



**New species of the copepod genus *Anthessius* Della Valle, 1880
(Poecilostomatoida: Anthessiidae) from *Turbo marmoratus* Linnaeus
(Gastropoda: Turbinidae) collected during the KUMEJIMA 2009 Expedition***

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Abstract

Anthessius isamusi n. sp. is described based on female and male specimens from a turbinid gastropod, *Turbo marmoratus* Linnaeus, collected in the East China Sea off Kumejima Island, the Ryukyu Islands, southern Japan, during the KUMEJIMA 2009 Expedition. The female of the new species is differentiated from its congeners by the following combination of characters: 1) the absence of denticles on the ventral surface of the anal somite; 2) the length to width ratio of the caudal ramus; 3) the antenna bearing 4 claws; 4) the maxilla with 3 distal teeth; 5) the exopod of leg 4 with 3 spines on the terminal segment, and; 6) leg 5 with a rod-like terminal segment.

Key words: Copepoda, new species, the Ryukyu Islands, gastropod

Introduction

Anthessius is the largest genus in the poecilostomatoid copepod family Anthessiidae Humes, 1986. Stock *et al.* (1963) recognised 23 species in the genus. Since then, 20 more species have been described, bringing the total to 43 known species (Avdeev & Kazatchenko 1986; Devi 1984; Do & Kajihara 1984; Ho 1983; Ho & Kim 1992; Humes 1973, 1976; Humes & Ho 1965; Humes & Stock 1965; Kim 1993, 2009; López-González *et al.* 1992; Reddiah 1966; Stock 1964; Suh & Choi 1991; Suh 1993). Almost all species are parasitic or commensal on marine bivalves and gastropods (Boxshall & Halsey 2004; Ho 1997), and some have been reported from molluscs of commercial importance (e.g. Humes 1973; Humes & Stock 1965; Tanaka 1961). During the KUMEJIMA 2009 Expedition conducted in the East China Sea around Kumejima Island, the Ryukyu Islands, southern Japan in November 2009, a new species of *Anthessius* was collected from *Turbo marmoratus* Linnaeus, which is commercially important in the Indo-West Pacific.

Materials and Methods

A specimen of *Turbo marmoratus* Linnaeus, was collected by SCUBA off Kumejima Island, the Ryukyu Islands, Okinawa, southern Japan, during the KUMEJIMA 2009 Expedition. After dissecting the snails, copepods were removed by rinsing in freshwater and preserved in 80% ethanol. Copepod specimens were soaked in lactophenol for 24 hours before dissection. The appendages were dissected and observed using the method of Humes & Gooding (1964). The drawings were made with the aid of a drawing tube. The terminology followed Huys &

Boxshall (1991). Measurements in micrometres are shown as ranges with means and standard deviations in parentheses. Length and width of each body parts is in square brackets together. Type specimens are deposited in the crustacean collection of the National Museum of Nature and Science, Tokyo (NSMT) and the University of the Ryukyus Museum, Fujukan (RUMF), Okinawa.

Taxonomic account

Order Poecilostomatoida Thorell, 1859

Family Anthessiidae Humes, 1986

Genus *Anthessius* Della Valle, 1880

Anthessius isamusi n. sp.

(Figs. 1–3)

Material examined. Holotype, female (NSMT–Cr 21665), ex *Turbo marmoratus* Linnaeus (Gastropoda: Turbinidae), off Ebi-ana (26°17'N, 126°47'E), Kumejima Island, the Ryukyu Islands, East China Sea, Japan, 13 November 2009. Allotype: a male (NSMT–Cr 21666) and Paratypes: 4 females and 1 male (NSMT–Cr 21667); 2 female and 1 male (RUMF–ZC–1503), Collection data of allotype and paratypes same as that of holotype.

Description of female holotype. Body (Fig. 1A) 2240 long, excluding caudal rami (n = 7). Cephalothorax ovoid, shorter than wide 969 × 1202, widest at posterior 3/4. Three free thoracic somites in prosome distinctly separated and narrowing posteriorly. Urosome 5-segmented, 768 long. Genital complex barrel-shaped, shorter than wide 227 × 292. Anal somite (Fig. 1C) shorter than wide 124 × 152, unarmed. Caudal ramus (Fig. 1C) longer than wide 140 × 67, length/width ratio 2.08, slightly longer than anal somite, with 6 setae; outer lateral seta naked and located on subterminal, most outer and inner seta plumose, 2 middle setae with small spinules on margin.

