

New Record of a Crangonid Shrimp, *Aegaeon rathbuni* (Crustacea: Decapoda: Caridea) from Japan, with Notes on Its Tegumental Scales

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Abstract The geographical range of a deep-water crangonid shrimp, *Aegaeon rathbuni* (De Man, 1918), is extended north in the Northwestern Pacific from Taiwan to Boso Peninsula, central Japan. Description and illustrations are given in order to supplement the taxonomic information of this species. Close examination has shown that *A. rathbuni* has minute tegumental scales on the body integument. This discovery represents the first certain example of the crangonid species having tegumental scales. A preliminary examination of selected species from *Aegaeon* and the two closely related genera, *Pontocaris* and *Parapontocaris*, has been made, and the presence of the tegumental scales is confirmed only in the congeneric *A. lacazei* (Gourret, 1887).

Key words: *Aegaeon rathbuni*, Caridea, Crangonidae, new record, Japan, tegumental scales.

Species of the crangonid genus *Aegaeon* Agassiz, 1846 are burrowing shrimp of warm temperate and tropical waters. Chan (1996) reinstated *Aegaeon* as a valid genus and clarified its status and nomenclature, assigning five species formerly included in the genus *Pontocaris* Bate, 1888. From Japanese waters, only one species, *A. lacazei* (Gourret, 1887) is known with certainty (Chan, 1996). Although Hayashi (1986) reported *A. rathbuni* De Man, 1918 (as *Pontocaris rathbuni*) from Tosa Bay, southern Japan, as Chan (1996) indicated, Hayashi's photographed specimen certainly represents a species other than *Aegaeon* or other closely related genera. Examination of deep-water samples from off Boso Peninsula, central Japan, and the East China Sea led to the determination that *Aegaeon rathbuni* is present in Japanese waters. Although the species was clearly diagnosed by Chan (1996), morphological details of this species has not been fully described. Therefore, I present here detailed description and illustrations of some selected parts for better understanding of morphology of *A. rathbuni*. The present study also shows the presence of the tegumental scales in the two species of

Aegaeon, *A. rathbuni* and *A. lacazei* (Gourret, 1887). This finding represents the first certain example of species which have the tegumental scales in Crangonidae.

Materials and Methods

The specimens examined in this study are deposited in the collection of the Natural History Museum and Institute, Chiba (CBM). The illustrations were prepared with the aid of a drawing tube mounted on a LEICA MZ8 stereomicroscope. The postorbital carapace length (cl) is used as a standard measurement indicating the size of specimen. The specimens were stained by methylen blue for detailed observation.

For comparative purpose, the following specimens have been examined.

Aegaeon lacazei (Gourret, 1887). Off Ta-Shi, I-Lan County, NE Taiwan, 100–200 m, 03. VIII. 1996, commercial trawler, coll. T. Komai, 1 female (cl 10.3 mm) (CBM-ZC 2766); off Shionomisaki, Kii Peninsula, Japan, 100 m, 20. I. 1992, dredge, coll. S. Nagai, 1 female (cl 9.1 mm) (CBM-ZC 2947).

Parapontocaris aspera Chace, 1984. Off Ta-Shi, I-Lan County, NE Taiwan, 300–400

m, 04. XII. 1997, commercial trawler, coll. T. Komai, 1 male (cl 14.0 mm), 1 female (cl 13.5 mm) (CBM-ZC 3883).

Pontocaris pennata Bate, 1888. Tosa Bay, Kochi, Shikoku, Japan, 33°20.79'N, 133°36.81'E, 92–94 m, beam trawl (RV "Toyohatamaru"), coll. K. Sasaki, 1 female (cl 11.5 mm) (CBM-ZC 3380).

Pontocaris sibogae (De Man, 1918). Off Kakeroma Island, Amami Islands, Japan, 28°04.71'N, 129°27.38'E, 310 m, 10. XI. 1994, sledge net (TRV "Toyoshio-maru"), coll. I. Takeuchi, 1 female (cl 12.8 mm) (CBM-ZC 1977).

Taxonomy

Aegaeon rathbuni De Man, 1918

(Figs. 1–3)

Restricted synonymy.

