



## Article

# Updated Checklist of the Freshwater Shrimps (Decapoda: Caridea: Atyidae) of Mindoro Island, the Philippines, with a Description of a New Species of *Caridina* <sup>†</sup>

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**Abstract:** Following recent expeditions to Mindoro Island, the Philippines, numerous samples of atyid shrimps were collected and then studied in an integrative taxonomy framework. A total of 16 species belonging to 4 genera are hereby reported, including 8 new records for the island and/or the Philippines: *Atydina atyoides*, *Caridina bruneiana*, *C. celebensis*, *C. elongapoda*, *C. papuana*, *C. parvirostris*, *C. typus*, *C. zhujiangensis*, and one new species, *Caridina leptopoda* sp. nov. Sequences of 16S rRNA have been produced for all of the species and taxonomical notes are provided. To account for the morphological variability across its range, *C. bruneiana* Choy, 1992 is herein re-described based on specimens from Mindoro. All of the species reported here from Mindoro have small eggs and are considered amphidromous, which suggests that they all potentially occur in other localities. This contrasts with other islands of the Philippines such as Bohol or Luzon where endemic species with large eggs can be found.

**Keywords:** integrative taxonomy; morphology; DNA; 16S; new species



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## 1. Introduction

Myers et al. (2000) [1] defined the Philippine archipelago as a biodiversity hotspot of global importance especially due to its taxa richness and high endemism rates. The Philippines' biogeographic history is shaped by substantial landmass movements, collisions between landmasses of different origin in the Miocene, and temporary land bridges during Pleistocene sea-level regression maxima.

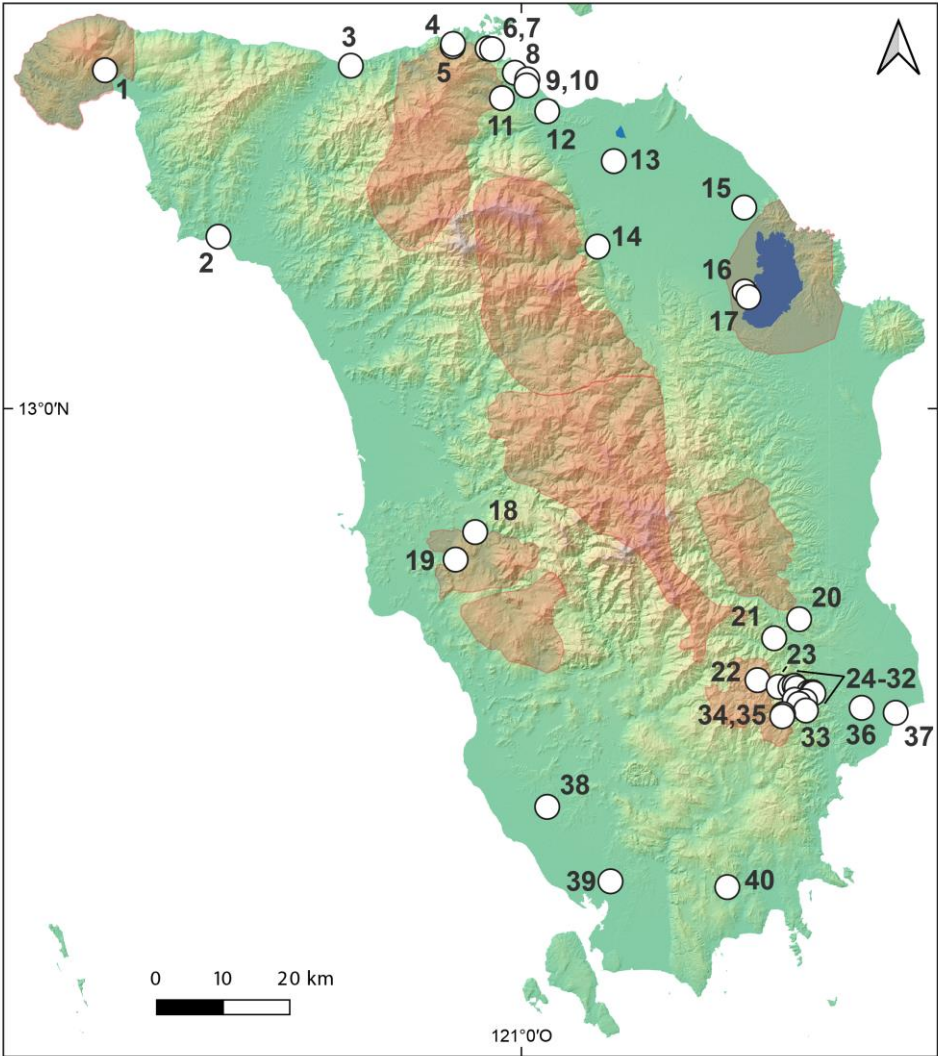
Mindoro, along with parts of Palawan and possibly portions of other adjacent areas, belongs to the oldest landmasses of the Philippines. Those areas are part of the so-called 'Palawan Microcontinental Block' or 'Mindoro Block' that separated from the margin of the Eurasian continent by the opening of the South China Sea (e.g., Hall 2002 [2], Zahirovic et al., 2014 [3]). A land connection with neighboring Luzon probably did not exist during the Pleistocene despite the proximity of the islands. This is somewhat supported by organismic and geological data (e.g., Shih et al., 2009 [4]; Esselstyn et al., 2009 [5]). Therefore, the island of Mindoro, including some small islands off-coast, is considered as its own intra-Philippine biogeographic region (Ong et al., 2002 [6]) with a specific, partly endemic

