

## Short Note

### A Preliminary Survey of the Freshwater Shrimp Genus *Caridina* from Eastern Sulawesi, Indonesia

DIKY DWIYANTO<sup>1</sup>, ANNAWATY ANNAWATY<sup>2</sup>,  
ACHMAD FARAJALLAH<sup>3</sup> AND DAISY WOWOR<sup>4\*</sup>

<sup>1</sup>Graduate School of Animal Bioscience, IPB University, Kampus IPB Dramaga, Bogor-16680, West Java, INDONESIA

<sup>2</sup>Department of Biology, Tadulako University, Kampus Bumi Tadulako Tondo, Palu-94119, Central Sulawesi, INDONESIA

<sup>3</sup>Department of Biology, IPB University, Kampus IPB Dramaga, Bogor-16680, West Java, INDONESIA

<sup>4</sup>Division of Zoology, Research Center for Biology, Indonesian Institute of Sciences (LIPI), Cibinong-16911, West Java, INDONESIA

\* Corresponding Author: Daisy Wowor (daisy\_wowor@yahoo.com)

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The atyid shrimp genus *Caridina* H. Milne Edwards, 1837 contains a large number of valid taxa on Sulawesi, Indonesia, of which 39 are endemic land-locked species<sup>1,2</sup>, and 37 are non-endemic amphidromous ones. The endemic taxa are characterized by having a relatively small number of large eggs and the larvae not going through a planktonic phase<sup>3,4,5</sup>. Most of the endemic species have relatively restricted distributions. For example, in Hong Kong, the endemic *C. cantonensis*, shows subtle genetic differences among individual populations even though it is found in several drainages<sup>6</sup>. Non-endemic species invariably have a large number of small eggs which helps in dispersal through the open sea<sup>7,8,9,10</sup>.

Tojo, Ampana, and Luwuk in the eastern arm of Sulawesi have not been well studied for their freshwater shrimp. The latest study by Klotz et al. (2007)<sup>11</sup> added two new *Caridina* records, i.e., *C. buehleri* Roux, 1934 (confirmed as *C. gueryi* by de Mazancourt et al. 2020)<sup>12</sup>, and *C. appendiculata* Jaliha & Shenoy, 1998, both from the Malotong Freshwater Spring near Ampana at Luwuk Peninsula. The first author therefore started to survey the diversity of *Caridina* in this area to

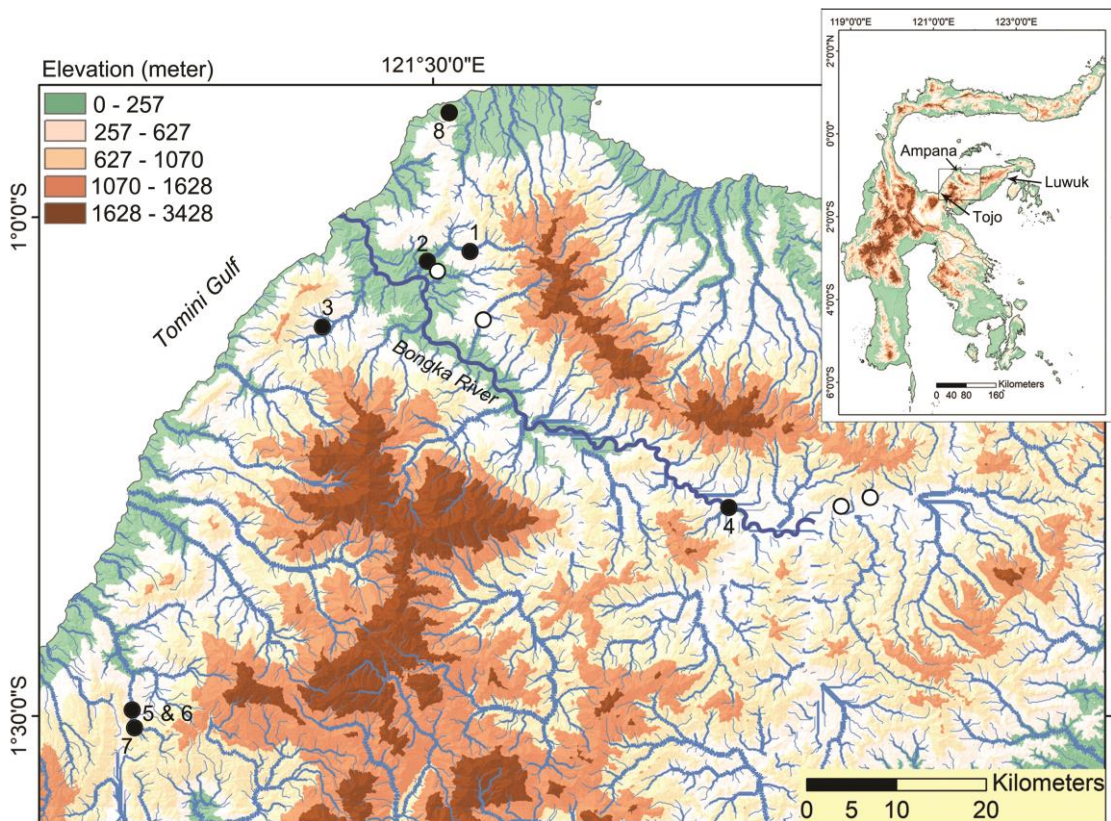
promote the conservation of key habitats present there.