Egeon orientalis: Rathbun, 1906: 911, pl. 23, fig. 3. Not *Egeon orientalis* Henderson, 1893.

Aegaeon Rathbuni De Man, 1918: 304 (type locality: Borneo, Indonesia); 1920: 300, pl. 24, fig. 74b, pl. 25, fig. 74–74a.

Pontocaris rathbuni: Chace, 1984: 44.

Aegaeon rathbuni: Chan, 1996: 281, fig. 4.

Not *Pontocaris rathbuni*: Hayashi, 1986: 147, fig. 97. See "Remarks".

Material examined. RV "Tansei-maru": KT 95–5, stn TB 14, off Taito-saki, Boso Peninsula, 35°09.6'N, 140°49.4'E, 311–325 m, 24. IV. 1995, coll. T. Komai, 1 male (cl 9.3 mm) (CBM-ZC 2478).

RV "Yoko-maru": stn E300–5, W of Tokara Islands, East China Sea, 28°57.00'N, 127°06.20'E, 307 m, 24. X. 1997, coll. T. Kosuge, 1 male (cl 7.3 mm) (CBM-ZC 5396).

TRV "Shin'yo-maru": SY99, stn 3, W of Izu Oshima Island, Izu Islands, 34°46.39'N, 139°20.07'E, 260–251 m, 15. X. 1999, coll. M. Osawa, 1 male (cl 7.8 mm) (CBM-ZC 5658).

Description (males). Body slender (Fig. 1). Integument of body not very firm.

Rostrum short, not reaching distal margin of cornea of eye, deeply bifurcate distally; dorsal surface deeply concave with raised lateral margins; lateral margin with 1 acute tooth.

Carapace (Figs. 1, 2A, E) partially covered with minute tegumental scales (partially

dense) and short setae; antennal spine moderately strong; branchiostegal spine moderately strong, directed forward; pterygostomial spine tiny; median carina armed with 5 acute teeth, third tooth smaller than or subequal in size to other teeth; first lateral carina armed with 7 acute teeth, continuous with lateral rostral carina; second lateral carina with 8–10 acute teeth, becoming weaker posteriorly, not continuous with antennal spine; third lateral carina with 5 or 6 acute teeth in anterior half, smooth in posterior half, continuous with branchiostegal spine; hepatic groove rudimentary, represented by shallow depression inferior to second tooth of second lateral carina.

Abdomen (Fig. 1) with 2 lateral pairs of longitudinal carinae on first to fifth somites, in line with first and second lateral carinae on carapace. First somite with sharp submedian carinae each terminating anteriorly in acute submarginal spine; second and third carinae sharp, each terminating anteriorly in acute marginal spine; pleuron with broadly rounded ventral margin. Second somite with median carina broadened posteriorly, terminating anteriorly in acute submarginal spine, dorsal surface of median carina shallowly sulcate; second carinae sharp, unarmed anteriorly; third carina rather blunt; post-erodorsal margin of tergum with shallow median notch; pleuron with broadly rounded ventral margin. Third somite with median carina slightly broadened posteriorly; first carina not very sharp, unarmed; post-erodorsal margin without distinct median notch; pleuron obtusely angular at anteroventral corner. Fourth abdominal somite with median carina slightly narrowed posteriorly; lateral surface with 3 blunt obliquely longitudinal carinae, third carina joined posteriorly with short vertical carina; post-erodorsal margin with blunt median tooth; pleuron obtusely angular at anteroventral corner, with small, acute posteroventral tooth. Fifth somite with sharp, posteriorly divergent submedian carinae, each terminating in acute marginal tooth; first and second carinae both sharp, but unarmed; pleuron with angular ventral margin, posterolateral margin with 2 acute or blunt projections. Sixth somite 1.5 times longer than fifth

