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Neocaridina iriomotensis, a new species of land-locked freshwater shrimp (Crustacea: Decapoda: Atyidae) from Iriomote Island, southern Ryukyus, Japan

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Abstract.—*Neocaridina iriomotensis* is described from Iriomote Island, southern Ryukyus, Japan. This species apparently belongs to the *N. palmata* species group and is morphologically closest to *N. anhuiensis* (Liang, Zhu & Wei, 1984) and *N. ishigakiensis* (Fujino & Shokita, 1975). It can be differentiated from the former by the longer rostrum and the presence of a pterygostomian spine, and from the latter by the armature of the rostrum.

Three species of land-locked shrimps have been reported from Iriomote and Ishigaki Islands, namely *Neocaridina ishigakiensis* (Fujino & Shokita, 1975), *N. brevirostris* (Stimpson, 1860) (cf. Kubo 1941, Shokita 1973) from Ishigaki Island, and *Macrobrachium shokitai* Fujino & Baba, 1973, from Iriomote Island. Recent investigation on the freshwater shrimps of Iriomote Island revealed the presence of a new *Neocaridina* species. A description and illustrations of the species are here provided in detail, and comparisons with allied congeners are highlighted.

Materials and Methods

Measurements of eggs were taken using a stereomicroscope (Nikon SMZ-10) and an eyepiece micrometer to the nearest 0.01 mm. Other characters were initially drawn using a stereomicroscope and a camera lucida. Each drawn character was measured using a digital slide caliper (Mitsutoyo CD-20C) to the nearest 0.01 mm before actual sizes were calculated. For ratio values, a median value, together with a range and a sample size (in brackets) are provided. To reduce the effect of allometric growth associated with size, only large specimens (CL > 4 mm) were used for description.

Abbreviations are as follows: Carapace length (CL); the National Science Museum, Tokyo, Japan (NSMT); the National Museum of Natural Science, Taichung, Taiwan (NMNS); the Ryukyu University Museum, Fujukan, Okinawa, Japan (RUMF); and Zoological Reference Collection, Raffles Museum of Biodiversity Research, National University of Singapore (ZRC).

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Systematics

Family Atyidae De Haan, 1849
Genus *Neocaridina* Kubo, 1938
Neocaridina iriomotensis, new species
Japanese name: Iriomote-Numaebi

Material examined.—All specimens were collected at the upper reaches of Nishifunatsuki, Nakama River, Iriomote Island. Holotype: 1 male, CL 4.59 mm, RUMF-ZC-100, coll. T. Naruse, 14 May 2000. Paratypes: 4 males, CL 4.27–4.60 mm, RUMF-ZC-101, coll. T. Naruse, 14 May 2000; 2 females, CL 4.45–5.85 mm, RUMF-ZC-102, coll. T. Naruse, Y. Cai & N. K. Ng, 16 June 2000; 1 male, CL 5.05 mm, NSMT-Cr 15724, coll. T. Naruse, 3 Dec 1999; 1 female, CL 5.73 mm, NSMT-Cr 15725, coll. T. Naruse, 3 Dec 1999; 1 male, CL 5.00 mm, NSMT-Cr 15726, coll. T. Naruse, 3 Dec 1999; 1 female, CL 5.23 mm, NSMT-Cr 15727, coll. T. Naruse, 3 Dec 1999; 1 female, CL 5.10 mm, NSMT-Cr 15728, coll. T. Naruse, 3 Dec. 1999; 1 male, CL 4.59 mm, NSMT-Cr 15729, coll. T. Naruse, 3 Dec 1999; 1 male, 4.56 mm, NSMT-Cr 15730, coll. T. Naruse, 3 Dec 1999; 3 males, CL 4.10–4.83 mm, NMNS 4190-001-003, 9 females, CL 4.08–5.35 mm, NMNS 4190-004-012, coll. T. Naruse, 3 Dec 1999; 4 males, CL 4.30–5.13 mm, 12 females, CL 4.10–4.82 mm, ZRC 2003.0599, coll. Tohru Naruse, 4 Dec 1999. Non-types: 4 males, CL 4.42–4.86 mm, 23 females, CL 4.14–5.39 mm, RUMF-ZC-104, coll. T. Naruse, 28 Nov 1999; 2 males, CL 4.17–4.59 mm, 2 females, CL 4.30–4.75 mm, RUMF-ZC-105, coll. T. Naruse, 2 Dec 1999; 2 males, CL 4.55–4.69 mm, RUMF-ZC-106, coll. T. Naruse, 29 Nov 1999; 1 female, CL 4.43 mm, RUMF-ZC-107, coll. T. Naruse, 29 Nov 1999; 1 male, CL 5.26 mm, 4 females, CL 4.55–5.15 mm, RUMF-ZC-108, coll. T. Naruse, 4 Dec 1999; 1 male, CL 4.09 mm, 9 females, CL 4.02–4.63 mm, ZRC 2003.0598, coll. T. Naruse, 2 Dec 1999.