Specimens were collected from seven localities (Fig. 1, Table 1) between December 2019 and August–November 2020, and included various types of habitats including small permanent pool, creek and streams. All specimens were caught with a tray net<sup>13</sup> and preserved in 95% ethanol. The study of the specimens was conducted with Nikon SMZ 745T and Olympus SZ61 stereomicroscopes equipped with an OptiLab camera. Line drawings were derived from photographs using Adobe Illustrator software. Specimens were kept in the Laboratory of Animal Biosystematics and Ecology, Department of Biology, Faculty of Mathematics and Natural Sciences, IPB University, Bogor, Indonesia. The preserved eggs were measured based on the longest and the shortest axis using a digital caliper (0.1 mm). The abbreviation “cl” was used for carapace length in millimeters (mm) and is measured from the margin behind the orbit to the posterior edge of the carapace.

#### *Caridina* sp. 1

(Fig 2A–C)

Habitat: One female (cl 4.02 mm) was found in Gui Creek, Ulubongka (Table 1), among



**FIGURE 1.** Sampling locations and distribution of *Caridina* spp. in eastern Sulawesi (see Table 1 for details). Black circle: samples present from location; white circle: samples absent from location. The map was prepared using DEM SRTM 90m provided by U.S. Geological Survey (<https://earthexplorer.usgs.gov/>).

twigs and sago leaves litter with muddy substrate, with dissolved oxygen of about 6.6 mg/l. The site is a small stream near a cornfield covered by dense riparian vegetation along the stream.

**Diagnosis.**— Rostrum very short, bent, not reaching end of first segment of antennular peduncle (Fig. 2A). Dorsal margin with 7 minute teeth, ventral margin with 2 minute teeth. Carpus of first pereopod excavated anteriorly, 1.3 times as long as wide (Fig. 2B). Second pereopod with slender carpus, about 4.6 times as long as wide (Fig. 2C). Propodus of third pereopod about 8.0 times as long as

wide. Uropodal diaeresis with 18 movable spinules. Unfortunately, no ovigerous females were found during the study.

**Remarks.**— This species resembles *C. minidentata* Cai & Anker, 2004<sup>14</sup> from a cave in West Samar, Philippines. *Caridina minidentata*, however, does not have rostral ventral tooth, and the carpus of the first and the second pereopods are proportionately more slender than those of *Caridina* sp. 1 (see Cai & Anker, 2004<sup>14</sup>: 250, Figs. 10, 11). At the moment the exact specific status of *Caridina* sp. 1 cannot be determined due to the lack of specimens.

**TABLE 1.** List of species *Caridina* spp. in eastern Sulawesi, Indonesia, with their respective localities and elevations.

Site code	Locations	Elevation (m)	Species	Date/ Source
1	Gui Creek, Ulubongka, Central Sulawesi, Indonesia	357	<i>Caridina</i> sp. 1	29/12/19
2	Borneang Stream, Ulubongka, Central Sulawesi, Indonesia	105	<i>Caridina laoagensis</i>	08/08/20
3	Watusongu Stream, Ulubongka, Central Sulawesi, Indonesia	158	<i>Caridina laoagensis</i> <i>Caridina weberi</i>	09/01/20
4	Stream near Uematopa that flows into the Bongka River, Ulubongka, Central Sulawesi, Indonesia	257	<i>Caridina laoagensis</i> <i>Caridina weberi</i>	10/11/20
5	Marondo Stream, Tojo, Central Sulawesi, Indonesia	517	<i>Caridina weberi</i>	22/08/20
6	Small permanent pool, near Marondo Stream, Tojo, Central Sulawesi, Indonesia	517	<i>Caridina</i> sp. 2	22/08/20
7	Ariston Stream, Tojo, Central Sulawesi, Indonesia	580	<i>Caridina</i> sp. 2	22/08/20
8	Freshwater spring in Malontong, Ampana, Central Sulawesi, Indonesia	15	<i>Caridina gueryi</i> <i>Caridina appendiculata</i>	Klotz et al. 2007