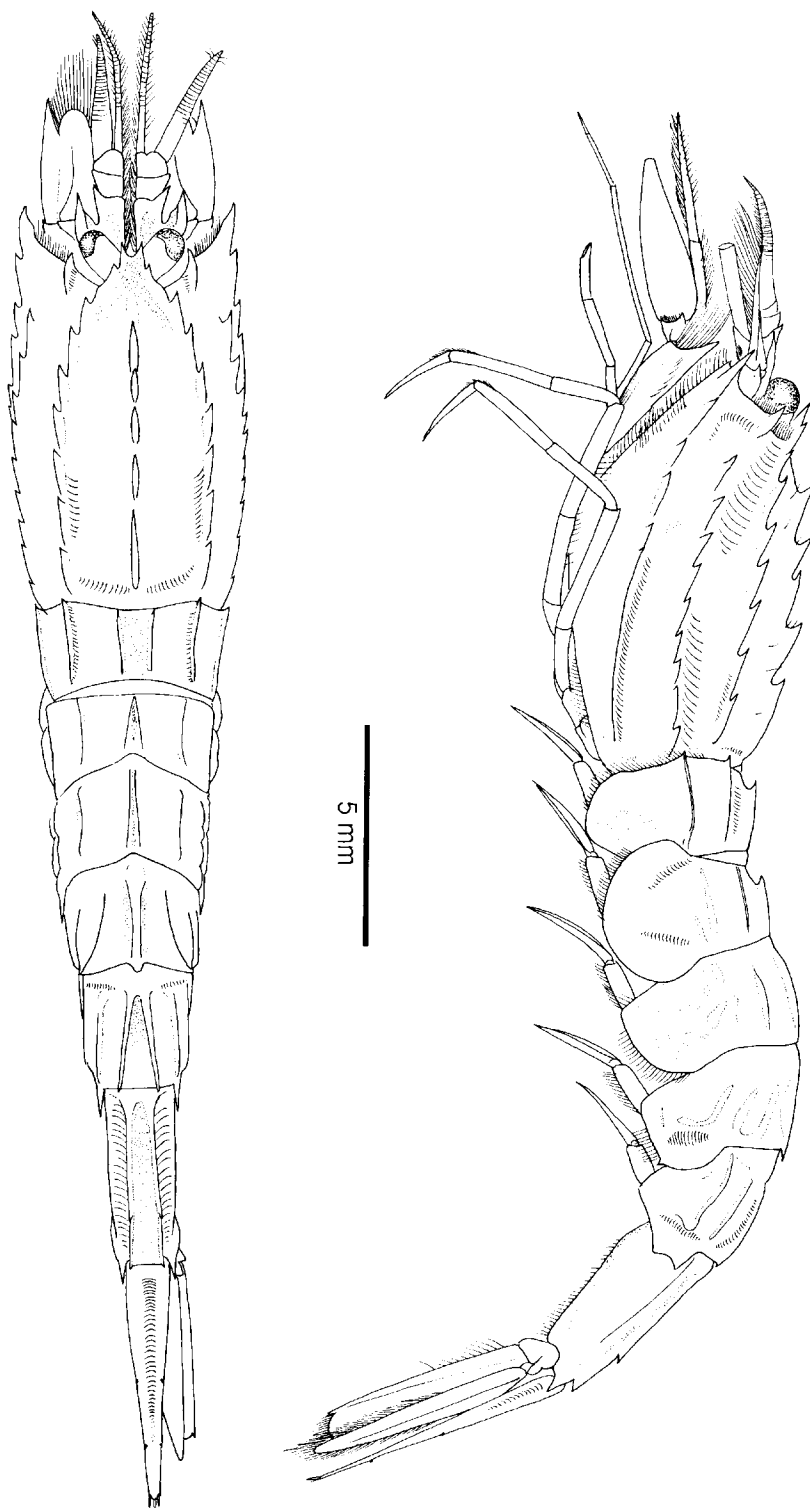


Fig. 1. *Aegaeon rathbuni* (De Man, 1918). Male from west of Tokara Islands, East China Sea (cl 7.3 mm; CBM-ZC 5396). Top, entire animal in lateral view; bottom, same, dorsal view.

somite, 2.3 times longer than anterior depth; dorsal surface with 2 sharp submedian carinae, slightly divergent posteriorly, each terminating posteriorly in small acute marginal

tooth, armed with small, acute tooth arising from 0.7 length; dorsolateral carina sharp, extending to level of dorsal tooth on submedian carinae; no anteroventral ridge on