Rostrum (Fig. 1B) broad. Antennule (Fig. 1D) 7-segmented, with armature formula 4, 17, 4, 3, 4 + 1 aesthetasc, 2 + 1 aesthetasc, 7 + 1 aesthetasc; all setae naked. Antenna (Fig. 1E) 3-segmented; proximal segment with 1 distal seta on anterior surface; middle segment with 1 subterminal seta on anterior surface; terminal segment bearing 1 short and 3 long setae proximally, 1 subterminal seta, and distal tip carrying 1 seta and 2 strong hook-like claws, one of them slender and long, and the other small.

Labrum (Fig. 1F) bilobed bearing median incision. Mandible (Fig. 2A) bearing 1 lash-like serrated inner seta and apical serrated lash with 2 proximally, bifurcated teeth at outer lash basis. Maxillule (Fig. 2B) bearing 2 long and 2 small setae, 3 blunt and 1 comb-like processes. Maxilla (Fig. 2C) 2-segmented; proximal segment rod-like, unarmed; distal segment tapering into pointed process, with 2 large and 1 small teeth on convex side and 2 spines near basis. Maxilliped (Fig. 2D) digitiform, with obscure suture line and distally tapering process with 1 setule.

Legs 1 to 4 (Fig. 2E–H) with coxa, basis, and 3-segmented rami; 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; III, I, 2
Leg 4	0–1	1–0	I–0; I–1; II, I, 5	0–1; 0–2; III, I, 1

Coxa of legs 1 to 4 with single row of small denticles on distal tip. Basis of legs 1 to 4 with single row of hairs along inner margin. Legs 1 to 3 bearing single row of fine spinules on margin of basis between endopod attachment area and outer protrusion. Proximal segment of exopod of legs 1 to 4 bearing single row of denticles along outer margin and rows of setules along inner margin; spines foliaceous, serrated along both lateral sides, excluding distal plumose spines along inner margin; terminal segment serrated along outer margin. Endopods of legs 1 to 4 fringed