arthropod freshwater fauna (Freitag et al., 2016 [7], Pelingen et al., 2020 [8], Ng and Takeda 1992 [9], Vidal et al., 2017 [10]).

The geography of the island is marked by a central mountain chain in a north–south direction (Figure 1), with its highest peak, Mt. Halcon (2585 m a.s.l.) causing a distinct climatic difference between the wetter eastern province of Oriental Mindoro compared to relatively dry Occidental Mindoro. The largest freshwater body is Lake Naujan (Figure 1) with about 8000 ha of open water and some associated wetlands. Butas River drains the lake and its catchment into the Tablas Strait. Although the island is comparably less populated (ca. 1.5 M inhabitants in 2020 (Philippine Statistics Authority 2022, [11]) and developed in terms of infrastructure, there are only very few remnants of primary forest while large parts of the island have been converted into cocoa plantations, paddy fields, slash-and-burn farmlands, and grasslands.

In the most recent studies of Philippine Atyidae (Cai and Shokita, 2006 [12]; Cai et al., 2009 [13], Han and Klotz, 2015 [14]), taxonomists indicate the presence of 36 species belonging to 8 genera: *Antecaridina*, *Halocaridinides*, *Atyoida*, *Atyopsis*, *Australatya*, *Parisia*, *Edoneus* with a single species each, and 29 species of *Caridina*. Some of the most species-rich islands are Bohol with 16 atyid species in 4 genera including 5 endemic *Caridina* (Cai et al., 2009 [13]) and Luzon with 13 species: 8 *Caridina* (including one endemic), 1 *Parisia* (endemic), and 4 *Edoneus* (all endemic) (Cai and Anker, 2004 [15]; Cai and Shokita, 2006 [12]; Cai and Husana, 2009 [16]). Other isolated endemic species of *Caridina* can be found on Cebu, Mindanao, and Palawan (one species each, Cai and Shokita, 2006 [12]). The earliest report of atyid shrimps from Mindoro is a species identified as *Caridina nilotica* (Roux, 1833) by Woltereck (1937) [17] collected from the northeast of the island (Suki River and Naujan Lake). The same year, Estampador (1937 [18] and 1959 [19]) reported two other species: *Atya moluccensis* De Haan, 1849 and *Atya serrata* Spence Bate, 1888 from the same region (Malayas River). Chace (1997) [20] provided a more complete record based on specimens collected during the Philippine expedition of the USS Albatross (1907–1910) by citing five species of the genus *Caridina* from the northwest tip of the island (Calawagan and Paluan Rivers): *Caridina brevicarpalis endehensis* De Man, 1892, *C. gracilirostris* De Man, 1892, *C. longirostris* H. Milne Edwards, 1837, *C. serratirostris* De Man, 1892, and *C. villadolidi* Blanco, 1939, in addition to *Atyopsis spinipes* (Newport, 1847) with some doubts regarding its exact sampling locality (“Varadero Mountain”, Mindoro (presumably a hill or small mountain in Puerto Galera near Varadero Bay)). Finally, the most recent and comprehensive account on atyids from Mindoro is that of Cai and Shokita (2006) [12] based on specimens collected during a Japanese crustacean expedition in 1985 in which they cite seven species: *Atyopsis spinipes*, *Caridina laoagensis* Blanco, 1939, *C. villadolidi*, *C. brevicarpalis* De Man, 1892, *C. endehensis* De Man, 1892, *C. elongapoda* Liang and Yan, 1977, and *C. gracilipes* De Man, 1892.