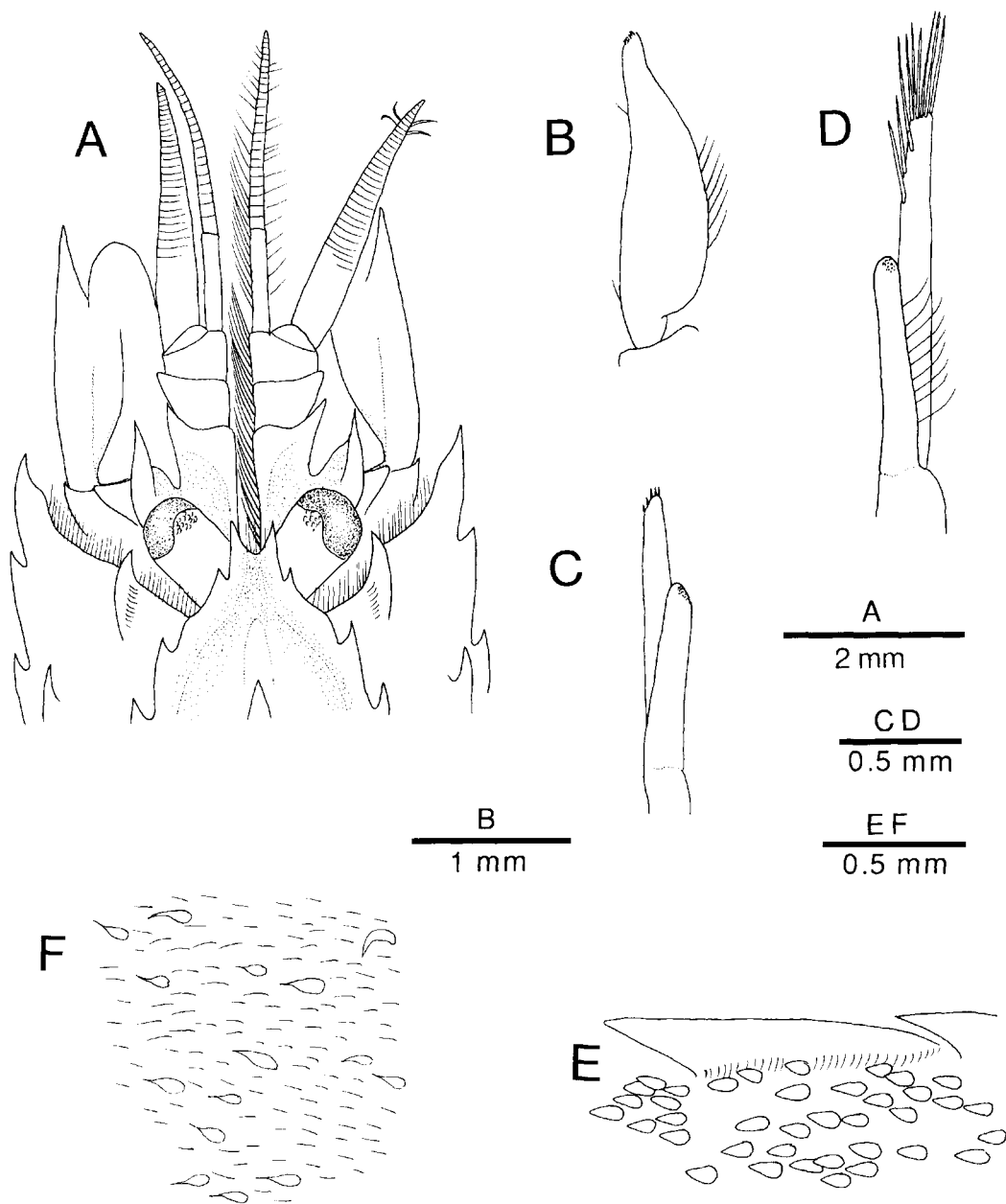


Fig. 2. A-E, *Aegaeon rathbuni* (De Man, 1918): A-C, E, male from W of Tokara Islands, East China Sea (cl 7.3 mm; CBM-ZC 5396); D, male from off Taitosaki, Boso Peninsula (cl 9.3 mm; CBM-ZC 2478); F, *Aegaeon lacazei* (Gourret, 1887), female from off Shionomisaki, Kii Peninsula (cl 10.3 mm; CBM-ZC 2766). A, anterior part of carapace and cephalic appendages, dorsal, setae partially omitted; B, endopod of first pleopod, dorsal; C, D, appendix masculina and interna of second pleopod, dorsomesial; E, F, tegumental scales on carapace.