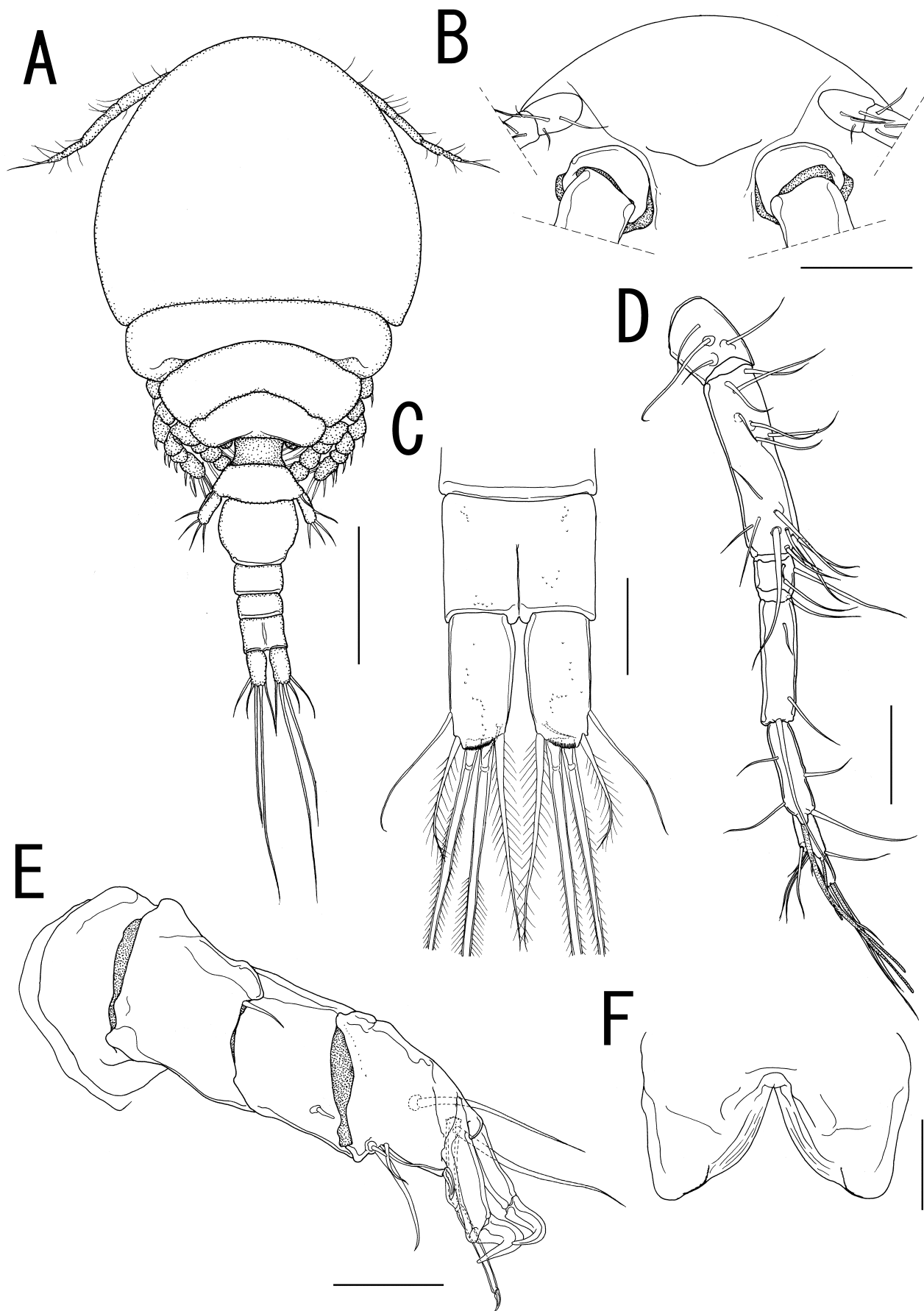


FIGURE 1. *Anthessius isamusi* n. sp., female, holotype NSMT-Cr 21665: A, habitus dorsal; B, rostrum area, ventral; C, anal somite and caudal rami, ventral; D, left antennule, posterior; E, left antenna, anterior; G, labrum. Scales: A = 500 μ m; B = 200 μ m; C, D, E = 100 μ m; F = 50 μ m.

