

Description of two species of *Protella* Dana, 1852 (Crustacea: Amphipoda): *P. gracilis* Dana, 1853, from Balabac Strait, the Philippines, and *P. amamiensis*, new species, from southern Japan

Ichiro Takeuchi^{1*}, Jacqueline Hui Chern Lim² & Yuki Inoue¹

Abstract. Two species of *Protella* Dana, 1852 (Crustacea: Amphipoda) are described in detail: *P. gracilis* Dana, 1853, based on type specimen collected from Balabac Strait, separating the Philippines and Borneo in the tropical Indo-Pacific and deposited in the Museum of Comparative Zoology, Harvard University; and *P. amamiensis*, new species, collected from Amami Islands, Ryukyu Archipelago, southern Japan, situated at the border of temperate and tropical regions in the northern Pacific. *Protella amamiensis*, new species, differs from *P. gracilis* in its 2-articulate pereopods 3 and 4, small penes, and elongated uropod 1.

Key words. description, *Protella amamiensis*, new species, *Protella gracilis*, Balabac Strait, Amami Islands

INTRODUCTION

Protella gracilis Dana, 1853 [sensu lato] (Crustacea: Amphipoda) was first described by Dana (1853) based on specimens collected from Balabac Strait, which is situated between the south end of Palawan Island, the Philippines and the northern tip of Borneo (north of Banggi Island, Sabah) in the tropical Indo-Pacific. However, no illustrations were provided. Dana (1855) subsequently provided illustrations for the descriptions of *P. gracilis* [sensu lato]. Dana's (1853, 1855) descriptions and illustrations of *P. gracilis* [sensu lato] were quite simple, which was usual for taxonomic descriptions in the 19th century. At the end of the 19th century, Mayer (1890) also described other specimens, believed to be *Protella gracilis* [sensu lato] at that time, collected from Misaki, south of Tokyo Bay, central Japan in the temperate northern Pacific. Mayer (1890) provided figures in four separate plates: pl. 1, showing a lateral body view of a male and dorsal view of pereonites 2 and 3; pl. 3, showing gnathopod 2 of mature and young males and a mature female, and pereopod 3 or 4 and its corresponding gill; pl. 5, showing abdomen of male (ventral and lateral view) and female; and lastly pl. 6, showing maxilliped and mandibular palp article 3. Subsequently, several descriptions on *P. gracilis* [sensu lato] were published based on specimens collected from central Japan (see Arimoto, 1929, 1976; Hiro, 1937; Utinomi, 1964). However, no detailed taxonomic comparison

of *Protella gracilis* [sensu lato] from the Philippines and from Japan has been conducted.

In this paper, the type material of *Protella gracilis* [sensu stricto] from Balabac Strait (deposited at the Museum of Comparative Zoology, Harvard University) was redescribed and illustrated in detail. *Protella gracilis* [sensu lato], newly collected from Amami Islands, southern Japan, was also described and illustrated. Comparison of *P. gracilis* [sensu lato] from southern Japan with types of *P. gracilis* [sensu stricto] revealed that they differ in several morphological characteristics such as pereopods 3 and 4, penes and abdominal appendages. Thus, *P. gracilis* [sensu lato] from Japan is described in this paper as a separate species, here named *P. amamiensis*, new species.

MATERIAL AND METHODS

Two type specimens of *Protella gracilis* contained in a vial were loaned from the Museum of Comparative Zoology, Harvard University. Pereopods left in the vial were mounted onto slides in polyvinyl-lactophenol. The lateral body view of somites and appendages were drawn under a microscope equipped with a camera lucida. About 15 specimens of *P. gracilis* [sensu lato] were collected from Amami Islands, southern Japan. The described specimen here was dissected under a binocular microscope. Gnathopod 1, pereopods 5–7 and mouthparts of the specimen were also mounted onto slides in polyvinyl-lactophenol. The lateral body view of somites, antennae, appendages, and mouthparts for *P. gracilis* [sensu lato] from Japan were also drawn under a microscope equipped with a camera lucida.

Type material of *P. amamiensis*, new species, are deposited at three museums: the Australian Museum, the Kitakyushu Museum of Natural History and Human History, and the

¹Department of Life Environment Conservation, Faculty of Agriculture, Ehime University, 3-5-7 Tarumi, Matsuyama, Ehime 790-8566, Japan; Email: takeuchi@agr.ehime-u.ac.jp (*corresponding author IT)

²School of Environmental & Natural Resource Sciences, Faculty of Science and Technology, Universiti Kebangsaan Malaysia, 43600 UKM Bangi, Selangor, Malaysia

Museum of Comparative Zoology, Harvard University. The familial classification of this study follows Takeuchi (1993). Abbreviations used are as follows: AM, the Australian Museum; KMNH, Kitakyushu Museum of Natural History and Human History; MCZ, the Museum of Comparative Zoology, Harvard University. A, antenna; ABD (L), abdomen lateral view; ABD (V), abdomen ventral view; G, gnathopod; GL, gill; LL, lower lip; MD, mandible; MX, maxilla; MXP, maxilliped; P, pereopod; UL, upper lip; L, left; R, right. The setal formula (1-x-y-1 or 1-x-1) is used to describe the setae on mandibular palp article 3.

TAXONOMY

Family Caprellidae Leach, 1814

Genus *Protella* Dana, 1852

Diagnosis. Head fused (suture present) with pereonite 1. Antenna 1 well developed; flagellum with more than 2 articles. Antenna 2 well developed; flagellum with 2 articles. Mandible well developed; molar present, well developed; palp 3-articulate, setal formula 1-x-y-1. Maxilliped well developed; inner plate (basal endite) smaller than outer plate (ischial endite); outer plate (ischial endite) well developed; palp article 3 without distal projection; palp article 4 well developed. Pereonite 4 clavate appendage absent. Pereonites 6 and 7 separated (dorsal suture oblique). Pereopod 3 vestigial, with 1–2 articles. Pereopod 4 vestigial, with 1–2 articles. Pereopod 5 well developed, with 7 articles, with sparse, short setae and well-developed dactylus. Pereopods 6 and 7 well developed, with 7 articles. Gills on pereonites 3 and 4. Pleopods absent. Uropods 2 pairs; Uropod 1 uniaarticulate, uniramous, with knob-like appendage. Uropod 2 uniramous, vestigial (unclear). Telson (dorsal lobe) present.

Remarks. Although the authors managed to clarify most of the generic diagnosis for *Protella* Dana, 1852, its mouthparts morphology are still unclear because the larger specimen among the types was lacking its head to pereonite 2 and the origin of the smaller specimen is questionable (see Remarks of *Protella gracilis* Dana, 1853). The state of its missing pereonites and consequently missing mouthparts such as maxilliped and mandibles, usually used for generic diagnosis, cannot be determined, and that is an issue because the genus *Protella* Dana, 1852, is one of the oldest genera in the Caprellidea, with several genera derived from this genus, i.e., *Paraprotella* Mayer, 1903, *Protellopsis* Stebbing, 1888, *Metaprotella* Mayer, 1890, and *Orthoprotella* Mayer, 1903. The diagnosis of antennae 1 and 2 and mouthparts are tentatively inferred from the descriptions of *Protella amamiensis*, new species. Thus, it is imperative that revision of the generic diagnosis for *Protella* and other related genera is conducted in the near future based on a complete specimen of *P. gracilis* [sensu stricto] collected from the type locality or adjacent areas by providing detailed descriptions and illustrations.

With respect to the generic diagnosis, it was recently determined that the fusion or distinct segmentation of

pereonites 6 and 7 is an important aspect of the Caprellidae (see Lim & Takeuchi, 2012). However, it has been widely described in many taxonomical papers of the Caprellidae as either “Pereonites 6 and 7 separated” like in most of the genera of the Caprellidae including *Caprella* (see Takeuchi, 1993; Krapp-Schickel & Takeuchi, 2005) or “Pereonites 6 and 7 completely fused (dorsal suture absent)” in the genus *Metaprotella* (Takeuchi & Lowry, 2007a; Lim & Takeuchi, 2012). Unlike the original figure of *P. gracilis* [sensu stricto] from Dana (1855), which showed pereonites 6 and 7 of *P. gracilis* clearly separated (as seen from pereonites 2–6), this study revealed that *P. gracilis* [sensu stricto] retained an intermediate trait between the two characteristics. Therefore, the generic diagnosis for *Protella* Dana, 1852, concerning fusion of pereonites 6 and 7 is revised to “Pereonites 6 and 7 separated (dorsal suture oblique).”

Protella gracilis Dana, 1853

(Figs. 1, 2)

Protella gracilis Dana, 1853: 812–813, 1855: 16, pl. 54 fig. 2a–f; Bate, 1862: 352, pl. 55 fig. 5; McCain & Steinberg, 1970: 69–70 (in part).