***Caridina* sp. 2**

(Fig 2D–F)

Habitat: Three males (cl 3.71–4.00 mm), two females (cl 4.16–4.63) and three ovigerous females (cl 3.98–4.25) were collected. This species was found from two sites: a small permanent pool near Marondo Stream, and in Ariston Stream (Table 1). At the first site, the shrimps were found associated with leaf litter in a small pool located about one meter from Marondo Stream with poor oxygenation ranging from 2.3–2.6 mg/l. In Ariston Stream, *Caridina* sp. 2 was seen from the riverbank with a very slow current, densely covered with leaf litter and twigs, and containing dissolved oxygen with the range 7.9–8.2 mg/l.

**Diagnosis.**— Rostrum short (Fig. 2D), reaching near or beyond end of basal segment of antennular peduncle, usually armed with rostral formula 0–2+0–7/0–3. Carpus of first pereopod about 2.0–3.2 as long as wide, and carpus of second pereopod 5.4–6.2 as long as wide. Uropodal diaeresis with 12–15 movable spinules. *Caridina* sp. 2 has few (22 or 23, n =

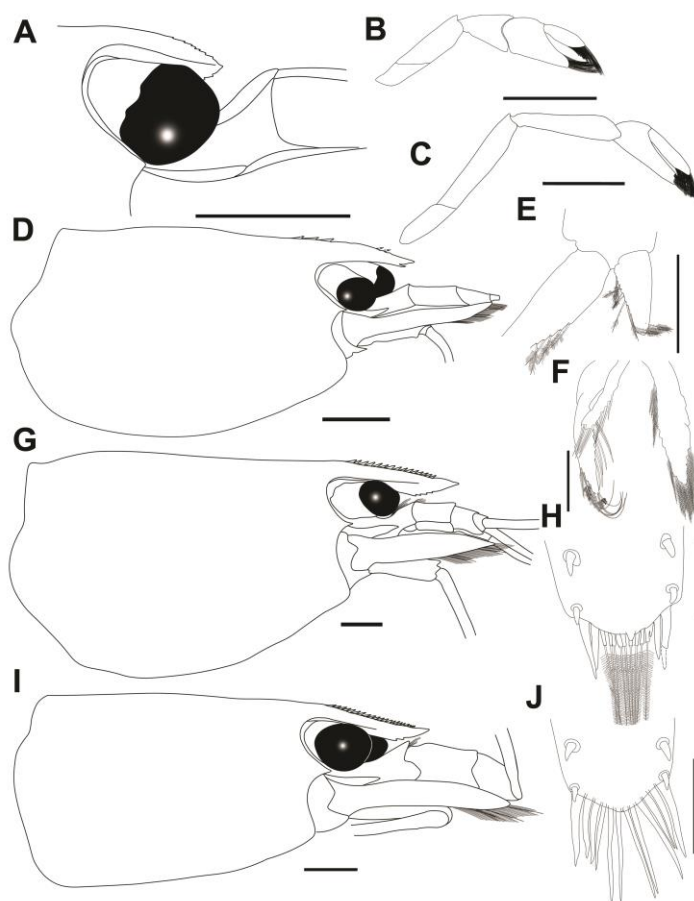
2) large egg-size (0.95–1.09 × 0.59–0.64 mm in diameter) (n = 2) (cl 3.98–4.14 mm).

**Remarks.**— This species is most similar to *C. sulawesi* Cai & Ng, 2009<sup>15</sup> based on the shape and the tooth formula of the rostrum. Male *Caridina* sp. 2, however, has a triangular endopod of the first pleopod (Fig. 2E) (versus subrectangular in *C. sulawesi*, cf. Cai & Ng, 2009: 1105, fig. 7G) and the appendix masculina is about half the length of the endopod (Fig. 2F) (versus almost as long as the length of the pleopod in *C. sulawesi*, cf. Cai & Ng, 2009: 1105, fig. 7H).