Description.—Rostrum (Fig. 1a) slender, straight in dorsal margin, larger individuals with longer rostrum, reaching to or near end of antennular peduncle, rostrum length 0.42 (0.20–0.63, n = 81) times as long as carapace length; dorsal margin usually unarmed, occasionally armed with 1–6 teeth; ventral margin unarmed or armed with 1–3 teeth (usually 0–2). Inferior orbital angle of carapace fused with antennal spine; pterygostomian angle with an acute spine in most individuals.

Eyes (Fig. 1a) well developed.

Antennule (Fig. 1b1, b2) with stout peduncle; stylocerite not reaching distal end of basal segment of antennular peduncle; inner flagellum narrowing at segment located approximately at proximal 1/3, proximal wider segments with aesthetes on ventral surface, each segment with 2 or 3 transversal rows of 2 or 3 aesthetes.

Antenna (Fig. 1c) with scaphocerite 3.0 times as long as wide.

Mandible (Fig. 1dl, dr) with left mandible relatively small; incisor process with approximately 6 teeth, anterior fourth to sixth larger than others; inner margin of molar process acute, connected to jagged keels of ventral surface. Right mandible large; incisor process with approximately 6 teeth, anterior first and fourth larger than others; molar process connected to keels of dorsal surface.

Maxillula (Fig. 1e) with broadly rounded lower lacina, upper lacina elongate, with many distinct spines on inner margin; palp slender.

Maxilla (Fig. 1f) with short palp; scaphognathite tapered posteriorly with long, distally hooked setae.

First maxilliped (Fig. 1g) with or without a lobate projection on outer distal part, not due to body size or sex.

Second maxilliped (Fig. 1h) typical of the genus.