Material examined. Types, 1 male (pereonites 3–7) and 1 immature female, MCZ 1536, from U.S. Explor. Expedition.

Type locality. Balabac Strait, the Philippines, 56.7 meters and Singapore?

Description. Male, MCZ 1536. Body length, >11.17 mm. Head, pereonite 1 and pereonite 2 detached/missing. Pereonite 3, 3.27 mm, dorsally smooth. Pereonite 4, 3.27 mm, equal length with pereonite 3 with one rounded anterodistal projection and one rounded dorsodistal projection. Pereonites 5–7 dorsally and laterally smooth. Pereonite 5, 3.17 mm. Pereonite 6 shortest, 0.63 mm. Pereonite 7, 0.83 mm.

Pereon. *Gnathopods* 1–2 missing. *Pereopod* 3, 0.15× pereonite 3, uniaarticulate with 4 marginal setae and 1 long facial seta near distal margin, apically with 3 setae. *Pereopod* 4 shorter than pereopod 3 (0.7× shorter), 0.1× pereonite 4, uniaarticulate with 3 marginal setae and 1 long facial seta at distal margin, apically with 3 setae. *Pereopods* 5–7 well developed, becoming more robust progressively. *Pereopod* 5 basis subequal with ischium and merus combined, with short distal setae on inner and outer corner; ischium with setae on anterodistal corner; merus slightly expanded at posterodistal corner with tuft of setae; carpus longest, 1.7× merus with row of setae on entire inner margin, distally with one small rounded projection, posterodistally with tuft of setae; propodus subequal in length with basis, with a pair of proximal grasping spines, followed by fine marginal setae on palm and outer margin, distally with group of longer setae; dactylus well developed, falcate, length subequal with merus. *Pereopod* 6 basis with scarce marginal setae, distally with setae on inner and outer corner; ischium with setae on both distal corners; merus expanded at posterodistal corner, with tuft of setae and few fine setae on inner margin; carpus 1.4× longer than merus, inner margin with row of marginal setae, distally with one small projection, posterodistally with

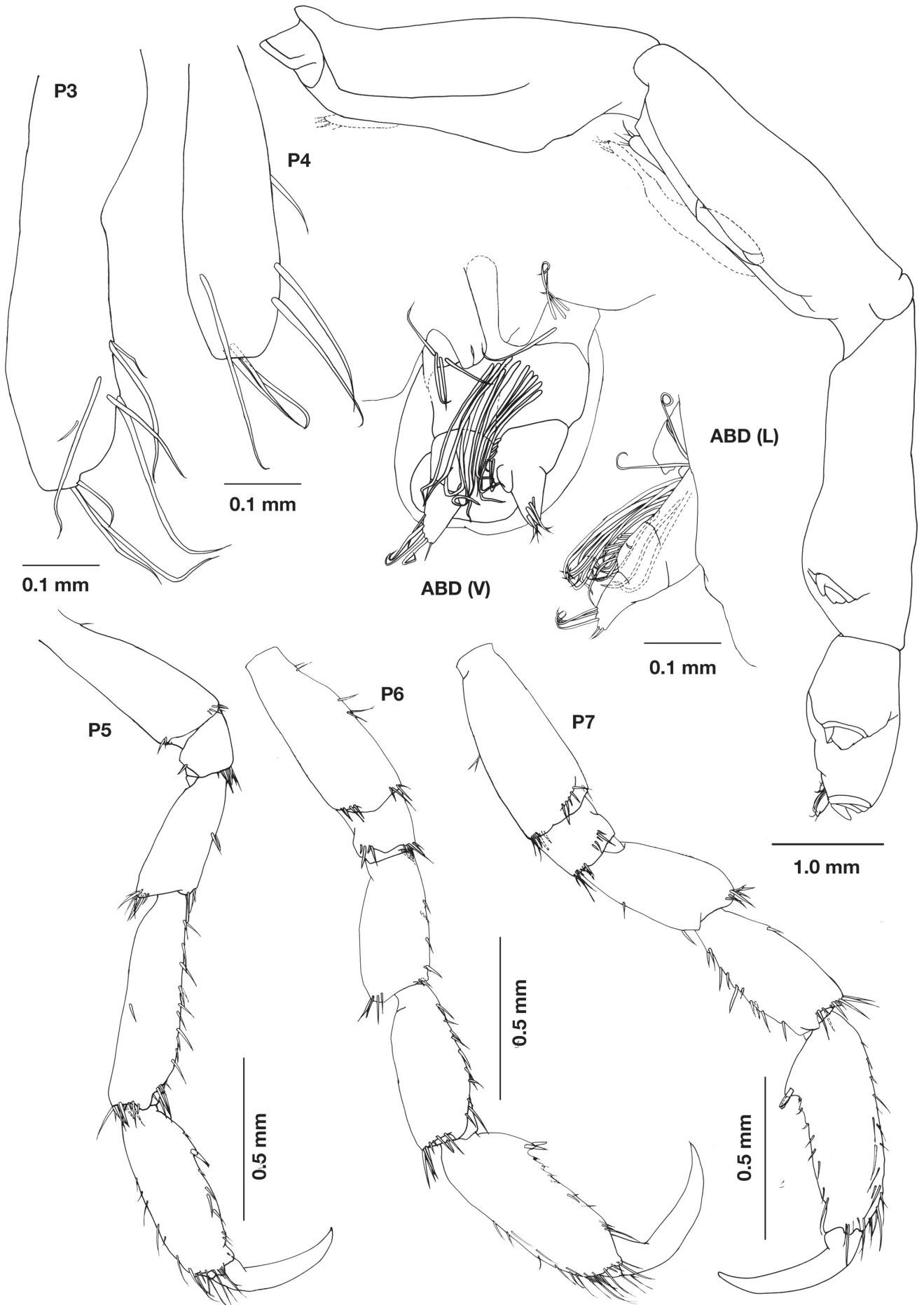


Fig. 1. *Protella gracilis* Dana, 1853, type, male, >8.85 mm, MCZ 1536, Balabac Strait, the Philippines.

tuft of setae; propodus 1.3× carpus, with a pair of grasping spines near proximal end of palm, palm with fine setae, outer margin with fine setae, becoming more dense and long moving towards distal margin of propodus; dactylus falcate. *Pereopod 7* basis subequal in length with basis of pereopod 5, with short distal setae on inner and outer corner; ischium with setae on inner and outer distal corner; merus expanded at posterodistal corner with tuft of setae; carpus 1.3× merus, inner margin with row of marginal setae, distally with one small triangular projection, posterodistally with tuft of setae; propodus with a pair of grasping spines at proximal end of palm, inner and outer margin of propodus with marginal setae, distally with longer setae; dactylus well developed, falcate, subequal in length to dactylus of pereopod 5.

Pleon. *Penes* large, bilobate, positioned medially. Tuft of 4 setae present between penes and uropod 1. *Uropod 1*

subconical; peduncle with a group of ca. 8 long setae, ramus triangular, subequal in length with peduncle, equipped with 3 long distal setae and 2 short apical setae and a small, knob-like appendage, 0.2× ramus, on distal margin. *Uropod 2* ramus very vestigial, confused with abdomen. *Telson* round.

Female (immature). MCZ 1536. Body length 6.77 mm. Head length 0.50 mm and pereonite 1, 0.25 mm; head and pereonite 1 fused, suture present; head smooth, no dorsal or lateral projections; eye round, distinctive. Pereonite 2, 1.05 mm, dorsally smooth. Pereonite 3, 1.45 mm. Pereonite 4, 1.30 mm. Pereonite 5, 1.38 mm. Pereonite 6, 0.48 mm. Pereonite 7, 0.36 mm. *Antenna 1* long, length 0.9× body length; peduncular article 2 longest, 2.1× peduncular article 1; peduncular article 3, 0.73× peduncular article 2; flagellum 0.95× peduncular length with >14 articles, proximal article composed of 3 articles. *Antenna 2* slender, 0.39× antenna

