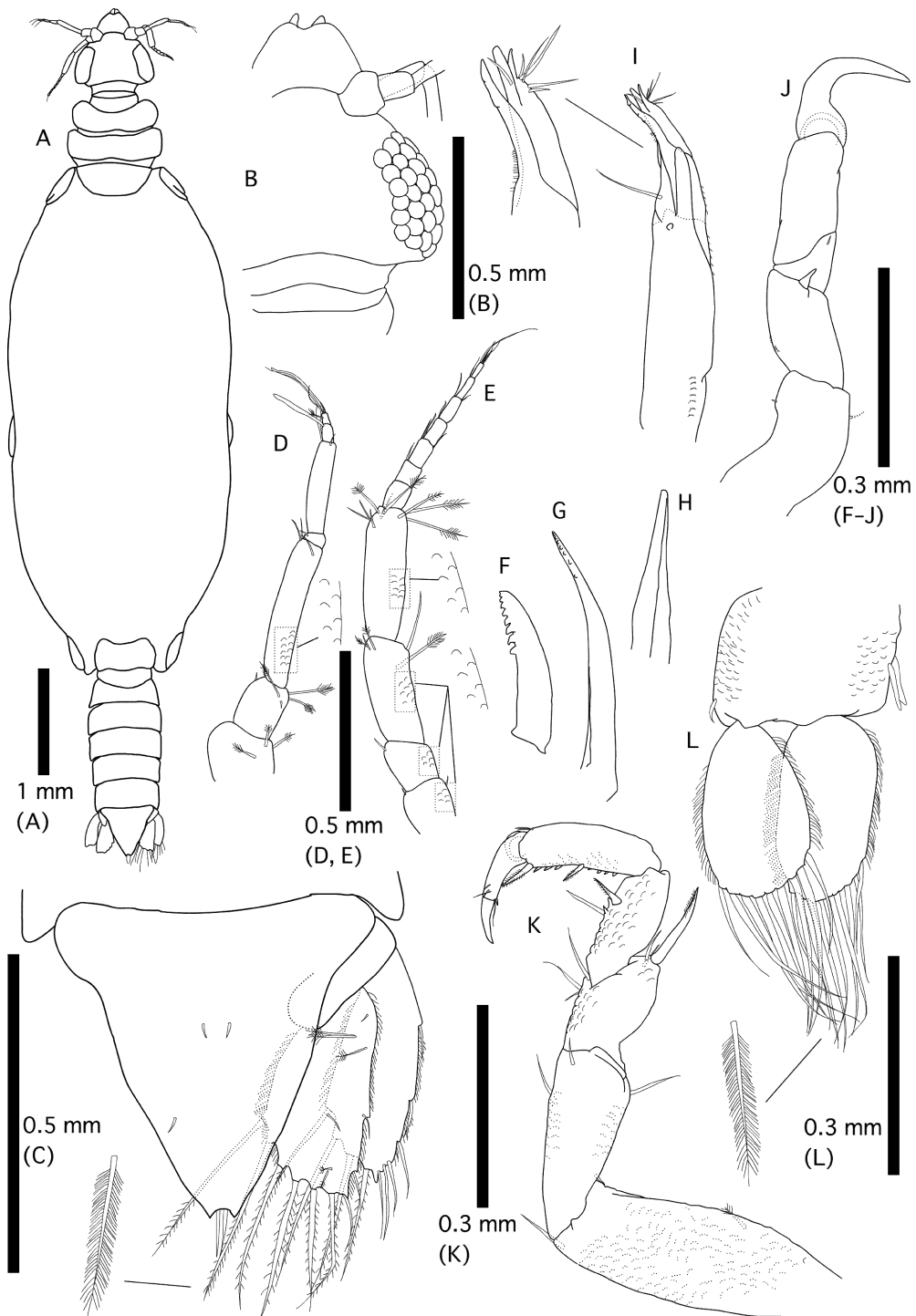
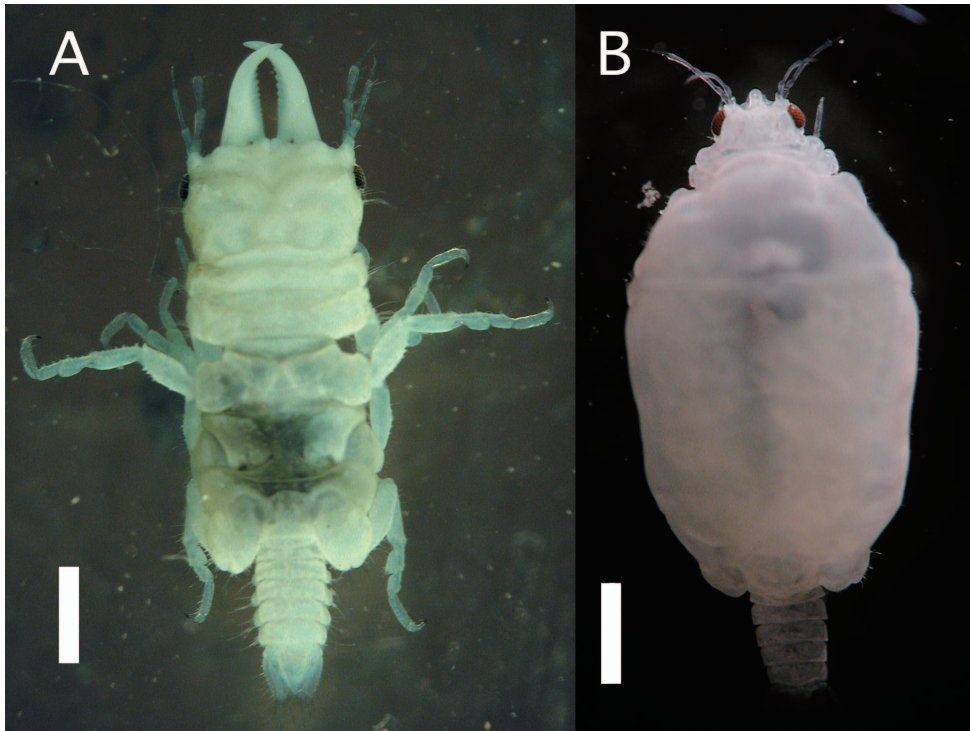