Third maxilliped (Fig. 1i) reaching end of antennular peduncle; endopod 3-

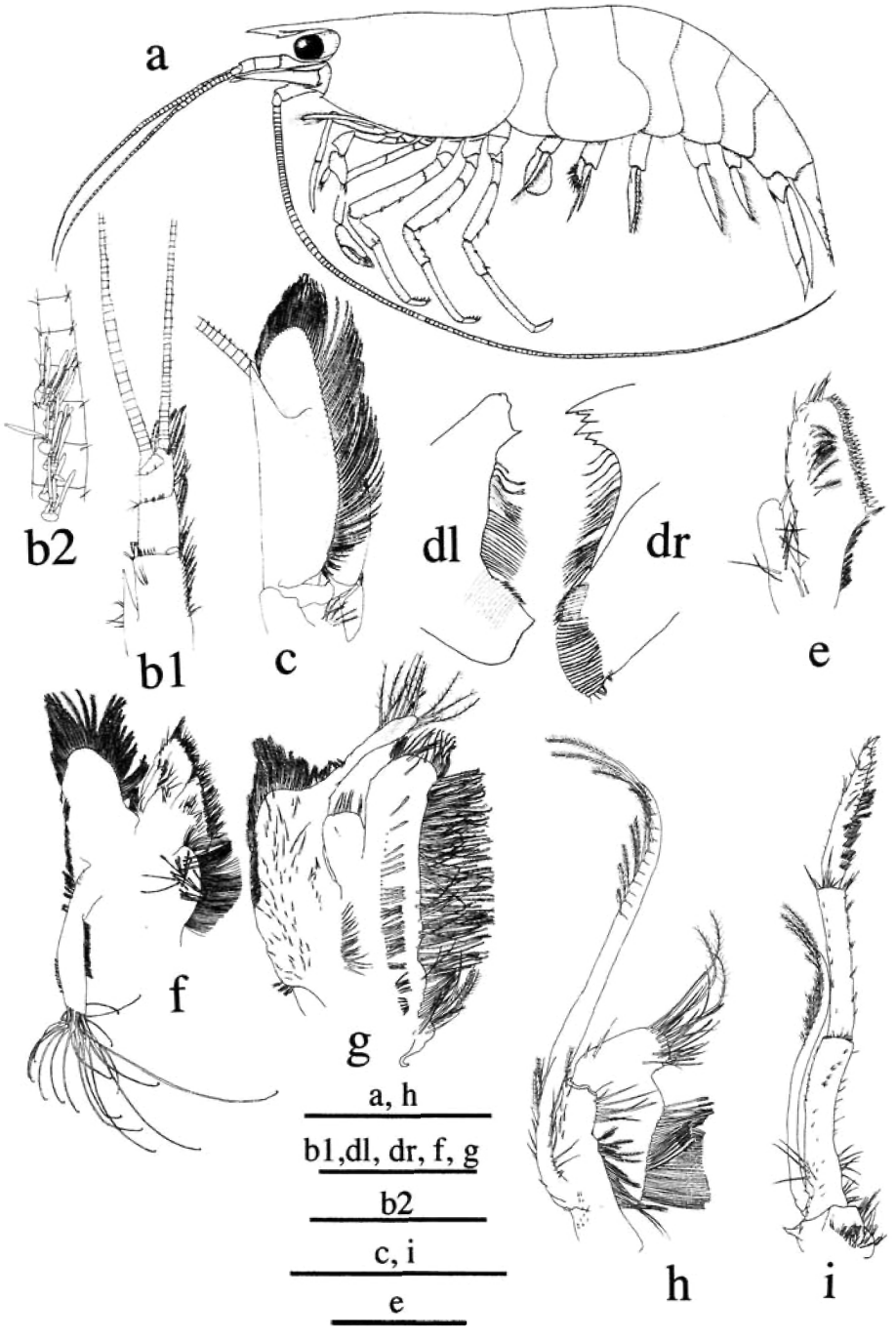

Fig. 1. *Neocaridina iriomotensis*. a, habitus, lateral view; b1, antennule, dorsal view; b2, magnification of the antennule exopod, ventral view; c, antenna, dorsal view; dl, left mandible, dr, right mandible; e, endopod and distal endite of maxillule; f, maxilla; g, first maxilliped; h, second maxilliped; i, third maxilliped. a, RUMF-ZC-101 (male, CL 4.40 mm); b–d, g, NSMT-Cr 15724 (male, CL 5.05 mm); e, f, h, RUMF-ZC-102 (female, CL 5.85 mm); i, NMNS 4190-001 (male, CL 4.83 mm). Scales = 5 mm (a), 2 mm (b1, c, i), 0.5 mm (b2, dl, dr, e), 1.5 mm (f), and 1 mm (g, h).

segmented, reaching end of antennular peduncle to scaphocerite; exopod reaching to middle of penultimate segment of endopod.

Pereopods with epipod on anterior four pairs, two setobranchs attached to coxae of all pereopods. First pereopod (Fig. 2a) reaching end of first segment of antennular peduncle; carpus excavated anteriorly, shorter than chela; palm length 1.07 (0.73–1.40, N = 73) times, propodus length 1.52 (1.17–1.98, N = 82) times, and carpus length 1.23 (0.84–1.51, N = 82) times as long as dactylus length, respectively.

Second pereopod (Fig. 2b) reaching end of antennular peduncle; coxa with hook-shaped projection on posterior part; carpus not excavated anteriorly; palm length 0.82 (0.65–1.12, N = 83) times, carpus length 1.85 (1.50–2.62, N = 83) times and merus length 1.85 (1.61–2.48, N = 81) times as long as dactylus, respectively.

Third pereopod with sexual variations in the specimens collected in summer. Among the specimens collected in summer, male propodus curved inwards, stout (Fig. 2c2); dactylus spines strongly curved inwards; female propodus straight, slender; dactylus spines not strongly curved inwards. Specimens collected in winter with no sexual differences (Fig. 2c1), third pereopod exceeding end of scaphocerite; dactylus armed with 5–7 spines, usually 6; propodus straight, dactylus length 0.21 (0.14–0.28, N = 80) times, carpus length 0.57 (0.47–0.68, N = 80) times, and merus length 1.40 (1.07–1.57, N = 40) times as long as propodus length, respectively.