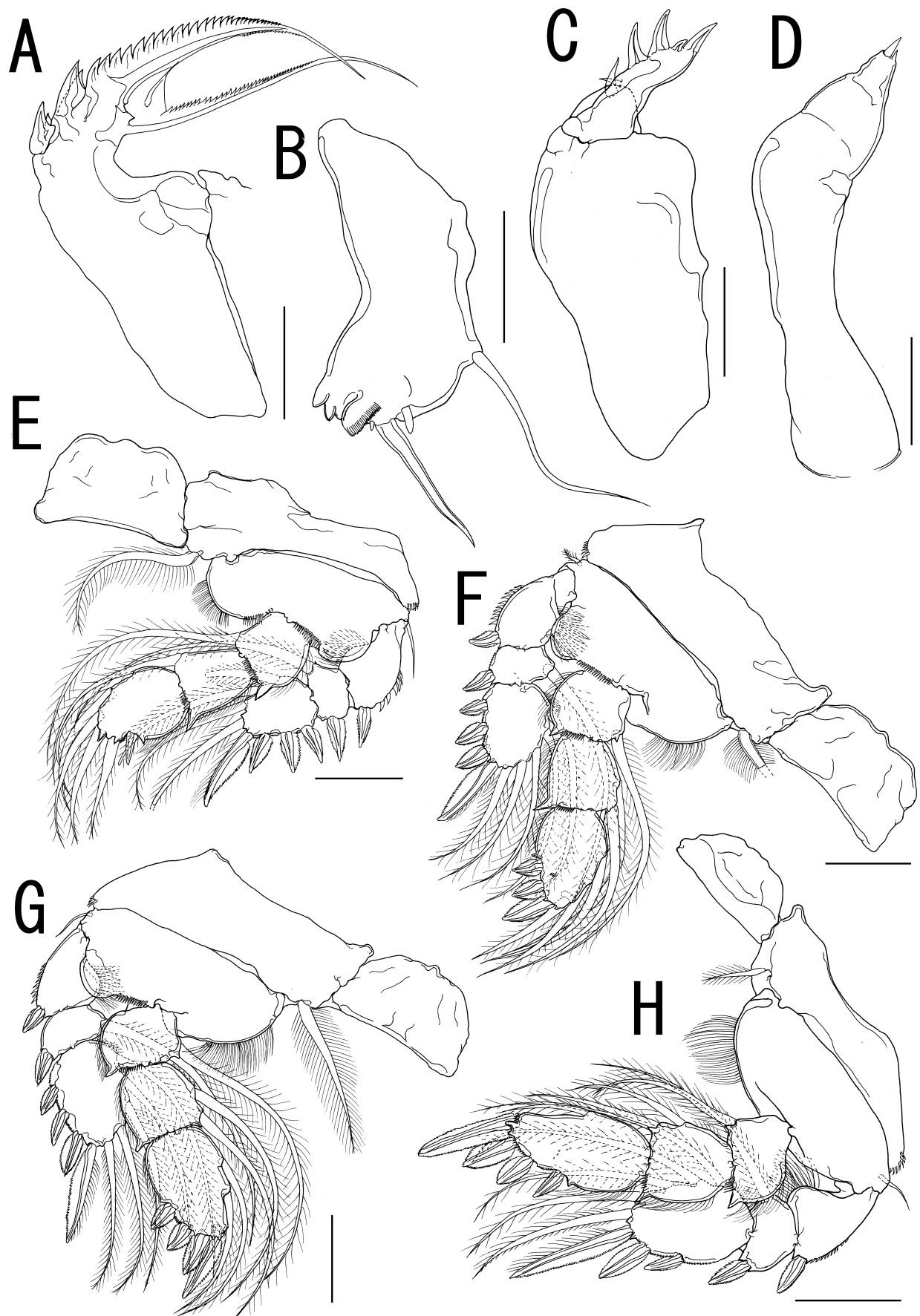


FIGURE 2. *Anthessius isamusi* n. sp., female, holotype NSMT–Cr 21665: A, left mandible, posterior; B, left maxillule, anterior; C, left maxilla, posterior; D, left maxilliped, posterior; E, left leg 1, ventral; F, right leg 2, ventral; G, right leg 3, ventral; H, left leg 4, ventral. Scales: A, C, D = 50 μ m; B = 40 μ m; E, F, G, H = 100 μ m.

with setules along outer margin; proximal and middle segment bearing pointed process on distal tip and single row of spinules along distal margin; spines foliaceous with serrated margin, except for leg 1, legs 3 and 4 ornamented with single row of setules along inner margin. Leg 5 (Fig. 3A) 2-segmented; proximal segment incompletely fused to 5th pedigerous somite with 1 naked seta on dorsal surface; terminal segment longer than wide 144×55 , with length/width ratio of 2.60, bearing 3 blunt spines and 1 naked seta, spinules along posterior quarter of inner margin and near base of each outer 3 elements. Leg 6 (Fig. 3A) rod-like with 2 elements.

Variability of measurement. Paratype females share all important morphological characters with the holotype. Measurement range of their body parts and appendages of female type series ($n = 7$) was as follows: body (excluding caudal rami) length 2063–2240 (2150 ± 65), cephalothorax length 857–989 (928 ± 46), cephalothorax width 1040–1202 (1095 ± 58), urosome length 714–865 (791 ± 53), genital complex length 206–254 (225 ± 18), genital complex width 270–297 (286 ± 10), anal somite length 119–126 (124 ± 2), anal somite width 142–162 (152 ± 7), caudal ramus length 133–145 (140 ± 4), caudal ramus width 63–70 (66 ± 2), caudal ramus length/width ratio 1.99–2.28 (2.16 ± 0.08), terminal segment length of leg 5 124–144 (134 ± 8), terminal segment width of leg 5 38–55 (44 ± 6), length/width ratio of terminal segment of leg 5 2.60–3.42 (3.09 ± 0.39).

Description of male allotype. Body (Fig. 3B) as in female, 1735 long, excluding caudal rami. Cephalothorax ovoid, shorter than wide 766×792 , widest at posterior 3/4. Urosome (Fig. 3B) 6-segmented, 629 long. Genital somite (Fig. 3C) shorter than wide 203×221 . Anal somite shorter than wide 75×122 . Caudal ramus longer than wide 93 ± 55 , with length/width ratio of 1.69. Sexual dimorphism distinctly present in antennule (Fig. 3D), antenna (Fig. 3E), and maxilliped (Fig. 3F). Antennule 7-segmented bearing 4 additional aesthetascs (Fig. 3D), with armature formula 4, 17+ 3 aesthetasc, 4, 3+ 1 aesthetasc, 4 + 1 aesthetasc, 2 + 1 aesthetasc, 7 + 1 aesthetasc; all setae naked. Antenna (Fig. 3E) as in female except proximal segment with long comb-like seta on distal margin. Maxilliped (Fig. 3F) 4-segmented; proximal segment rod-like bearing conical, subterminal process on inner margin and single row of spinules on outer distal corner; middle segment fusiform bearing 2 setae and 3 patches of spinules; third segment shortest, bearing 1 seta and 1 pointed process; terminal claw curved, with spinulated inner margin covered with spinules and bearing 1 seta. Legs 1 to 4 as in female. Leg 5 (Fig. 3C) with rod-like terminal segment, longer than wide 122×35 , with length/width ratio of 3.46, slender than that of female. Leg 6 (Fig. 3C) represented by 2 naked setae on posterolateral tip of genital flap.