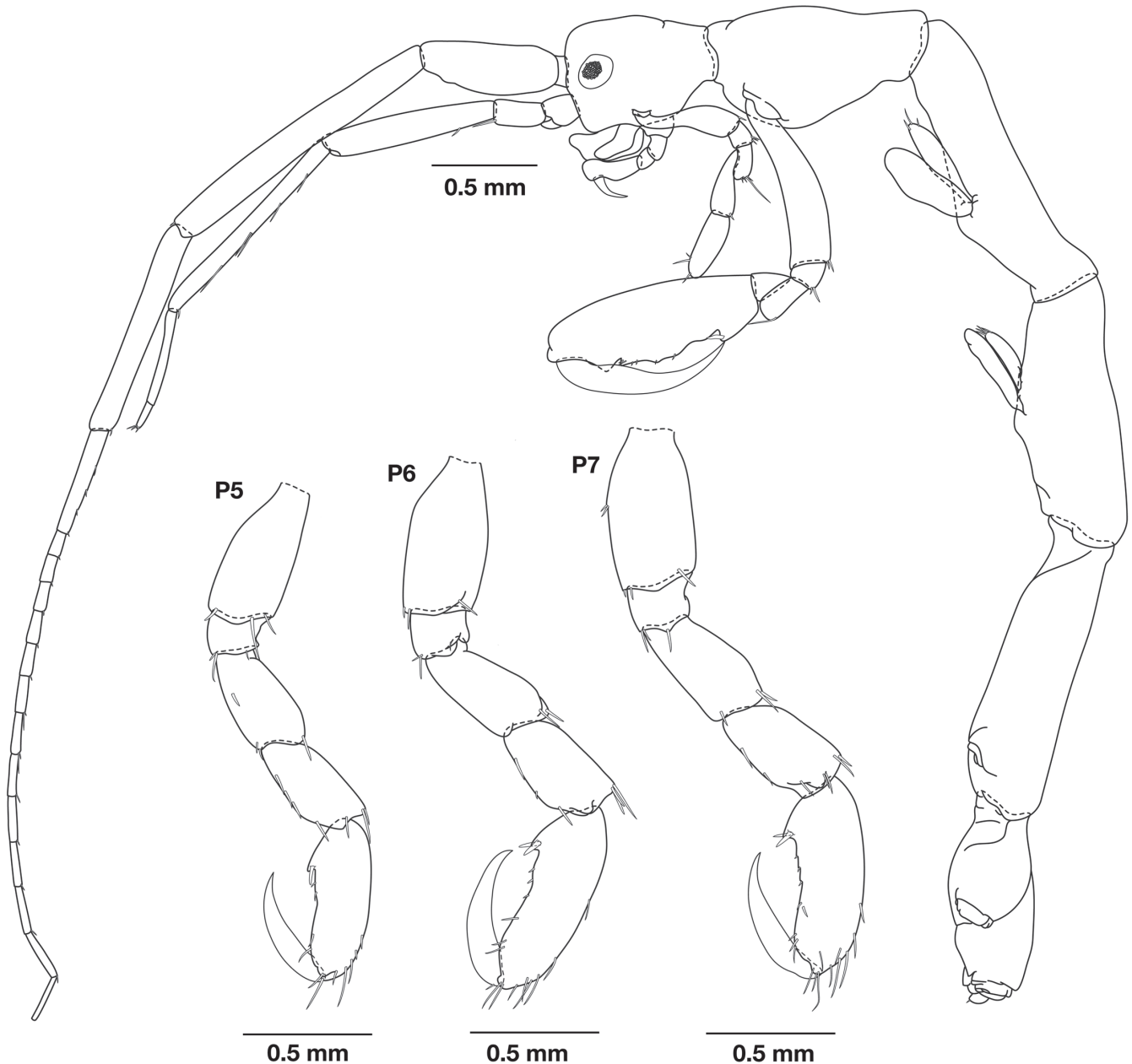


Fig. 2. *Protella gracilis* Dana, 1853, type, immature female, 6.77 mm, MCZ 1536, Balabac Strait, the Philippines, 56.7 meters or Singapore?

1; flagellum $0.25\times$ peduncle, 2-articulate, article 2, $0.33\times$ article 1.

Pereon. *Gnathopod 1* basis subequal with ischium, merus and carpus combined. *Gnathopod 2* begins $1/4$ along anterior margin of pereonite 2, basis subequal in length with pereonite 2, longer than ischium, merus, and carpus combined; propodus $1.2\times$ basis, longer than wide, palm of propodus, proximal projection with 1 grasping spine followed by 2 small projections, distally with 1 small projection and a sinus, followed by one larger triangular projection; dactylus slightly curved, fitting onto palm. *Gill 3* length $0.35\times$ pereonite 3, oval. *Pereopod 3* subequal with gill 3 length, $0.30\times$ pereonite 3, 1-articulate with 3 distal setae. *Gill 4* length $0.38\times$ pereonite 4, oval, subequal with gill 3. *Pereopod 4*, $0.25\times$ pereonite 4, $0.64\times$ gill 4, smaller than pereopod 3, 1 articulate with 4 distal setae. *Pereopods 5–7* well developed, becoming more robust progressively. *Pereopod 5* basis with 3 setae at distal margin; carpus subequal in length with merus; propodus subequal in length with basis, proximal projection with a pair of grasping spines, distal margin of propodus with 4 short and long setae; dactylus falcate. *Pereopod 6* basis with 3 setae on anterodistal and posterodistal corner; merus with 2 setae on posterodistal corner, carpus with one projection distally; propodus subequal in length with basis, proximal projection with a pair of grasping spines, distal margin of propodus with 8 short and long setae; dactylus falcate. *Pereopod 7* basis subrectangular; merus with 2 setae on posterodistal margin; carpus with one projection distally; propodus proximal projection with a pair of grasping spines; distal margin of propodus with 8 short and long setae; dactylus falcate.

Remarks. *Protella gracilis* [sensu lato] was originally described based on a mature male and female collected from Balabac Strait, south of the Philippine Islands in the tropical Indo-Pacific by Dana (1853). However figures of the types were only provided in Dana (1855), showing a mature male with a short portion of antenna 1 flagellum, pereopod 7 (propodus to dactylus) and a mature female with a short portion of antenna 1 flagellum. Figures of the head and pereonite 1 of another variety as well as a portion of a female gnathopod 2 (carpus to dactylus) were also provided (Dana, 1855). A few years later, Bate (1862) also cited the descriptions and figures of Dana (1853, 1855), followed by Mayer (1882) who referred to the distribution record of Dana (1853) in his description of *Protella gracilis* [sensu lato]. This species was then cited in Mayer (1890), whereby the author provided considerably more detailed figures of *Protella gracilis* [sensu lato] than those of Dana (1853, 1855) that were based on specimens collected from another locality, Misaki, situated near the opening of Tokyo Bay, central Japan. Mayer (1890) also stated that the present species was distributed in two localities: Balabac Strait, Cebu, Lapinig (on the north coast of Bohol), the Philippines, and Misaki, central Japan (about 48 km south of Tokyo).

Arimoto (1929) and Hiro (1937) described *P. gracilis* [sensu lato] from Tateyama Bay, near the opening of Tokyo Bay, and from Tanabe Bay, Kii Peninsula, central Japan, respectively.

McCain & Steinberg (1970) then recorded the type locality for this species as “Balabac Strait, Philippine Islands, 56.7 meters” and other records as “warm water species from Indo-Pacific Islands, Philippine Islands, and southern Japan”. Following that, Arimoto (1976) cited the descriptions and figures of Arimoto (1929) and reported similar “type locality” and “other records” as those of McCain & Steinberg (1970). In addition, the authors also provided detailed distribution data along the Japanese coasts.

The identification and records of *P. gracilis* [sensu lato] by the various authors above have been accepted thus far. Nevertheless, in recent years, Spalding et al. (2007) proposed a new global system for coastal and shelf areas called the “Marine Ecoregions of the World”, a brainchild resulting from the lack of detailed and comprehensive biogeographic system to classify the oceans. This system encompasses 232 ecoregions, in 62 provinces from 12 realms. According to this new system, Balabac Strait is situated in the Central Indo-Pacific (realm), Western Coral Triangle (province), Palawan/North Borneo (ecoregion), while, Misaki is situated in the Temperate Northern Pacific (realm), Warm Temperate Northwest Pacific (province), Central Kuroshio Current (ecoregion), a totally different realm from the type locality of *P. gracilis* in the Central Indo-Pacific. According to Spalding et al. (2007), each realm coincides with high levels of endemism, and this prompted the present authors to revise records of *P. gracilis* [sensu stricto] from the Philippines and *P. gracilis* [sensu lato] from Japan. Furthermore, Arimoto’s (1929) and Hiro’s (1937) records of *P. gracilis* [sensu lato] from Tateyama Bay and Tanabe Bay, Japan, are both situated in the same realm and province as Misaki, Japan.

Types that were deposited in the MCZ were loaned for comparisons with specimens from Japan. The types consist of a larger but damaged male and a smaller immature female plus six detached pereopods. In order to determine the origin of these pereopods (whether it belongs to the mature male or immature female), they were separated into 2 groups according to size (2.60–2.86 mm and 3.48–3.52 mm); the 3 larger pereopods were inferred to belong to the larger male while the 3 smaller ones to the immature female.