With the development of molecular taxonomy, species delimitations are becoming increasingly more precise, rendering past inventories uncertain when new pseudocryptic species keep being described. Based on new collections supported by previously published records, the present study aims to update the checklist of atyid shrimps from Mindoro Island with the description of a new species. The new and additional material treated herein is mainly from national key biodiversity areas (sensu Ong et al., 2002 [6]): “69 Hinunduang Mt.” (including parts of the Baroc River Catchment), “64 Naujan Lake National Park” and “62 Puerto Galera” of Mindoro which are recognized as priority areas for conservation and research of high or highest urgency. Many of the samples were retrieved by the Ateneo Biodiversity Laboratory (second author) through research and biodiversity teaching projects with students which have already led to several discoveries of new freshwater arthropods in the last decade (Freitag 2013 [21]; Garces et al., 2018 [22], 2020 [23]; Komarek and Freitag 2014 [24], 2020 [25]; Mey and Freitag 2013 [26]; Pelingen and Freitag 2020 [27]; Zettel and Pangantihon 2010 [28]).



**Figure 1.** Map of the localities sampled on Mindoro listed in Table 1. Areas highlighted in red are Key Biodiversity Areas (BirdLife International, Adapted with the permission from Ref. [29]. Copyright 2022 Tom Lambert); Lake Naujan is in blue. Made with QGIS v. 2.1.

**Table 1.** List of the localities sampled on Mindoro with the species collected at each locality.

Locality	Locality	Latitude	Longitude	Species Found
1	Paluan, Bgy. Harrison, small mountain river NE of summit Mt. Calavite	13.4542	120.425	<i>Atydina atyoides</i> <i>Caridina parvirostris</i>
2	Mamburao, Bgy. Tayainaan, Tugilan River/Sitio, 1 km upstream of estuary	13.2308	120.5817	<i>Caridina gracilipes</i> <i>Caridina villadolidi</i>
3	Abra de Ilog, lowland creek in a rural area	13.4603	120.7644	<i>Caridina celebensis</i> <i>Caridina gracilipes</i>
4	Puerto Galera, NR km 59, downstr. Aniuan Falls	13.4862	120.905	<i>Caridina laoagensis</i> <i>Caridina papuana</i> <i>Caridina villadolidi</i>
5	Puerto Galera, 8 km W of Muelle, Talipanan Riv.	13.4894	120.9056	<i>Caridina elongapoda</i> <i>Caridina laoagensis</i> <i>Caridina papuana</i> <i>Caridina typus</i>

Table 1. Cont.