Variability of measurement. Paratype males share all important morphological characters with the allotype. Measurement range of their body parts and appendages of male type series ($n = 3$) was as follows: body (excluding caudal rami) length 1600–1735 (1679 ± 70), cephalothorax length 727–766 (751 ± 21), cephalothorax width 773–840 (801 ± 34), urosome length 498–629 (567 ± 66), genital somite length 168–203 (183 ± 18), genital somite width 211–227 (220 ± 8), anal somite length 75–83 (80 ± 5), anal somite width 122–137 (129 ± 7), caudal ramus length 93–95 (94 ± 1), caudal ramus width 50–55 (53 ± 2), caudal ramus length/width ratio 1.69–1.85 (1.77 ± 0.08), terminal segment length of leg 5 109–127 (119 ± 9), terminal segment width of leg 5 28–35 (32 ± 4), length/width ratio terminal segment of leg 5 3.46–3.94 (3.78 ± 0.28).

Attachment site. In mantle cavity.

Remarks. The species of *Anthessius* can be separated into 2 groups according to the number of spines on the third exopodal segment of leg 4 of the female. The female of the new species has 3 spines on the terminal exopodal segment of leg 4. This condition is shared with the following 17 species, *A. atrinae* Suh & Choi, 1991, *A. dilatatus* (Sars, 1918), *A. graciliunguis* Do & Kajihara, 1984, *A. investigatoris* Sewell, 1949, *A. kimjensis* Suh, 1993, *A. leptostylis* (Sars, 1916), *A. longipedis* Ho & Kim, 1992, *A. lophiomi* Avdeev & Kazachenko, 1986, *A. navanacis* (Wilson, 1935), *A. nortoni* Illg, 1960, *A. pinnae* Humes, 1959, *A. placunae* Devi, 1984, *A. projectus* Kim, 1993, *A. proximus* Stock, Humes & Gooding, 1963, *A. saecularis* Stock, 1964, *A. sensitivus* Stock, Humes & Gooding, 1963, and *A. varidens* Stock, Humes & Gooding, 1963. Nine species, namely, *A. atrinae*, *A. dilatatus*, *A. graciliunguis*, *A. leptostylis*, *A. lophiomi*, *A. nortoni*, *A. pinnae*, *A. placunae*, and *A. saecularis*, are distinctly separated from the new species by the caudal ramus longer than 3 times of the width (vs. 2 times longer than wide in the new species). Three species, *A. kijimensis*, *A. navanacis*, and *A. projectus*, are differentiated from the new species by the terminal segment of leg 5 oval and shorter than twice the width, and by the maxilla bearing more than 5 teeth (vs. terminal segment of the leg 5 about 2.5 times longer than wide, and the maxilla with 3 teeth in the *A. isamusi* n. sp.). *Anthessius investigatoris*, *A. longipedis*, *Anthessius sensitivus* differ from the new species by the elongate terminal segment of leg 5 longer than 3 times of the width. *Anthessius varidense* differs from the new species by the following characters: the antenna bearing a very small inner most apical claw and 3 subequal claws