Dana (1853), provided the “length” of this species as “seven-eighths of an inch” (p. 813), which corresponds to 2.2 cm. But two years later, Dana (1855) also provided a body length on a caption for plate 54 and noted “*Protella gracilis*, male, enlarged two and a half diameters; a’, same, natural size, on a coral” (“diameters” should be cm). The body length of “a” on plate 54 is 16 mm (10.5 mm from pereonites 3–7), while “length” in Dana (1853, 1855), was 2.2–2.5 cm (including antennae and body somites). Thus, among the two type specimens, i.e., the larger male of 11.17 mm (from pereonites 3–7) described here is closer to the male described and figured in Dana (1853, 1855). However, the mature female that was described and illustrated in Dana (1853, 1855) is missing; therefore the immature female (Fig. 2) was described and illustrated here instead. In the vial containing the type specimens, the locality of the types were labelled as “Singapore ? / Balabac Str.” although the

distribution of this species from Singapore was never recorded clearly in any taxonomical studies (Dana 1853, 1855, Bate 1862, Mayer 1882, 1890). Furthermore, McCain & Steinberg (1970) recorded the distribution of this species as “Warm water species from the Indo-Pacific Islands, Philippine Islands, and southern Japan” in their species catalogue of Caprellidae of the world. As a result, it is likely that the smaller immature female type specimen, was collected from Singapore and placed in the vial of the types after Dana (1853, 1855), instead of the original mature female which was described and illustrated in Dana (1853, 1855).

***Protella amamiensis*, new species**
(Figs. 3–7)

***Protella gracilis*.** Mayer, 1890: 21–23, pl. 1 figs. 10–11, pl. 3 figs. 17–20, pl. 5 figs. 15–17, pl. 6 figs. 6, 21; ? Arimoto, 1929: 123–126, pl. 1 figs. 7–15; ? Hiro, 1937: 311, pl. 22 figs. 3–4; Utinomi, 1964: 14, 24–25, pl. 2 fig. 4; McCain & Steinberg, 1970: 69–70 (in part); ? Arimoto, 1976: 50–53, figs. 21–22; Arimoto & Kikuchi, 1977: 96–97, fig. 4K; ? Arimoto, 1980: 105; Takeuchi, 1999: 6. [not *Protella gracilis* Dana, 1853].

Material examined. **Holotype**, 1 male, KMNH IvR 500,682, 10.35 mm, off Sakinome, Amami Oshima Island, Amami Islands, Kagoshima Prefecture, Japan, 28°10'53"N, 129°15'46"E, hydroids, 17 m depth, 29 August 2000, coll. K. Hagiwara. **Paratype**, 1 male, KMNH IvR 500,683, 1 mature female, KMNH IvR 500,684, 1 mature female, KMNH IvR 500,685, 5 mature females, 1 premature female and 1 juvenile, KMNH IvR 500,686, 2 males and 2 mature

females, MCZ 25221, 1 male and 2 mature females, AM-P.90992, location and station data same as holotype.

Type locality. Amami Oshima Island, Amami Islands, Ryukyu Archipelago, Japan.

Other localities. Amakusa Islands, west coast of Kyushu, western Japan, Tanabe Bay, Kii Peninsula, Misaki, the entrance of Tokyo Bay, and ? Tateyama Bay, central Japan.

Etymology. Named after the type locality, Amami Oshima Island, Amami Islands.

Description. Male (holotype), Body length, 10.86 mm, KMNH IvR 500,682. Head, 0.61 mm. Pereonite 1, 0.56 mm. Head and pereonite 1 fused, suture present; head smooth, no dorsal or lateral projections; eye round, distinctive. Pereonite 2, 1.96 mm, dorsally smooth. Pereonite 3, 2.35 mm with 1 small anterolaeral round projection. Pereonite 4, 2.26 mm, subequal with pereonite 3. Pereonite 5, 2.00 mm. Pereonite 6, 0.56 mm. Pereonite 7, 0.56 mm. *Antenna 1*, 1.2× body length; peduncular article 1 with 5 fine/plumose proximal setae, article 2, 2.7× article 1, article 3 longest, 1.2× article 2, with fine marginal setae on inner and outer margin; flagellum 0.57× peduncle, with 19 articles, proximal article composed of 3 articles. *Antenna 2* slender, 0.38× antenna 1; peduncular article 1 short, gland cone reaching tip of peduncular article 2; peduncular article 2 scarcely setose; peduncular article 3, 3.7× article 2 with long and short

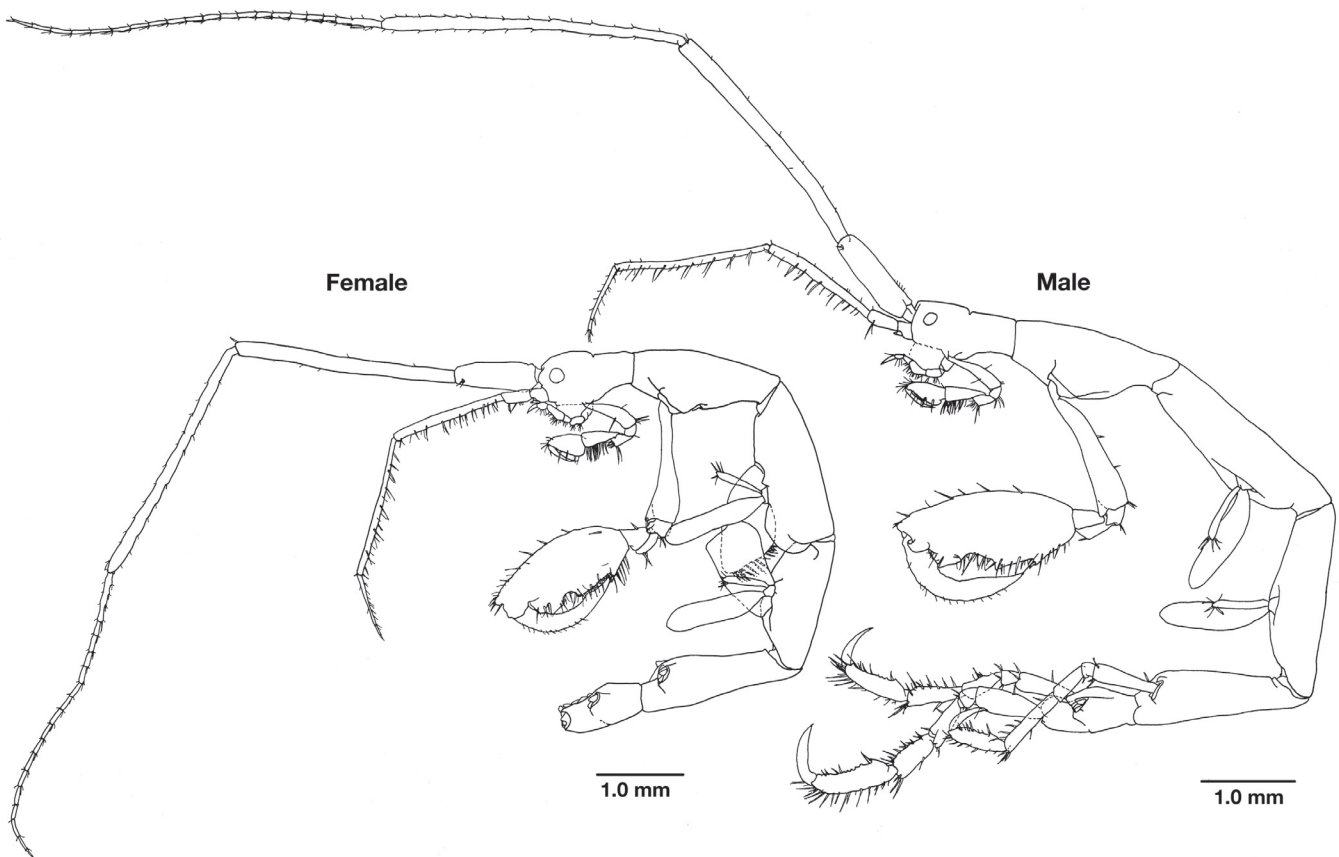


Fig. 3. *Protella amamiensis*, new species, holotype, male, 10.35 mm, KMNH IvR 500,682 and paratype, mature female, 9.48 mm, KMNH IvR 500,684, off Sakinome, Amami Oshima Island, Amami Islands, southern Japan.