Fourth pereopod similar to third pereopod, reaching to base or middle of second segment of antennular peduncle.

Fifth pereopod (Fig. 2d) reaching to middle or end of second segment of antennular peduncle; dactylus with 52–60 spines on flexor margin; dactylus length 0.30 (0.21–0.36, N = 81) times, carpus length 0.46 (0.38–0.52, N = 81) times, and merus length 0.82 (0.74–0.94, N = 81) times as long as propodus length, respectively.

Endopod of male first pleopod (Fig. 2e) extending approximately to proximal 4/5 of exopod, palm-shaped, about 1.5 times as long as broad, armed with many small spines on the marginal region of anterior surface, with appendix interna reduced to a small point at base of enlarged part.

Appendix masculina of male second pleopod (Fig. 2f1, f2) swollen, inner to anterior surface densely armed with long spines, its distal end reaching to proximal half of endopod; appendix interna with a few hook-like setae at distal part of inner margin, reaching to distal 5/6–4/5 of appendix masculina.

Uropod (Fig. 2g). Diaeresis of exopod lined with 14–23 movable spines, usually 16–18.

Telson (Fig. 2g) terminating in blunt postomedian projection; with 5 (4–7, N = 73) dorsal spines on each side, 1 pair of dorsolateral spines near posterolateral angle, 3–5 pairs on distal margin, lateral pair longer than sublateral pair, median 2–4 spines subequal, slightly longer than sublateral pair; preanal carina obtuse, no spine.

Size of eyed eggs 1.05–1.35 × 0.73–0.88 mm. Clutch size 21–82.

Distribution.—Iriomote Island, southern Ryukyus, Japan.

Habitat.—*Neocaridina iriomotensis* was collected from the upper stream of Nakama River, Iriomote Island. It occupies the lower part of the headwater, ca. 5–10 m in width and approximately 1 m in depth, with slow-flowing water. *Neocaridina iriomotensis* can commonly be found on aquatic vegetation or roots of trees, together with *Macrobrachium shokitai.*

Etymology.—The new species is named after the type locality, Iriomote Island.