Locality	Locality	Latitude	Longitude	Species Found
6	Puerto Galera, NR km 49, Tagbinai Munti River	13.4833	120.953	<i>Caridina papuana</i>
7	Puerto Galera, NR km 48.2, Tagbinai Malaki River	13.4825	120.9594	<i>Caridina endehensis</i>
8	Puerto Galera, NR km 37.2, downstream of Tamaraw Falls	13.4508	120.9908	<i>Caridina brevicarpalis</i> <i>Caridina celebensis</i> <i>Caridina cf. elongapoda</i> <i>Caridina endehensis</i> <i>Caridina laoagensis</i> <i>Caridina papuana</i> <i>Caridina parvirostris</i>
9	Puerto Galera, small creek	13.4622	120.9864	<i>Caridina brevicarpalis</i> <i>Caridina celebensis</i> <i>Caridina gracilipes</i> <i>Caridina sp. 'Palawan'</i>
10	Puerto Galera, Bisayaan River	13.4333	120.9731	<i>Caridina laoagensis</i> <i>Caridina papuana</i> <i>Caridina parvirostris</i>
11	Puerto Galera, Calsapa, lower Bisaan River	13.4153	120.9575	<i>Caridina serratirostris</i>
12	Baco, small creek	13.3992	121.0356	<i>Caridina typus</i>
13	Baco, Pinagsabangan River	13.3322	121.1275	<i>Caridina brevicarpalis</i> <i>Caridina endehensis</i> <i>Caridina gracilipes</i> <i>Caridina laoagensis</i> <i>Caridina serratirostris</i>
14	Baco, Tagbungan, Lantuyan mountain river	13.3044	121.0642	<i>Caridina laoagensis</i> <i>Caridina papuana</i> <i>Caridina typus</i>
15	Naujan, Bancuro	13.2700	121.3075	<i>Caridina celebensis</i>
16	Victoria, Malayas, Malayas River, W Naujan tributary	13.1572	121.3081	<i>Caridina endehensis</i>
17	Victoria, Malayas, W coast Naujan Lake	13.1497	121.3133	<i>Caridina leptopoda</i> sp. nov.
18	Sablayan, large mountain river	12.8339	120.9361	<i>Caridina endehensis</i>
19	Sablayan, SPPE, small limestone river	12.7969	120.9092	<i>Caridina laoagensis</i>
20	Bongabong, Formon, Pastuhan, Tangisan Falls	12.7167	121.3833	<i>Caridina laoagensis</i>
21	Bongabong, Lisap, lower Siange River	12.6911	121.3489	<i>Caridina laoagensis</i>
22	Roxas, San Vicente, Sitio Tauga Diit, Baroc River tributary Tauga Daka	12.6347	121.3258	<i>Caridina laoagensis</i>
23	Roxas, San Vicente, Sitio Taugad Diit, Baroc River tributary Taugad Daka	12.6325	121.3367	<i>Caridina laoagensis</i>
24	Roxas, San Vicente, Sitio Taugad Diit, Baroc River tributary Taugad Diit River	12.6256	121.3714	<i>Caridina laoagensis</i>
25	Roxas, San Vicente, Taugad River unnamed tributary	12.6272	121.3772	<i>Caridina laoagensis</i>
26	Roxas, San Vicente, Baroc River tributary Hiyong Creek	12.6242	121.3808	<i>Caridina laoagensis</i>
27	Roxas, San Vicente, Taugad River	12.6183	121.3970	<i>Caridina laoagensis</i>
28	Roxas, San Vicente, Baroc River	12.6169	121.4031	<i>Caridina zhujiangensis</i>
29	Roxas, Baroc River	12.6169	121.4031	<i>Caridina bruneiiana</i> <i>Caridina laoagensis</i>
30	Roxas, San Vicente, Sitio Quirao, Hinundungan River tributary Tagugoy Creek	12.6083	121.3772	<i>Caridina laoagensis</i>

Table 1. Cont.

Locality	Locality	Latitude	Longitude	Species Found
31	Roxas, San Vicente, Sitio Quirao, Baroc River tributary Hinundungan River	12.6064	121.3914	<i>Caridina laoagensis</i>
32	Roxas, San Vicente, Sitio Quirao, Hinundungan River tributary Quirao Buhay Creek	12.6028	121.3833	<i>Caridina laoagensis</i>
33	Roxas, San Vicente, Sitio Quirao, Hinundungan River tributary Quirao na Balete Creek	12.5939	121.3928	<i>Caridina laoagensis</i>
34	Roxas, San Vicente, Sitio Tagaskan, Hinundungan River tributary Quianao Creek	12.5889	121.3611	<i>Caridina laoagensis</i>
35	Roxas, San Vicente, Upper Hinundungan River	12.5861	121.3600	<i>Caridina laoagensis</i> <i>Caridina</i> sp.
36	Roxas, Baroc River	12.5975	121.4697	<i>Caridina laoagensis</i> <i>Caridina villadolidi</i>
37	Roxas, Bagumbayan, Magugo River	12.5928	121.5175	<i>Caridina serratirostris</i> <i>Caridina elongapoda</i>
38	San Jose, “Central”, Purok Tunnel, Busuanga River	12.4642	121.0356	<i>Atyopsis spinipes</i> <i>Caridina endehensis</i> <i>Caridina laoagensis</i> <i>Caridina villadolidi</i>
39	San Jose, Palangeran River	12.3638	121.1230	<i>Caridina gracilipes</i> <i>Caridina serratirostris</i>
40	Bulalacao, Bagonsikat, Paluguan River	12.3561	121.2842	<i>Caridina laoagensis</i>