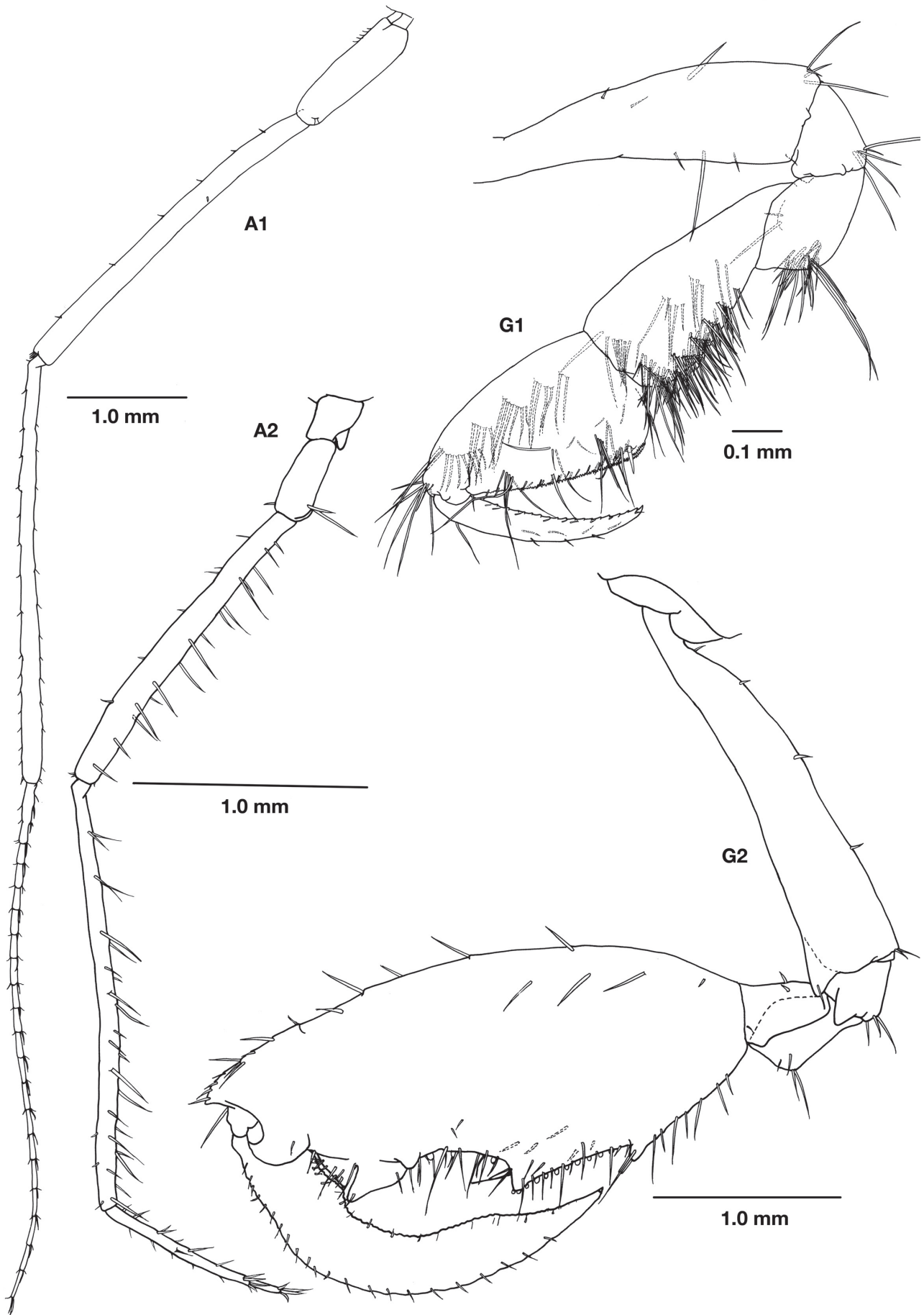


Fig. 4. *Protella amamiensis*, new species, holotype, male, 10.35 mm, KMNH IvR 500,682, off Sakinome, Amami Oshima Island, Amami Islands, southern Japan.

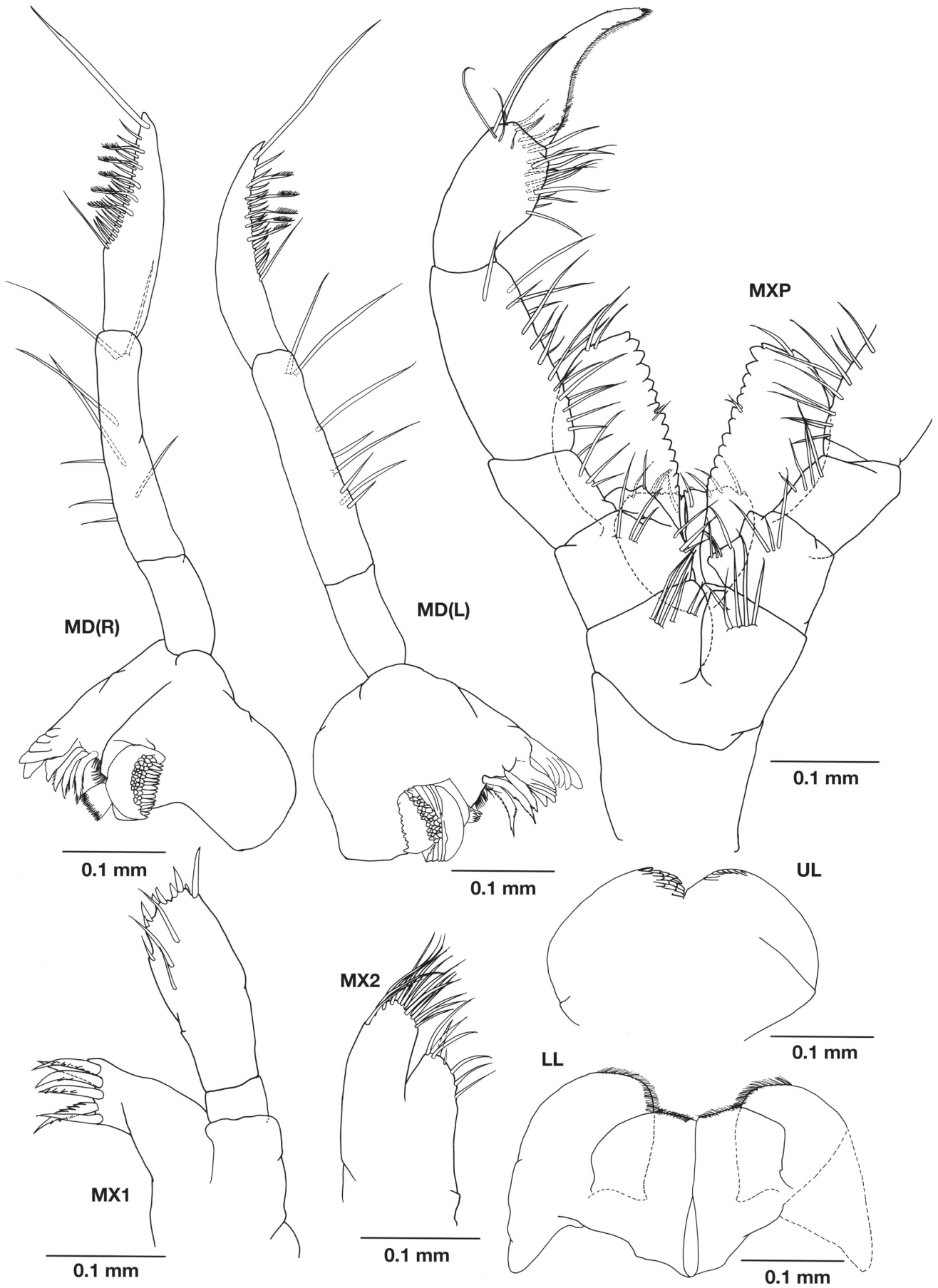


Fig. 5. *Protella amamiensis*, new species, holotype, male, 10.35 mm, KMNH IvR 500,682, off Sakinome, Amami Oshima Island, Amami Islands, southern Japan.