lateral face; posterolateral process acute; posteroventral corner rounded; ventral surface concave, with ventrolateral margins elevated and bluntly ridged; preanal spine small. Telson 1.4 times longer than sixth abdominal somite, gradually tapering posteriorly to acute median process, armed with 2 pairs of tiny dorsolateral spines, and 2 pairs of posterior spines (mesial spine much longer than lateral spine) and 1 pair of plumose setae on either side of posteromedian process; dorsal surface deeply sulcate.

Thoracic sternite armed with long, forwardly directed tooth on sixth somite between coxae of third pereopods; seventh and eighth somites each with sharp median carina terminating anteriorly in small tooth between coxae of fourth and fifth pereopods respectively. Abdominal sternites with small median tooth on first and second somites; third abdominal sternite with small median tubercle; fourth and fifth abdominal sternites each with low median elevation, but without spine or tubercle.

Corneal region of eye (Fig. 2A) not inflated; eye-stalk with numerous curled setae distally on dorsal surface.

Antennular peduncle (Fig. 2A) stout, slightly overreaching mid-length of scaphocerite. Basal segment with dorsolateral distal corner produced in strong spine; stylocerite slightly overreaching distal margin of basal segment (except for dorsolateral spine), terminating in acute spine, lateral margin somewhat elevated, strongly convex in dorsal view. Penultimate segment becoming broader distally, distinctly wider than long. Ultimate segment wider than long. Outer flagellum broad, flattened, proximal 0.3 not articulated; inner flagellum much more slender and longer than outer flagellum, with short setae laterally and mesially.

Antennal peduncle (Fig. 2A) with basicerite bearing small but acute tooth at dorsolateral distal angle. Carapocerite reaching distal margin of blade of scaphocerite. Scaphocerite about 0.4 times as long as carapace, 2.2 times longer than wide; lateral margin slightly convex; distolateral tooth very large, overreaching distally produced, rounded blade.

Mouthparts similar to those of species of *Parapontocaris* illustrated by Chace (1984).

Third maxilliped with 2 distal segments flattened, ultimate segment with few elongate spines on mesial margin; antepenultimate segment with bluntly ridged ventral surface bearing 4 tiny spinules subdistally; exopod well developed.

First pereopod (Fig. 3A, B) overreaching scaphocerite by half length of palm; palm slightly narrowed distally, cutting edge strongly oblique, showing as very thin, chitinous plate; fixed finger small, triangular; carpus very short, with 2 spines on lateral margin; merus with very large dorsodistal spine bearing numerous long setae and additional small spine on distolateral margin, lateral face with blunt longitudinal carina, ventral face unarmed; ischium strongly obliquely articulated with merus; exopod very short, with fringe of dense setae on margins. Second pereopod (Fig. 3C, D) reaching scaphocerite; chela about 0.7 times as long as carpus; dactylus half length of palm, terminating in 2 minute corneous claws; fixed finger with shallow, broad notch in proximal half, thus leaving hiatus when dactylus closed; merus and ischium with numerous plumose setae on dorsal and ventral surfaces, merus about 0.7 times as long as ischium. Third pereopod (Fig. 3E) slender, overreaching scaphocerite by length of dactylus, propodus and 0.4 of carpus; dactylus half length of propodus; carpus elongate, 1.9 times longer than distal 2 segments combined; merus slightly shorter than ischium. Fourth pereopod (Fig. 3F) moderately slender, overreaching scaphocerite by length of dactylus; dactylus subspatulate, 0.7 times as long as propodus, with numerous short setae on dorsal surface proximally, terminating in thin lateral projection covering unguis and bearing few minute setae (Fig. 3G); carpus 0.6 times as long as propodus, with numerous short and few longer setae on dorsal surface; merus and ischium with long setae dorsally, merus subequal in length to ischium. Fifth pereopod (Fig. 3H, I) similar to fourth in structure, but less setose.