***Caridina laoagensis* Blanco, 1939**

(Fig. 2G, H)

Habitat: One male (cl 5.00 mm), one female (cl 6.72 mm), and four ovigerous females (cl 7.63–8.76 mm) were collected from three locations, i.e. Borneang Stream, Watusongu Stream, and a stream near Uematopa that flows into the Bongka River (Table 1). This species was found from low altitude sites to highlands, and commonly found clinging on



**FIGURE 2.** Morphology of *Caridina* spp. from this study. *Caridina* sp. 1, ♀ cl 4.02 mm; A. Rostrum; B. First pereopod; C. Second pereopod. *Caridina* sp. 2, ♀ cl 4.16 mm; D. Cephalothorax; ♂ cl 3.9 mm; E. First male pleopod; F. Second male pleopod. *Caridina laoagensis*, ovigerous ♀ cl 8.18 mm; G. Cephalothorax; H. Distal portion of telson. *Caridina weberi*, ♂ cl 5.20 mm; I. Cephalothorax; J. Distal portion of telson. Scale bars: A–D, G, I = 1 mm; E, F, H, J = 0.5 mm.

plant roots, water plants, and leaf litter with sandy and rocky substrates.

**Diagnosis.**— Rostrum reaching end of second segment to near middle of third segment of antennular peduncle, straight downward with no dorsal teeth behind orbit (Fig. 2G). Rostral formula 0+15–23/2–5. Carpus of first pereopod excavated anteriorly, 1.4–1.7 times as long as wide ( $n = 4$ ). Carpus of second pereopod more slender, 4.8–5.5 times as long as wide ( $n = 4$ ). Diaeresis with 19–20 movable spinules. Distal margin of telson with 2 pairs of lateral spines, outer spine

longer than sublateral one (Fig. 2H). Size of eggs  $0.28\text{--}0.41 \times 0.18\text{--}0.25$  mm in diameter ( $n = 2$ ) (cl 8.18–8.21 mm).

**Remarks.**— According to several workers<sup>14,16</sup>, this species is closely related to *C. weberi* De Man, 1892 but can be easily differentiated by the dorsal rostral armature and the presence of lateral spines on the distal margin of the telson. On the basis of the specimens we have, it appears that only the presence of the lateral spines on the distal margin of the telson is a reliable character to separate the two species.

***Caridina weberi* De Man, 1892**

(Fig. 2I–J)

Habitat: Four males (cl 4.05–5.55) and one female (cl 5.83) were found in three sites, i.e. Watusongu Stream, a stream near Uematopa and Marondo Stream. *Caridina laoagensis* is also present in the first two mentioned streams (Table 1).

**Diagnosis.**— Rostrum straight, reaching distinctly beyond end of basal segment but never reaching distal end of second segment of antennular peduncle (Fig. 2I). Rostral formula 0+14–21/2–4. Carpus of first pereopod 1.7–1.8 times as long as wide ( $n = 2$ ) and carpus of second pereopod 4.5–4.6 times as long as wide ( $n = 2$ ). Diaeresis with 13–18 movable spinules. Distal margin of telson with 1 pair of lateral spines (Fig. 2J). Size of eggs  $0.35\text{--}0.42 \times 0.19\text{--}0.25$  mm diameter<sup>12</sup>.

**Remarks.**— The Sulawesi specimens agree well with the original description of *C. weberi*<sup>17</sup> (see de Mazancourt et al. 2020)<sup>12</sup>.

**General Discussion**

This survey increases the number of *Caridina* species present in the eastern part of Sulawesi. The sampling effort, however, could nevertheless be improved as there were many more sites which could not be surveyed due to the constraints of time and logistics. More thorough sampling efforts and studies will be needed in the future to better understand the diversity and distribution of *Caridina* species in Sulawesi, especially in the eastern part of this island.

In 2016, *C. laoagensis* was recorded from Palu area, Central Sulawesi<sup>18</sup>. The present finding of this species from the eastern arm of Sulawesi becomes the second report of this taxon from outside of the Philippines<sup>14,18,19</sup>. Since the specific status of *C. laoagensis* and *C. weberi* is not very clear<sup>20</sup>, molecular studies should be done in the future which may help clarify their identities.

The taxonomic status of *Caridina* sp. 1 and *Caridina* sp. 2 cannot be resolved at present and they are treated as two different taxa for the time being. An ongoing molecular analysis is being conducted to solve the problem.

This study shows that only *Caridina* sp. 2 from Marondo and Ariston has large egg-sizes, a character of a land-locked species. It probably spends its entire lifecycle in freshwater and is likely to have a small distribution. In contrast, *C. laoagensis*<sup>21</sup> and *C. weberi*<sup>12</sup> have numerous small eggs, and their larvae almost certainly will have a long-life planktonic phase which require high-level salinity water.

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