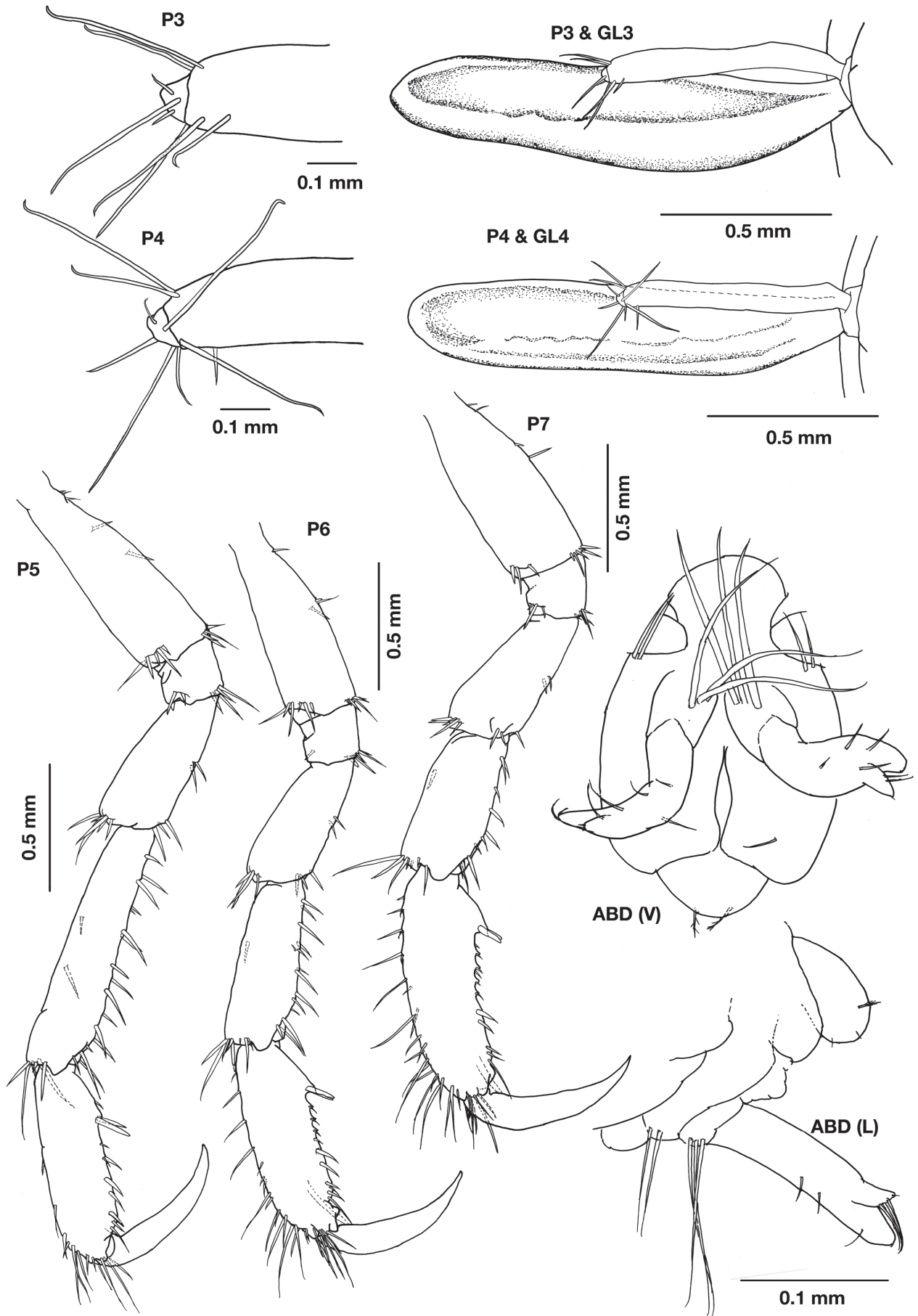


Fig. 6. *Protella amamiensis*, new species, holotype, male, 10.35 mm, KMNH IvR 500,682 (P3, P3 & GL3, P4, P4 & GL4, P5, P6, and P7) and paratype, male, 10.36 mm, KMNH KMNH IvR 500,683 [ABD(V) and (ABD(L))] off Sakinome, Amami Oshima Island, Amami Islands, southern Japan.

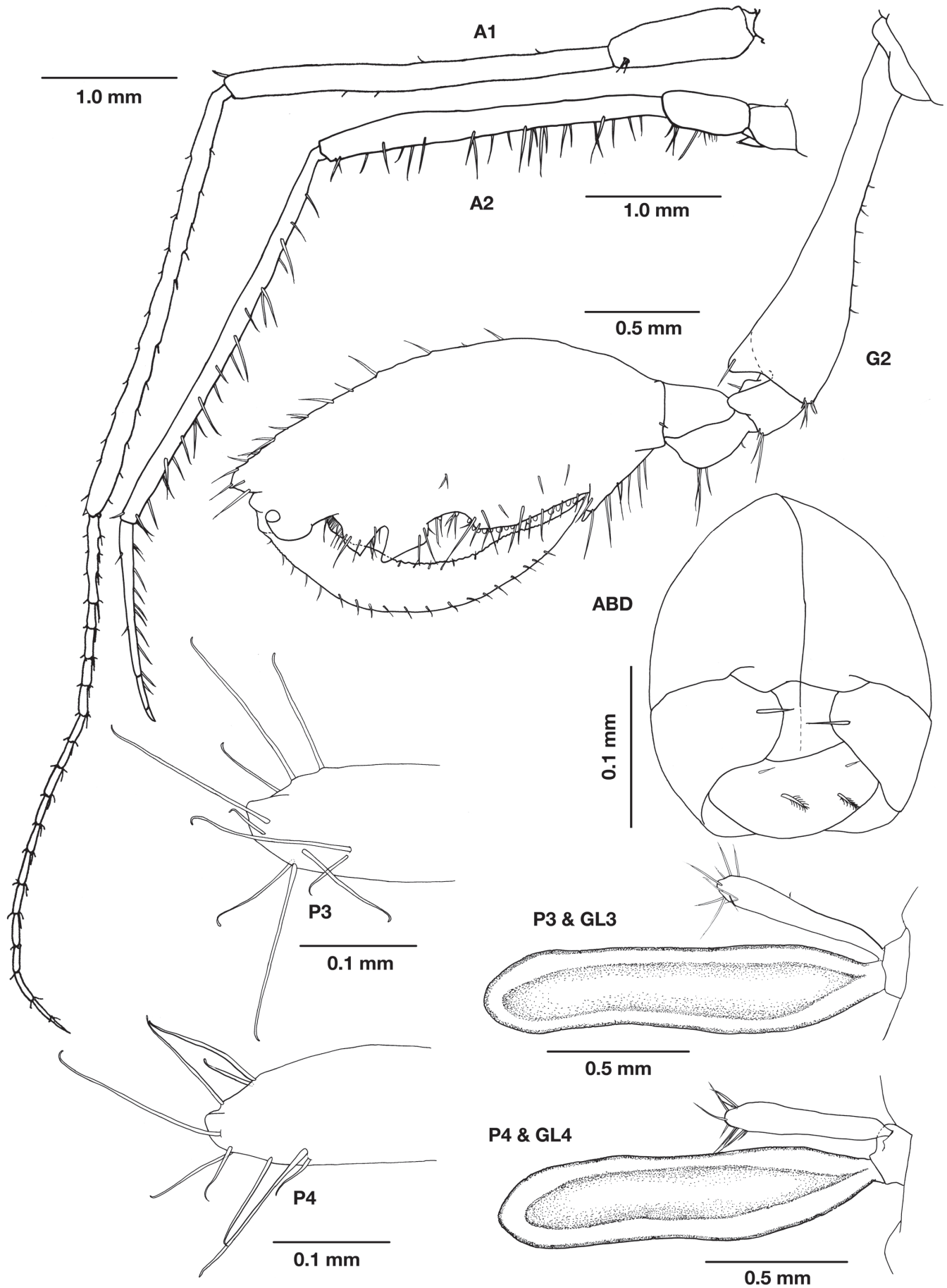


Fig. 7. *Protella amamiensis*, new species, paratypes, mature female, 9.48 mm, KMNH IvR 500,684 (A1, A2, G2, P3, P3 & GL3, P4, and P4 & GL4) and mature female, 10.65 mm, KMNH IvR 500,685 (ABD), off Sakinome, Amami Oshima Island, Amami Islands, southern Japan.

setae along ventral margin; article 4 longest, with long and short setae along ventral margin; flagellum $0.2\times$ length of peduncle, 2-articulate, article 2, $0.2\times$ article 1.