Fig. 4. *Gnathia teruyukiae* sp. nov., paratype, praniza larva (NSMT-Cr 21452, total length, 8.0 mm). A, body, dorsal view; B, cephalosome, dorsal view; C, pleotelson, dorsal view; D, antenna 1, medial view; E, antenna 2, medial view; F, mandible, dorsal view; G, paragnath, lateral view; H, maxillule, dorsal view; I, maxilliped, lateral view; J, gnathopod, lateral view; K, pereopod 2, medial view; L, pleopod 2, ventral view.



tennal peduncles also with indistinct pectinate scales (Fig. 4E).

Mandible (Fig. 4F) with 8 teeth. Maxillule (Fig. 4G) with 7 teeth on apex. Paragnath (Fig. 4H) straight. Maxilliped (Fig. 4I) composed of basis and 2-articulated palp; basis with 1 coupling hook on inner margin; endite with 1 seta; apex of palp article 1 slightly dentate with 2 teeth; apex of palp article 2 divided into 2 parts, with 1 seta on inner part, 5 setae and 1 spine on outer part. Gnathopod (Fig. 4J) simple pediform with reduced small carpus. Merus with projection on distal margin. Propodus with distal bulbous protrusion. Dactylus terminating in sharp, pointed unguis.

Pereopods (Fig. 4K) more slender than those of adult male, bearing fewer setae.

Plumose setae of pleopods (Fig. 4L) longer than those of adults. Exopod fan-shaped, with 8 or 9 plumose setae. Endopod elliptical, with 7 or 8 plumose setae on distal margins. Uropod (Fig. 4C) not reaching apex of pleotelson; exopod bearing 6 setae and 4 plumose setae laterally; endopod bearing 3 setae and 6 plumose setae laterally.

Remarks. *Gnathia teruyukiae* sp. nov. appears most similar to *G. meticola* Holdich and Harrison, 1980 because of the following characters; the frontlateral process is smoothly rounded, the lateral margins of the pleotelson are noticeably sinuous, and the appendix masculina is lacking on pleopod 2 (Holdich and Harrison, 1980). However, the new species is readily distinguished from *G. meticola* in the much larger body size (6.8–8.7 mm in the total length versus approximately 3.0 mm), the relatively longer mandible occupying the two-thirds length of the cephalosome (occupying the half length in *G. meticola*) and the 2-articulated, rather than 3-articulated, pylopod.