Gill formula summarized in Table 1. Pleurobranches each with anteriorly directed ventral apex.

First pleopod with endopod (Fig. 2B) about half length of exopod, tapering distally, bear-

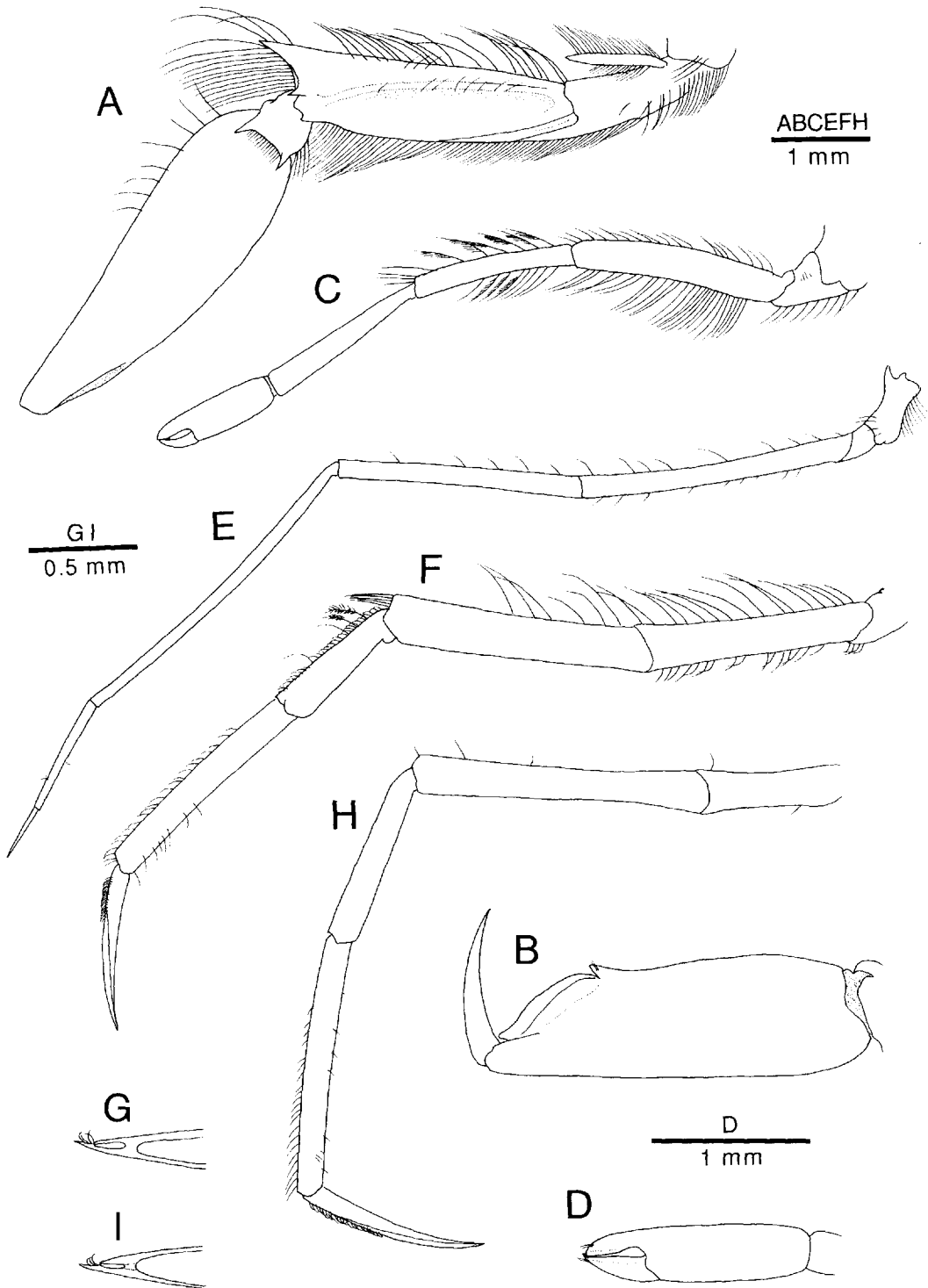


Fig. 3. *Aegaeon rathbuni* (De Man, 1918). Male from west of Tokara Islands, East China Sea (cl 7.3 mm; CBM-ZC 5396). Left pereopods. A, first pereopod, lateral; B, same, chela, dorsal; C, second pereopod, lateral; D, same, chela, lateral; E, third pereopod, lateral; F, fourth pereopod, lateral; G, same, tip of dactylus, dorsal; H, fifth pereopod, lateral; I, same, tip of dactylus, dorsal.