Upper lip notched, wider than deep, forming rounded quadrilateral projections each with rows of flake-like structures. *Lower lip* well developed, inner lobe distal margin pubescent, shoulders broad, with fine distal setae. *Mandible left* incisor with 5 teeth, lacinia mobilis with 5 teeth followed by 3 bundled setae and row of fine setae; molar flake present, small; molar well developed, truncate, edge serrated; palp 3-articulate, article 1 shortest, article 2, $2.5\times$ article 1, with 3 long and 3 short simple setae and 2 long distal setae, article 3 subequal in length with article 2, slightly curved, tapering towards tip with setal formula of 1-21-5-1. *Mandible right* incisor with 5 teeth, lacinia mobilis with many fine teeth followed by 3 bundled setae and row of fine setae; molar flake present, larger than left molar flake; molar well developed, truncate, terminally with teeth-like process; palp 3-articulate, subequal in length with left mandibular palp, article 2 with 3 long and 3 short simple setae and 2 long distal setae, article 3 tapering to a pointed tip with setal formula of 1-20-5-1. *Maxilla 1* inner plate absent; outer plate armed with 7 stout apical setal-teeth; palp biarticulate, article 1 short, article 2, $5.67\times$ article 1, subequal in length with outer plate, terminally with 7 short and 1 long robust setae, distally with row of 3 facial slender setae. *Maxilla 2* inner plate with 7 slender setae at distal margin; outer plate $0.7\times$ inner plate with 14 slender apical setae. *Maxilliped* basal endite (inner plate) with 2 stout tooth and 4 simple setae apically; ischial endite (outer plate) $2.2\times$ the length of inner plate with 2 simple setae apically, inner margin scalloped with 2 setae medially; palp 4-articulate, article 1 shortest, inner margin scarcely setose; article 2 longest, $2.3\times$ article 1, setose on entire inner margin; article 3, $0.8\times$ article 2, without triangular distal projection, distal margin with tuft of long and short setae; article 4 (dactylus) falcate, with row of setules on inner margin.

Pereon. *Gnathopod 1* basis subequal with merus and carpus combined; ischium posterodistal corner with several long and short setae; merus subquadrate, posteroventral corner setaceous; carpus subequal in length with propodus, posterior margin densely setaceous, facially with 4 rows of setae; propodus with 5 rows of submarginal setae, distal margin with several long setae, palm begins $1/5$ along posterior margin, straight, finely setose along entire margin, with 1 robust/stout proximal seta; dactylus slightly curved, inner margin with serriformed teeth. *Gnathopod 2* begins $1/3$ along anterior margin of pereonite 2, coxa bilobate; basis $1.2\times$ the length of pereonite 2, with an acute anterodistal projection equipped with 1 seta; ischium with an acute laterodistal projection; merus posteroventral corner with 4 setae; carpus subtriangular; propodus enlarged, $2.2\times$ as long as wide, anterodistal corner pronounced/acute, palm begins $1/3$ along posterior margin, proximal projection with 1 robust seta (grasping spine), mid-palmar triangular projection followed by a wide concaved area, and 2 additional triangular projections with a narrow sinus in between followed by a small triangular projection proximally, palm with pegs

between grasping proximal and mid-palmar projection, concaved area lined with setae; dactylus falcate with fine marginal setae on inner and outer margin. *Gill 3* length $0.6\times$ pereonite 3, oval. *Pereopod 3* slender, $0.3\times$ pereonite 3, 2-articulate; article 1 long, with 5 distal setae; article 2 small, $0.04\times$ article 1 with 1 long and 2 short apical setae. *Gill 4* length $0.6\times$ pereonite 4, oval. *Pereopod 4* slender, $0.3\times$ pereonite 4, subequal in length with pereopod 3, 2-articulate; article 1 with 6 distal setae; article 2 small, with 1 long and 2 short apical setae. Pereopods 5–7 well developed, basis and carpus of pereopods 5–7 becoming shorter and more robust progressively. *Pereopod 5* basis and ischium with 2–5 setae on antero and posterodistal corner; merus slightly expanded posterodistally with tuft of setae; carpus longest, $1.7\times$ merus with row of robust setae along entire inner margin, distally with one small triangular projection and 6 setae; propodus subcylindrical, same length as ischium and merus combined, with a pair of proximal grasping spines, palm with 9 setae, distal margin of propodus with group of longer setae; dactylus falcate, fitting onto palm, smooth. *Pereopod 6* basis shorter than pereopod 5 basis ($0.87\times$ shorter), with 5–6 setae on antero and posterodistal corner; ischium $0.25\times$ basis; merus slightly expanded posterodistally with tuft of setae; carpus $1.3\times$ merus, with row of robust setae along entire inner margin, distally with one small triangular projection and 8 setae; propodus same length as basis, palm with a pair of proximal grasping spines followed by several fine and robust setae, outer margin of propodus becoming more dense and long moving towards distal margin; dactylus falcate, fitting onto palm, smooth. *Pereopod 7* shorter than pereopod 5 but longer than pereopod 6, basis subequal in length with ischium and merus combined, with 3–5 setae on antero and posterodistal corner; merus expanded posterodistally; carpus subequal in length with merus, inner margin with row of robust setae, posterodistal corner with tuft of setae; propodus palm with a pair of proximal grasping spines followed by several fine and robust setae, outer margin with many long setae especially at distal margin; dactylus falcate, fitting onto palm, smooth.

Pleon (based on male, body length, 10.36 mm, KMNH IvR 500,683). *Penes* small, bilobate, positioned laterally. 2 setae present between penes and uropod 1. *Uropod 1* peduncle with 3 long setae; ramus elongated, $7\times$ peduncle and curved outwards, with 3–4 fine facial setae, distally with a small, knob-like appendage, equipped with 1 short and 3 long setae. *Uropod 2* ramus vestigial, with one seta. *Telson* round, with a pair of plumose setae.

Female (paratype), Body length, 9.48 mm, KMNH IvR 500,684. Head 0.69 mm. Pereonite 1, 0.48 mm. Head and pereonite 1 fused, suture present; head smooth, no dorsal or lateral projections; eye round, distinctive. Pereonite 2, 1.83 mm, dorsally smooth. Pereonite 3, 2.00 mm. Pereonite 4, 1.56 mm. Pereonite 5, 1.96 mm. Pereonite 6, 0.48 mm. Pereonite 7 equal with pereonite 6, 0.48 mm. *Antenna 1* long, $1.2\times$ body length; peduncular article 1 scarcely setose, peduncular article 2, $2.7\times$ longer than peduncular article 1, peduncular article 3 longest, $1.2\times$ article 2, with fine marginal setae on inner and outer margin; flagellum $0.55\times$ peduncle, with 17

articles, proximal article composed of 4 articles. *Antenna* 2 slender, $0.7\times$ antenna 1; peduncular article 1 short, gland cone reaching tip of peduncular article 2; peduncular article 2, $2.0\times$ article 1; peduncular article 3, $4.25\times$ peduncular article 2 with long and short setae along ventral margin; peduncular article 4 longest, $1.24\times$ peduncular article 3, with long and short setae along ventral margin; flagellum $0.22\times$ length of peduncle, 2-articulate, article 2, $0.2\times$ article 1.

Pereon. *Gnathopod* 2 begins $1/3$ along anterior margin of pereonite 2, coxa bilobate; basis $0.90\times$ the length of pereonite 2, with an acute anterodistal projection equipped with 1 seta; ischium with an acute laterodistal projection; merus posteroventral corner with several setae; carpus subtriangular; propodus enlarged, $1.25\times$ basis, $2.4\times$ as long as wide, anterodistal corner pronounced/acute, palm begins $1/4$ along posterior margin, proximal projection with 1 robust seta (grasping spine), mid-palmar triangular projection not distinct, followed by a concaved area, and 2 additional triangular projections with a narrow sinus in between, palm provided with pegs/serriformed teeth between grasping proximal and mid concaved area; dactylus falcate with fine marginal setae on inner and outer margin. *Gill* 3 length $0.8\times$ pereonite 3, oval and elongated. *Pereopod* 3 slender, $0.36\times$ pereonite 3, $0.46\times$ gill 3 length, 1-articulate with 10 distal setae. *Gill* 4 length $0.9\times$ pereonite 4, oval and elongated. *Pereopod* 4 slender, $0.40\times$ pereonite 4, $0.44\times$ gill 4 length, subequal in length with pereopod 3, 1-articulate with 9 distal setae.

Pleon (based on mature female, body length, 10.65 mm, KMNH IvR 500,685). *Uropod* 2 ramus vestigial, degenerated into 1 seta, present on inner margin. *Telson* round, with 1 pair of plumose setae and 1 pair of normal setae.

Remarks. The present specimens of *Protella gracilis* [sensu lato] were collected from Amami Islands, which are situated in the northern part of the Ryukyu Archipelago between Kyushu Island and Taiwan. According to Spalding et al. (2007), Amami Island is situated at the border of temperate and tropical regions, namely the Temperate Northern Pacific (realm), Warm Temperate Northwest Pacific (province), Central Kuroshio Current (ecoregion) and the Central Indo-Pacific (realm), South Kuroshio (province), South Kuroshio (ecoregion).