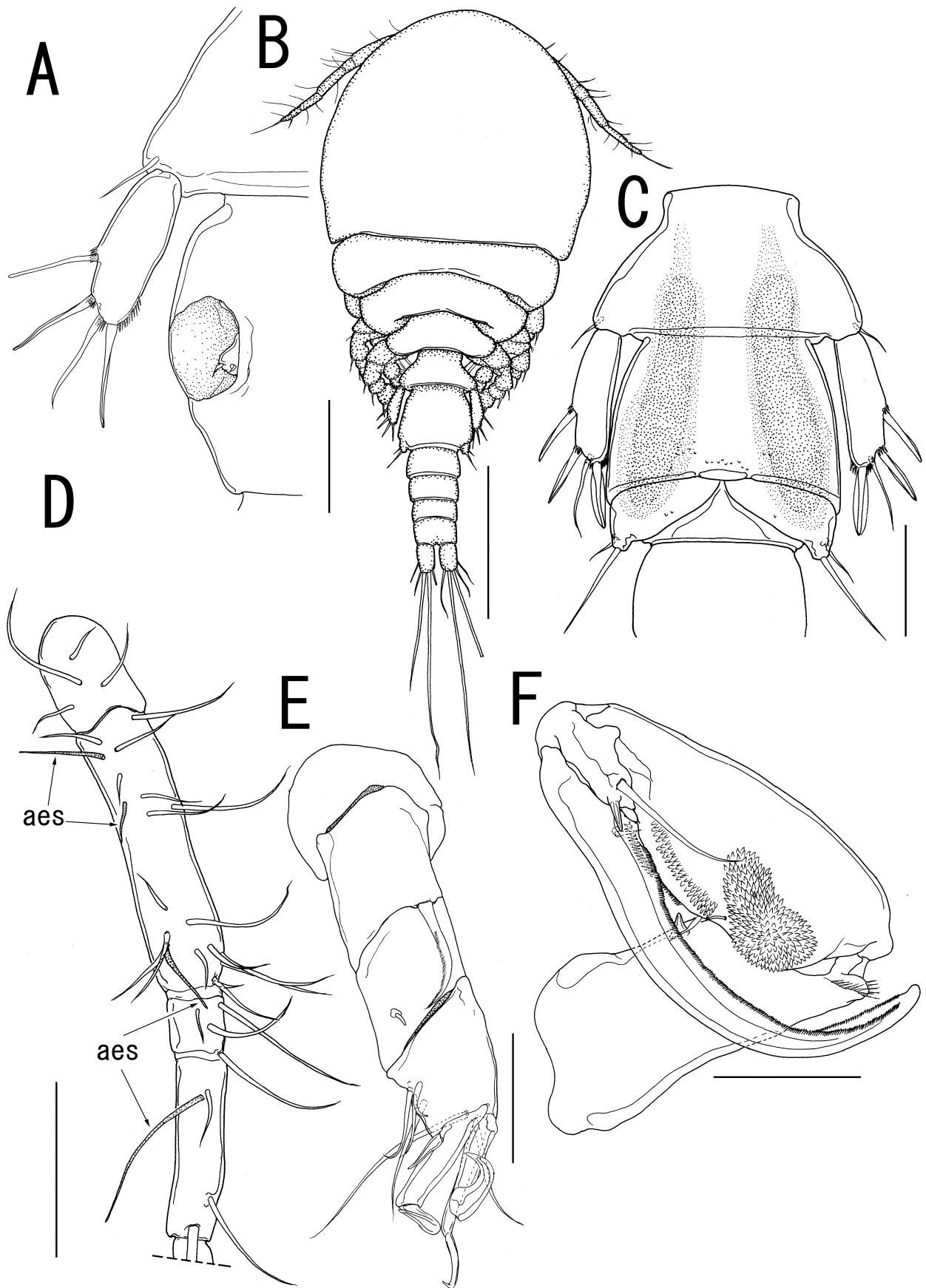


FIGURE 3. *Anthessius isamusi* n. sp., female, holotype NSMT–Cr 21665: A, leg 5 and genital complex, dorsal. *A. isamusi* n. sp., male, allotype NSMT–Cr 21666. B, habitus, dorsal; C, fifth pediger and genital somite, ventral; D, first to fourth segment of left antennule, posterior, aes = aesthetasc; E, left antenna, anterior; F, left maxilliped, posterior. Scale s: A, C, D, E, F = 100 μ m; B = 50 μ m.

distally, and the maxilla carrying 5 teeth without protuberance (vs. the antenna bearing 2 strong, 1 long, and 1 small claws distally, and the maxilla bearing only 3 teeth). *Anthessius proximus* differs from the new species by the following characters: the antenna with 4 strong claws distally, and leg 5 with the rows of inconspicuous spinnules at the basis on each 2 distal spines (vs. the rows of spinnules existing distinctly at the basis of distal 2 spines on leg 5 in the *A. isamusi* n. sp.).