Table 1. *Aegaeon rathbuni* (De Man, 1918). Gill formula. r, rudimentary.

Thoracic somites	1	2	3	4	5	6	7	8
	Maxillipeds			Pereopods				
	1	2	3	1	2	3	4	5
Pleurobranchs	—	—	—	+	+	+	+	+
Arthrobranchs	—	—	2	—	—	—	—	—
Podobranch	—	—	—	—	—	—	—	—
Exopods	+	—	+	r	—	—	—	—
Epipods	+	+	—	—	—	—	—	—

ing some cincinnuri distally; mesial margin weakly sinuous, lateral margin weakly convex. Second pleopod with appendix masculina (Fig. 2C, D) distinctly longer than appendix interna, with few minute terminal bristles or about 15 long spiniform setae. Uropod (Fig. 1) with both rami not reaching posterior end of telson; exopod shorter than endopod, with small, triangular posterolateral tooth reaching subtruncate posterior margin of blade, devoid of diaeresis.

Coloration. In life, body generally reddish brown; eye darkly pigmented (based on field note).

Distribution. Widely distributed in tropical and subtropical waters in the Indo-Pacific: Hawaii, Taiwan, Indonesia, Southwestern Australia, New Caledonia, Madagascar and Zanzibar; at depths of 11 m to at least 809 m (Chan, 1996). The present specimen from off Boso Peninsula, central Japan, significantly extends the known geographical range of *A. rathbuni* to north.

Remarks. The Japanese specimens generally agree with the descriptions of *Aegaeon rathbuni* by De Man (1920) and Chan (1996). The lateral carinae on the fourth abdominal somite appears less sharp in the present specimens than in the illustration of Chan (1996). As mentioned by Chace (1984) and Chan (1996), the size of the third tooth of the five median teeth on the carapace is variable also in the present material. In the specimen from the East China Sea (CBM-ZC 5396), the third tooth is smaller and is less ascending than the other teeth. In the specimens from off Boso Peninsula (CBM-ZC 2478) and Izu Oshima Island (CBM-ZC 5658), the third tooth is similar to other teeth in size and curvature.

The polymorphism of the appendix masculina, previously reported in the two species of the closely related genus *Parapontocaris* Alcock, 1901 (*P. aspera* Chace, 1984 and *P. levigata* Chace, 1984) by Chace (1984), is observed also in the present material of *Aegaeon rathbuni*. In the specimens from off Boso Peninsula (CBM-ZC 2478; cl 9.3 mm) and Izu Oshima Island (CBM-ZC 5658; cl 7.8 mm), the appendix masculina is about twice length of the appendix masculina and bears about 15 long spiniform setae in the distal 0.3 (Fig. 2 D). On the other hand, in the specimen from the East China Sea (CBM-ZC 5396; cl 7.3 mm), it is less elongate and bears about five minute bristles distally (Fig. 2C). I have been unable to associate the difference of the appendix masculina with any other morphological characters. Like the case of the two species of *Parapontocaris* reported by Chace (1984), the elongation and the development of the armature of the appendix masculina in the present specimens seem to be not associated with increase of body size. The polymorphism in the appendix masculina may suggest the existence of secondary females developed from spent males in the populations of *A. rathbuni* and the two species of *Parapontocaris*. Regarding the Crangonidae, such a pattern of protandric hermaphroditism has been documented in *Crangon crangon* (Linnaeus, 1758) (Boddeke *et al.*, 1991).

Aegaeon rathbuni is characterized by the absence of a distinct hepatic groove from the carapace and rather simple abdominal sculpture. *Aegaeon orientalis* Henderson, 1893 and *A. boschii* (Christoffersen, 1988) also lack the hepatic groove, but they have more complex abdominal sculpture with the distinctly sinuous dorsolateral ridges on the second and

third abdominal somites. In addition, in these latter two species, the rostrum is clearly tridentate distally, rather than bifurcate in *A. rathbuni*. *Aegaeon lacazei*, another species of the genus known from Japanese waters, is immediately separated from *A. rathbuni* by the presence of a deep hepatic groove and much more strongly sculptured abdomen.