Compared with descriptions and figures of the types of *Protella gracilis* [sensu stricto], *Protella gracilis* [sensu lato] from Amami Islands, Japan differs in the following characteristics:

1. Pereopods 3 and 4 of the type specimen is 1-articulate, while that of *P. gracilis* [sensu lato] from Amami Islands is 2-articulate.
2. Penes of the type specimen is large with presence of 4 setae between penes and uropod 1, while *P. gracilis* [sensu lato] from Amami Islands is provided with 2 setae between penes and uropod 1.
3. Uropod 1 of the type specimen is short and subconical in shape with a group of 11 long setae at the base; ramus is subequal in length with peduncle with a very small

knob-like appendage. On the contrary, in *P. gracilis* [sensu lato] from Amami Islands, Japan, ramus of uropod 1 is elongated, ca. 7 times of peduncle with a knob-like appendage at distal margin, equipped with 3 long and 1 short setae.

Examination of the characters above showed that the difference in number of articles in pereopods 3 and 4 (1-articulate in *Protella gracilis* [sensu stricto]) could be due to the condition of the old material making it difficult to observe its segmentation. Meanwhile, character of the penes and abdomen are more distinctive. These clear differences indicate that *P. gracilis* [sensu lato] from Amami Islands, Japan, is a different species from the type *P. gracilis* [sensu stricto]. Moreover, the male type *P. gracilis* [sensu stricto] is estimated to be larger, 13.70 mm; by using the body somite ratio of *P. gracilis* [sensu lato] from Amami Islands, 9.48 mm. Thus, *P. gracilis* [sensu lato] from southern Japan is described as a separate species, *P. amamiensis*, new species, as described in this paper. Recently, Takeuchi & Lowry (2007b) reported that *Orthoprotella berentsae* Takeuchi & Lowry, 2007b, can be distinguished from *O. mayeri* K. H. Barnard, 1916, mainly by the characteristics of the uropod 1, although characteristics of body somites resemble each other.

Protella gracilis [sensu lato] was described and illustrated in detail based on specimens collected from the Temperate Northern Pacific in one of the 12 major realms (see Mayer, 1890; Arimoto, 1929, 1976). The characteristics of *P. amamiensis*, new species, agrees well with *P. gracilis* [sensu lato] in Mayer (1890) and Arimoto (1929, 1976) in: 1) antenna 1 longer than body length; 2) antenna 1 peduncular article 3 longest; 3) propodus of gnathopod 2 has two additional triangular projections near the middle region of the palm; 4) pereopods 3 and 4 are slender; and 5) uropod 1 is elongated. However, pereopods 3 and 4 of *P. amamiensis*, new species, are 2-articulated, while those of Mayer's (1890) and Arimoto's (1929, 1976) specimens are 1-articulated. In addition, uropod 1 of *P. amamiensis*, new species, and that of Mayer's (1890) specimen is curved outwards, while Arimoto's (1929, 1976) specimen is curved inwards. But as mentioned above, the segmentation of pereopods 3 and 4 could be sometimes obscured. These differences indicate that *Protella gracilis* [sensu lato] in Arimoto (1929, 1976) might be an undescribed species or subspecies of *P. amamiensis*, new species, endemic to the Temperate Northern Pacific. Further detailed studies on *Protella* spp. from different ecoregions along the Singapore coast and the Japanese Archipelago needs to be conducted in the near future.

ACKNOWLEDGEMENTS

We express our sincere thanks to Adam Baldinger, of the Museum of Comparative Zoology, Harvard University, for loaning the types of *Protella gracilis* [sensu stricto] and Kiyoshi Hagiwara, the Yokosuka City Museum for kindly providing us the specimens of *P. amamiensis*, new species, collected from Amami Islands, southern Japan. The present study was conducted at the Faculty of Agriculture, Ehime

University and the Faculty of Science and Technology, Universiti Kebangsaan Malaysia (UKM). We would also like to express our thanks to Othman bin Haji Ross for his kind support and usage of research facilities at UKM.

LITERATURE CITED

- Arimoto I (1929) Caprellidae: Amphipoda of Tateyama Bay. Journal of Tokyo Natural History Society, 27: 115–125, pl. 1.
- Arimoto I (1976) Taxonomictudies of caprellids (Crustacea, Amphipoda, Caprellidae) found in the Japanese and adjacent waters. Special Publications from the Seto Marine Biological Laboratory, Kyoto University, 3: 1–229.
- Arimoto I (1980) Supplements to the Japanese caprellid fauna. I. Caprellids from the Korean Straits and adjacent waters. Publications from the Seto Marine Biological Laboratory, Kyoto University, 25: 95–113.
- Arimoto I & Kikuchi T (1977) Caprellids obtained in the vicinity of Amakusa Islands, west Kyushu. Publications from the Amakusa Marine Biological Laboratory, Kyushu University, 4: 91–98.
- Barnard KH (1916) Contributions to the Crustacean fauna of South Africa. 5. Annals of the South Africa Museum, 12: 105–302, pls 26–27.
- Bate CS (1862) Catalogue of Specimens of Amphipodous Crustacea in the Collection of the British Museum, London. 399 pp., 58 pls.
- Dana JD (1852) On the classification of the Crustacea Chrostopoda or Tetradeapoda. American Journal of Science and Arts, Series 2, 14: 297–316.
- Dana JD (1853) Crustacea. Part II. United States Exploring Expeditions. During the Years 1838, 1839, 1840, 1841, 1842. Under the Command of Charles Wilkes, U.S.N. 14: 689–1618.
- Dana JD (1855) Atlas. Crustacea. United States Exploring Expeditions. During the Years 1838, 1839, 1840, 1841, 1842. Under the Command of Charles Wilkes, U.S.N. 3–27: pls 1–96.
- Hiro F [= Utinomi H] (1937) Caprellids from Tanabe Bay. Annotationes Zoologicae Japonenses, 16: 310–317, pl. 22.
- Krapp-Schickel T & Takeuchi I (2005) A new species of *Caprella* (Amphipoda: Caprellidae) from the Cape Verde Islands (Atlantic), with note on Mediterranean *Caprella liparotensis*. Journal of the Marine Biological Association of the United Kingdom, 85: 95–100.
- Lim JHC & Takeuchi I (2012) The distinctive species characteristics of *Metaprotella sandalensis* Mayer, 1898 (Crustacea: Amphipoda), commonly distributed throughout the tropical West Pacific coasts. Raffles Bulletin of Zoology, 60: 23–34.
- Mayer P (1882) Caprelliden. Fauna und Flora des Golfes von Neapel, 6: 1–201, pls. 1–10.
- Mayer P (1890) Die Caprelliden des Golfes von Neapel und der angrenzenden Meeres-Abschnitte. Fauna und Flora des Golfes von Neapel, 17: 1–157, pls. 1–7..
- Mayer P (1903) Die Caprelliden der Siboga-Expedition. Siboga-Expeditie, 34: 1–160, pls. 1–10.
- McCain JC & Steinberg JE (1970) Amphipoda-1, Caprellidea-1. Crustaceorum Catalogus, 2: 1–78.
- Spalding MD, Fox HE, Allen GR, Davidson N, Ferdaña ZA, Finlayson M, Halpern BS, Jorge MA, Lombana A, Lourie SA, Martin KD, Mcmanus E, Molnar J, Recchia CA & Robertson J (2007) Marine ecoregions of the world: A bioregionalization of coastal and shelf areas. BioScience, 57: 573–583.
- Stebbing TRR (1888) Report on the Amphipoda collected by H.M.S. Challenger during the years 1873–76. Report on the Scientific Results of the Voyage of H.M.S. Challenger during the Years 1873–76, Zoology, 29: xxiv + 1–1739.
- Takeuchi I (1993) Is the Caprellidae a monophyletic group? Journal of Natural History, 27: 947–964.
- Takeuchi I (1999) Checklist and bibliography of the Caprellidae (Crustacea: Amphipoda) from Japanese waters. Otsuchi Marine Science, 24: 5–17.
- Takeuchi I & Lowry JK (2007a) Description of *Metaprotella haswelliana* (Mayer, 1882) (Crustacea: Amphipoda: Caprellidae) from Western Australia with designation of a neotype. Zootaxa, 1466: 11–18.
- Takeuchi I & Lowry JK (2007b) Redescription of *Orthoprotella mayeri* K.H. Barnard, 1916 (Amphipoda: Caprellidae) from Cape Province, South Africa and description of *O. berentsae* sp. nov. from New South Wales, Australia. Zootaxa, 1632: 37–48.
- Utinomi H (1964) [Caprellidae]. In: Kikuchi T (ed.) [Fauna and Flora of the Sea around the Amakusa Marine Biological laboratory, Part V. Amphipod Crustacea]. Amakusa Marine Biological Laboratory, Kyusyu University, Kumamoto, Japan, pp. 11–15, 22–25. [in Japanese]