Etymology. The specific name of the new species, *isamusi*, is derived from an arbitrary combination of “Isamu Nakayoshi” and “musi”. Isamu-san is a crackerjack fisherman in Kumejima Island and also a collector of the specimens of *T. marmoratus* for this study. He also supported the KUMEJIMA 2009 in various ways. “Musi” is a generic term for small animals in Japanese. The name “*isamusi*” alludes to the new species as “Isamu’s animal”, and it is also his nickname. The name is used as noun in apposition.

Discussion

The genus *Anthessius* now comprises 44 species, including 1 new species described in this study. Only two species, *A. pectinis* and *A. graciliunguis*, have been reported so far from Japanese waters (Do & Kajihara 1984; Tanaka 1961; Ueda *et al.* 2006). Among these 44 species, 21 of them (48%) are known from bivalves, but only 5 species (11%) have been found from prosobranchs (Devi 1984; Ho 1997; Kim 2009; present study, Table 1).

TABLE 1. Occurrence of the 44 species of *Anthessius* constructed after Ho (1997).

Occurrence	Number of species	Name of species
In weed washings	1	<i>A. brevifurca</i>
In plankton	5	<i>A. concinnus</i> , <i>A. dilatatus</i> , <i>A. graciliunguis</i> , <i>A. groenlandicus</i> , <i>A. investigatoris</i>
In bivalves	21	<i>A. alatus</i> , <i>A. amicalis</i> , <i>A. arenicola</i> , <i>A. atrinae</i> , <i>A. brevicauda</i> , <i>A. discipedatus</i> , <i>A. distensus</i> , <i>A. fitch</i> <i>A. graciliunguis</i> , <i>A. kimjensis</i> , <i>A. minor</i> , <i>A. mytilicolus</i> , <i>A. nosybensis</i> , <i>A. pectinis</i> , <i>A. pinctadae</i> <i>A. pinnae</i> , <i>A. placunae</i> , <i>A. projectus</i> , <i>A. saecularis</i> , <i>A. solecurti</i> , <i>A. solidus</i>
In prosobranchs	5	<i>A. isamusi</i> n. sp., <i>A. leptostylis</i> , <i>A. longipedis</i> , <i>A. sensitivus</i> , <i>A. teissieri</i>
In opisthobranchs	12	<i>A. arcuatus</i> , <i>A. dolabellae</i> , <i>A. hawaiiensis</i> , <i>A. lighti</i> , <i>A. navanacis</i> , <i>A. nortoni</i> , <i>A. obtusispina</i> <i>A. ovalipes</i> , <i>A. pleurobrancheae</i> , <i>A. proximus</i> , <i>A. stylocheili</i> , <i>A. varidens</i>
On fish	1	<i>A. lophiomi</i>

In this study, *A. isamusi* n. sp. is distinguished from its congeners by the following characters of the female: the unarmed anal somite on the ventral surface; the non-elongate caudal ramus; the antenna bearing 4 claws; the maxilla with 3 teeth; the fourth exopod with 3 spines on the terminal segment; and leg 5 with a rod-like, not extremely elongate terminal segment. These characters were utilized in the keys to species of *Anthessius* by Illg (1960) and Stock *et al.* (1963) and in a cladistic analysis by Ho (1997). Because the length to width ratio of the caudal ramus and the terminal segment of leg 5 cannot be used reliably all the time to distinguish between congeneric species, it is better, in addition to the ratio, to use the shape of the terminal segment of leg 5 and the relative length of the caudal ramus and the anal somite.

The gastropod host, *T. marmoratus*, is widely distributed in the tropical to subtropical waters of the Indo-West Pacific and is extensively consumed as food and adornment (Poutires 1998). The distribution of *Anthessius isamusi* n. sp. may be as widespread as the host. We also collected and examined a number of specimens of *T. marmoratus* at Moorea Island, the South Pacific Ocean, French Polynesia during Moorea Biocode Project, in November 2010 but did not find *A. isamusi* n. sp. Although *T. marmoratus* has been introduced into French Polynesia since the 1960s (Poutires 1998), the copepod may not have been introduced there.

Studies have reported damage caused due to the infection of *A. pinctadae* Humes, 1973 in the pearl oyster, *Pinctada maxima* (Jameson) in northern Australia (Humphrey *et al.* 1998; Jones 2007). *Anthessius isamusi* n. sp. may cause similar adverse impact on the gastropod host, however, no damage in *T. marmoratus* individuals carrying *A. isamusi* n. sp. in this study were found.

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