Currently, six species of *Gnathia* are known as

ectoparasites of elasmobranch fish: *G. pantherina* Smit and Basson, 2002; *G. capillata* Nunomura and Honma, 2004; *G. grandilaris* Coetzee, Smit, Grutter, and Davies, 2008; *G. trimaculata* Coetzee, Smit, Grutter, and Davies, 2009; *G. maculosa* Ota and Hirose, 2009; and *G. nubila* Ota and Hirose, 2009. The male of these six species all have a 3-articulated pylopod and pleopod 2 having an appendix masculina (Smit and Basson, 2002; Nunomura and Honma, 2004; Coetzee *et al.*, 2008, 2009; Ota and Hirose, 2009a; 2009b). *Gnathia teruyukiae* sp. nov. is easily distinguishable from these six species by the possession of 2-articulated pylopod and the lack of an appendix masculina on pleopod 2.

Detailed morphological information on females and larvae is available for some congeneric species: *G. africana* Barnard, 1914 (female; Smit *et al.*, 2002, larva; Smit *et al.*, 1999); *G. andrei* Pires, 1996 (female only; Pires, 1996); *G. aureamaculosa* Ferreira and Smit, 2009 (Ferreira *et al.*, 2009); *G. camuripenis* Tanaka, 2004 (Tanaka, 2004); *G. firingae* Müller, 1991 (Müller, 1991); *G. grandilaris* (female; Ota and Hirose, 2009b, larva; Coetzee *et al.*, 2008); *G. grujanovae* Golovan, 2006 (female only; Golovan, 2006); *G. lignophila* Müller, 1993 (female only; Müller, 1993); *G. maculosa*, *G. nubila*; *G. pantherina*; *G. pilosus* Hadfield, Smit, and Avenant-Oldwage, 2008; *G. limicola* Ota and Tanaka, 2007; *G. ricardoi* Pires, 1996 (female only); and *G. trimaculata*. It has been shown that the following main characters are diagnostic for species differentiation for females: the body size; the shape of the frontal border and the pleotelson; and the number of pylopodal and maxillipedal setae (e.g., Smit *et al.*, 2002; Smit and Basson, 2002). On the other hand, diagnostic characters for differentiations of praniza larvae include the shape of the pleotelson, the body length of the final stages, and the number of mandible teeth (e.g., Smit and Basson,

Fig. 5. *Gnathia teruyukiae* sp. nov., living specimens in dorsal view, showing coloration in life. A, adult male (NSMT-Cr 21452), paratype; B, adult female (NSMT-Cr 21452), paratype; C, final stage of larva before feeding (NSMT-Cr 21454), paratype; D, final stage of larva with expanding pereonite 4–6 (NSMT-Cr 21454), paratype; E, final stage of larva after feeding (NSMT-Cr 21455), paratype. Scale bars: 1 mm. Photo by Y. Ota.

2002). Furthermore, coloration in life is also useful for species recognition (e.g., Coetzee *et al.*, 2009).

The female of *G. teruyukiae* sp. nov. is easily distinguished from those of the other known species of *Gnathia* by the horn-shaped frontal border. Adult females known in some *Gnathia* species have a rounded frontal border (e.g., *G. lignophila*; Müller, 1993), or (slightly) convex frontal border (e.g., *G. africana*; Smit *et al.*, 2002; *G. maculosa*; Ota and Hirose, 2009a).

Praniza larvae of *Gnathia teruyukiae* sp. nov. are most similar to those of *G. pantherina*. However, in *G. pantherina*, a pair of short setae is present on the cephalosome, and the uropodal rami extend beyond the apex of the pleotelson (Smit and Basson, 2002). In contrast, in the new species, there are no paired short setae on the cephalosome, and the uropodal rami do not extend to the pleotelson. As in the present new species, the larvae of *G. trimaculata*, *G. grandilaris*, *G. maculosa*, and *G. nubila* infest elasmobranch fish in the Ryukyus (Ota and Hirose, 2009a, 2009b) and they are often found with *G. teruyukiae* sp. nov. in a same host. In life, *G. teruyukiae* sp. nov. is easily distinguished from the latter four species by the whitish color with white speckles or swollen dapples on the thorax. Larvae of *G. trimaculata* have greenish-yellow pigmentation and often a few spots on the lateral margins of the swollen thorax (Coetzee *et al.*, 2009). Larvae of *G. maculosa*, *G. grandilaris*, and *G. nubila* are dark red or black with white patterns on the swollen thorax, whereas other parts are light brown or white (Coetzee *et al.*, 2008; Ota and Hirose, 2009a, 2009b).

Etymology. The specific name is derived from the fishing boat “Teruyuki-maru,” which helped the author to collect many of elasmobranch fish and gnathiid specimens.

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