Although Hayashi's (1986) description of a specimen from Tosa Bay agrees well with the present species, the given photograph is not referable to *Aegaeon* or even to the closely related two genera, *Pontocaris* or *Parapontocaris*, but most probably to a species of *Paracrangon*. There has been no certain record of *A. rathbuni* from Japanese waters.

The present study has shown that there are minute tegumental scales, possibly representing a kind of sensillum (Mauchline *et al.*, 1977), on the carapace and abdomen in *A. rathbuni*. The presence of the tegumental scales has been reported in various taxa of carideans, for example, *Acanthephyra* spp. and *Systellapsis* spp. (Oplophoridae) (Mauchline *et al.*, 1977), and *Chlorotocus* spp., *Heterocarpus* spp. and *Plesionika* spp. (Pandalidae) (Holthuis, 1951; Sivertsen and Holthuis, 1956; Chace, 1985). In addition, Duris (1992) illustrated similar scale-like structures in the crangonid, *Vercoia gibbosa* Baker, 1904, but he attributed them simply to "swollen setae". The present discovery represents the first certain example of the presence of the tegumental scales in the Crangonidae. The minute tegumental scales are not easily discernible in casual observation, and they can be easily missing even during the process of catch. Although a review of the presence of the tegumental scales in Crangonidae is beyond scope of this paper, I have examined specimens of the congeneric, *Aegaeon lacazei* (Gourret, 1887), and selected species from the closely related genera, *Pontocaris* and *Parapontocaris*: *Pontocaris pennata* Bate, 1888, *P. sibogae* (De Man, 1918) and *Parapontocaris aspera* Chace, 1984. The presence of the tegumental scales has been confirmed in the congeneric *A. lacazei*, but no scales were detected in the other three species. The structure and density of the scales are considerably different between *A. rathbuni* and *A. lacazei*. In *A. rathbuni*, the scales are generally

ovate or subtriangular in shape and closely attached to the integument (Fig. 2E); the density is relatively high according to portions. In *A. lacazei*, however, the scales have an abruptly narrowed, elongated distal portion and they are raised from the integument; each scale bears a short basal stalk inserted into the pore on the integument, like oplophorids and pandalids (Mauchline *et al.*, 1977); the density is relatively low (Fig. 2F). Future study may eventually reveal the phylogenetic significance of the presence or absence of the tegumental scales in Crangonidae.

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イトゲイワエビの日本からの新記録と、 外骨格鱗状感覚器の発見

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房総半島太東崎沖、伊豆大島西方沖、および東シナ海から採集された3個体の雄標本に基づき、エビジャコ科トゲイワエビ属の1種 *Aegaeon rathbuni* De Man, 1918 を報告した。林(1986)は、土佐湾産の標本に基づき、本種を記録したが、写真から判断する限りでは、その標本はトゲイワエビ属あるいは近縁の他属にも所属せず、おそらくヤツアシエビ属の1種と考えられる。本研究により、本種の日本近海での分布が確認された。和名については、林(1986)により与えられた、「イトゲイワエビ」をそのまま使用することを提唱する。

さらに、標本を詳しく検討したところ、本種において、頭胸甲および腹部の外骨格表面に微小な鱗状構造が存在することが判明した。この鱗状構造は、コエビ目他の分類群(ヒエドシエビ科やタラバエビ科)で知られている外骨格表面感覚器官に類似するが、エビジャコ科ではこれまでこのような鱗状構造の存在は報告されていなかった。同属のトゲイワエビ *A. lacazei* や、近縁の他属3種(ツブイワエビ *Pontocaris pennata*, *Pontocaris sibogae*, *Parapontocaris aspera*)の標本を検討したところ、トゲイワエビにおいて同様な鱗状構造の存在が認められた。将来、より包括的な検討を行うことにより、鱗状構造の存在の系統学的な意義が明らかにされることが期待される。