Remarks.—Some individuals of *Neocaridina iriomotensis* possess a lobate pro-

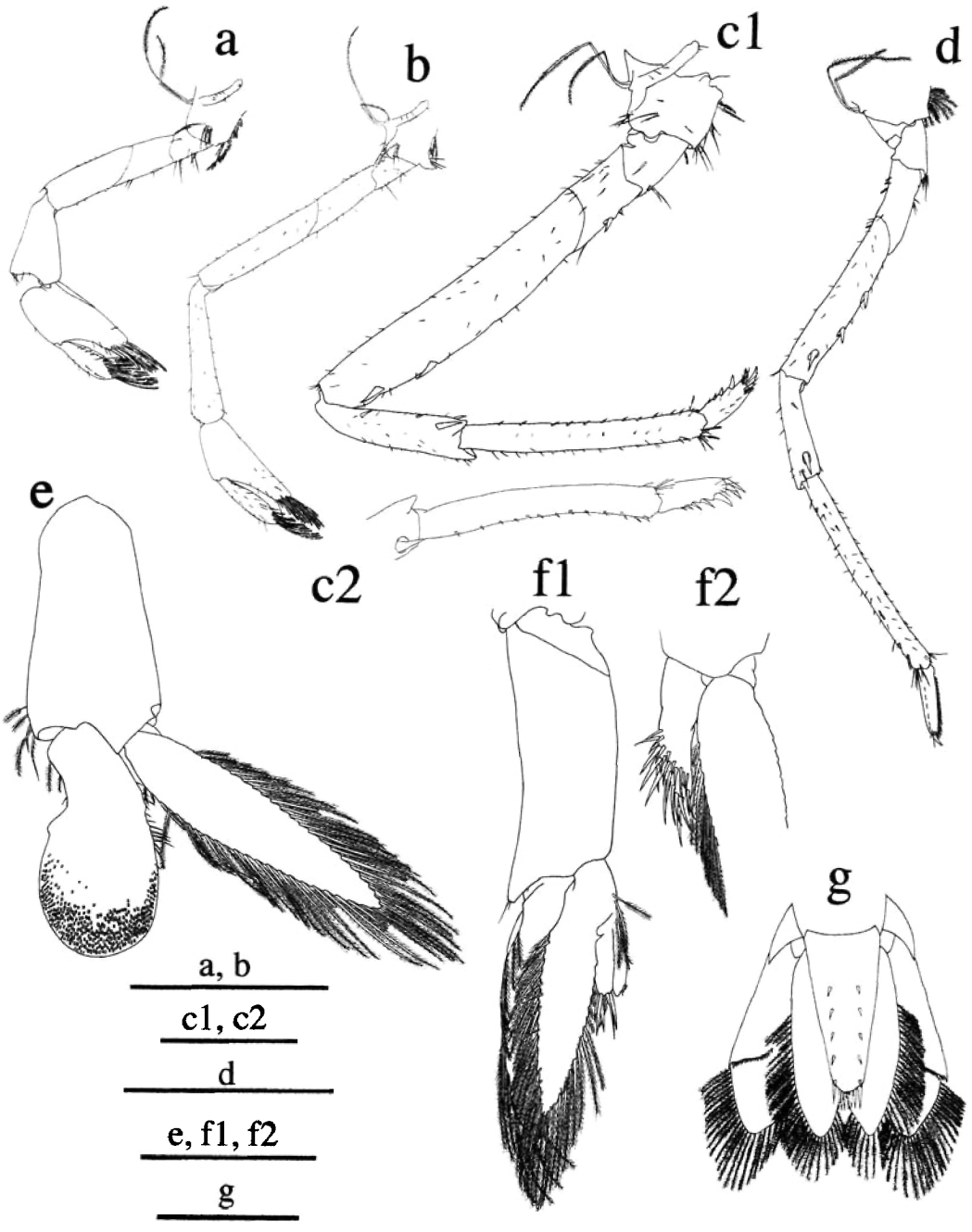

Fig. 2. Appendages and telson of *Neocaridina iriomotensis*. a, first pereopod; b, second pereopod; c1, third pereopod of specimen collected in winter; c2, third pereopod of specimen collected in summer; d, fifth pereopod; e, male first pleopod; f1, male second pleopod, frontal view, f2, male second pleopod, posterior view; g, telson and uropods, dorsal view. a, e, NSMT-Cr 15724 (male, CL 5.05 mm); b, c1, NMNS 4190-001 (male, CL 4.83 mm); c2, RUMF-ZC-100 (male, CL 4.59 mm); f, NSMT-Cr 15730 (male, CL 4.56 mm); g, RUMF-ZC-101 (male, CL 4.40 mm). Scales = 2 mm (a, b, d, g), and 1 mm (c1, c2, e, f1, f2).

Table 1.—Comparison of proportional characters between *Neocaridina iriomotensis* and *Neocaridina anhuiensis*. The ratio of third pereopod was calculated from specimens collected in winter.

	N. iriomotensis	*N. anhuiensis* after Liang et al. (1984)
First pereopod		
Dactylus length/carpus length ratio	0.81 (0.66–1.18, N = 82)	1.5–1.6
Second pereopod		
Dactylus length/palm length ratio	1.22 (0.89–1.53, N = 83)	1.5–1.8
Third pereopod		
Propodus length/dactylus length ratio	4.65 (3.53–7.00, N = 80)	2.8–3.5
Fifth pereopod		
Propodus length/dactylus length ratio	3.33 (2.81–4.75, N = 81)	2.9–3.4

jection on the outer distal part of the endopod of the first maxilliped, not due to body size or sex, although Kubo (1938) considered the absence of such a projection as one of three important characters for the genus *Neocaridina*. However, *N. iriomotensis* possesses additional characters for the genus *Neocaridina*, viz the male first pleopod with enlarged endopod and male second pleopod with appendix masculina thickened and densely covered with setae. The presence of a projection at the distal margin of the palp of first maxilliped should not be retained as a diagnostic character for *Neocaridina* as amended by Kubo (1941) and Cai (1996). Liang (2004) found that species of the genus *Neocaridina* have a posteriorly directed hook-like projection on the posterior part of coxa of the second pereopod; this character is present in the new species.

The enlarged palm-like endopod of the male first pleopod is a distinctive feature of the *N. palmata* species group (cf. Cai 1996). *Neocaridina iriomotensis* possesses features of the *N. palmata* species group, and is morphologically related to *N. anhuiensis* (Liang, Zhu & Wei, 1984) by their having fewer teeth on the upper margin of the rostrum. *Neocaridina iriomotensis* is, however, differentiated from *N. anhuiensis* by the length of the rostrum (reaching as far as the end of the antennular peduncle in *N. iriomotensis* vs. reaching as far as the distal end of the basal segment or to the middle of the second segment of the antennular peduncle in *N. anhuiensis*), presence of the pterygostomian spine in most individuals (vs. absent), and dactylus-length/carpus-length ratio of the first pereopod (0.66–1.18 vs. 1.5–1.6) (Table 1).

Neocaridina iriomotensis can be easily differentiated from *Neocaridina ishigakiensis* by the distinctly fewer teeth on the dorsal margin of the rostrum (0–6, usually 0 in *N. iriomotensis* vs. 2–11, usually 6–8 in *N. ishigakiensis*). Liang (2004) treated *N. ishigakiensis* as a subspecies of *N. denticulata* (De Haan 1844) using materials collected from Wenling, Zhejiang, China. However, topotypic material of *N. ishigakiensis* has the palm-shaped endopod of the male first pleopod, and it is clear that *N. ishigakiensis* is a member of *N. palmata* species group. The material illustrated by Liang (2004) as *N. denticulata ishigakiensis* is most probably a different species.

Samples of *Neocaridina* living in the headwater of the Nakama River are morphologically very similar to what we describe here, with exception of the length of the rostrum and some other minor differences. However, even in the length of the rostrum, the difference is substantial and some individuals show intermediate lengths. They are thus considered tentatively as ecomorph populations of *N. iriomotensis*. On-going molecular testing and ecological studies may suggest a better taxonomic solution for the identity of these ecomorph populations.

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Literature Cited

Cai, Y. 1996. A revision of the genus *Neocaridina* (Crustacea: Decapoda: Atyidae).—Acta Zootaxonomica Sinica 21(2):129–160. [In Chinese with English abstract.]

De Haan, W. 1833–1850. Crustacea, *in* P. F. von Siebold, ed., Fauna Japonica sive Descripto Animalium, quae in Itinere per Japoniam, Jussu et Auspiciis Superiorum, qui Summum in India Batava Imperium Tenent, Suscepto, Annis 1823–1830 Collegit, Notris, Observationibus et Adumbrationibus Illustravit, i–xxxi, ix–xvi, 1–243, plates A–J, 1–Q, 1–55, circ. tab. 2. Lugduni-Batavorum. [Leiden]. (Not seen.)

Fujino, T., & K. Baba. 1973. A new fresh-water prawn of the genus *Macrobrachium* (Crustacea, Decapoda, Caridea) from Iriomote Island of the Ryukyus.—Annotationes Zoologicae Japonenses 46:100–110.

———, & S. Shokita. 1975. Report on some new atyid shrimps (Crustacea, Decapoda, Caridea) from the Ryukyu Islands.—Bulletin of Science and Engineering Division, University of the Ryukyus (Mathematics & Natural Science) 18:93–113.

Kubo, I. 1938. On the Japanese atyid shrimps.—Journal of the Imperial Fisheries Institute, Tokyo 33:67–100.

———. 1941. On some fresh-water shrimps from the Ryukyu Islands.—Biogeographica 3:303–318, pl. 20.

Liang X. 2004. Fauna Sinica. Invertebrata, vol. 36. Crustacea. Decapoda. Atyidae. Science Press, Beijing, China, 375pp., 156 figs. (In Chinese, with English abstract.)

———, J. Zhu, & X. Wei. 1984. A new subspecies of *Caridina denticulata* De Haan (Crustacea Decapoda) from China.—Chinese Journal of Fishery 8(3):251–253. [In Chinese with English abstract.]

Shokita, S. 1973. Abbreviated larval development of freshwater atyid shrimp, *Caridina brevirostris* Stimpson from Iriomote Island of the Ryukyus (Decapoda, Atyidae).—Bulletin of the Science and Engineer Division, University of the Ryukyus 16:222–231.

Stimpson, W. 1860. Prodromus descriptionis animalium evertebratorum, quae in Expeditione ad Oceanum Pacificum septentrionalem, a republica federate missa, Cadwaladaro Ringgold et Johanne Rodgers Ducibus, observavit et descripsit. Pars VIII. Crustacea Macrura.—Proceedings of the Academy of Natural Sciences of Philadelphia 12:22–47.

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