## 2. Material and Methods

### 2.1. Sampling

Specimens were collected with the help of a fine-meshed hand net in various micro-habitats from lentic and lotic areas of freshwater bodies on Mindoro. They were preserved in 96% ethylic alcohol.

The localities prospected are numbered from 1 to 40 (Figure 1) and listed in Table 1 with the species collected. Details on the collected specimens are available in the Supplementary Material.

### 2.2. Molecular Study

DNA was extracted from abdominal tissue using either a Qiagen Blood and Tissue Kit or a Qiagen BioSprint with the Plant Kit (but lysis with 10 mL Qiagen Proteinase K (20 mg/mL) added) according to the manufacturer’s instructions. Fragments of the mitochondrial 16S rRNA (16S, ~590 bp) were amplified by polymerase chain reaction (PCR) and sequenced using primers 16S-F-Car and 16S-R-Car1 (von Rintelen et al., 2007 [30]). Amplifications were conducted in 25 µL volumes containing 50–100 ng DNA, 1x PCR buffer, 200 mM of each dNTP, 0.5 mM of each primer, 2 mM MgCl<sub>2</sub>, and 1 U of Taq polymerase. After an initial denaturation step of 3 min at 94 °C, 35 cycles of 30 s at 94 °C, 60 s at 50 °C, and 60 s at 72 °C were performed, followed by a final extension step of 5 min at 72 °C. PCR products were sent to Macrogen Europe for purification and sequencing of both strands of the amplified gene fragments using the primers as given above.

Contigs of forward and reverse strands were assembled using Geneious Prime (v. 2019.2.1) and corrected by sight. The sequences were aligned using the Muscle algorithm (Edgar, 2004 [31]) implemented in MEGA 7 (Kumar et al., 2016 [32]). To determine the best substitution model for Bayesian inference analyses (see below), hierarchical likelihood ratio tests were carried out with jModelTest (Posada, 2008 [33]). Based on the Akaike inference criterion (AIC), the HKY + I + G model was retained.



All new sequences (77 from Mindoro species and 12 from other localities) have been deposited in GenBank (for accession numbers and museum voucher numbers, see Supplementary Table S1). The sequences were retrieved from GenBank to compile our dataset with other samples from Mindoro and samples close to the type locality of several species to support our identifications.

Phylogenetic trees were reconstructed by Bayesian inference (BI; Huelsenbeck et al., 2001 [34]) using MrBayes 3.2.7 (Ronquist and Huelsenbeck, 2003 [35]) implemented in the Cyber Infrastructure for Phylogenetic Research (CIPRES) portal v. 3.3 (Miller et al., 2010 [36]: <https://www.phylo.org/> (accessed on 21 September 2023)). The MCMC algorithm was run with four independent chains for 10,000,000 generations, samplefreq = 1000, and burnin = 10%. Maximum likelihood (ML) analyses were run with RaxML-HPC2 (Stamatakis, 2014, [37]) and branch support was obtained through non-parametric bootstrapping (1000 replicates; Felsenstein, 1985 [38]). BI and ML analyses were run using the molecular evolution model specified above.

The dataset was analyzed using Assemble Species by Automatic Partitioning (ASAP) (Puillandre et al., 2021 [39]) to provide statistical support to our species hypotheses, following the phylogenetic species concept. This new method implements a hierarchical clustering algorithm that uses pairwise genetic distances and proposes species partitions ranked by a new scoring system (the lower the score, the better the partition) that uses no biological prior insight into intraspecific diversity.

### 2.3. Morphological Study

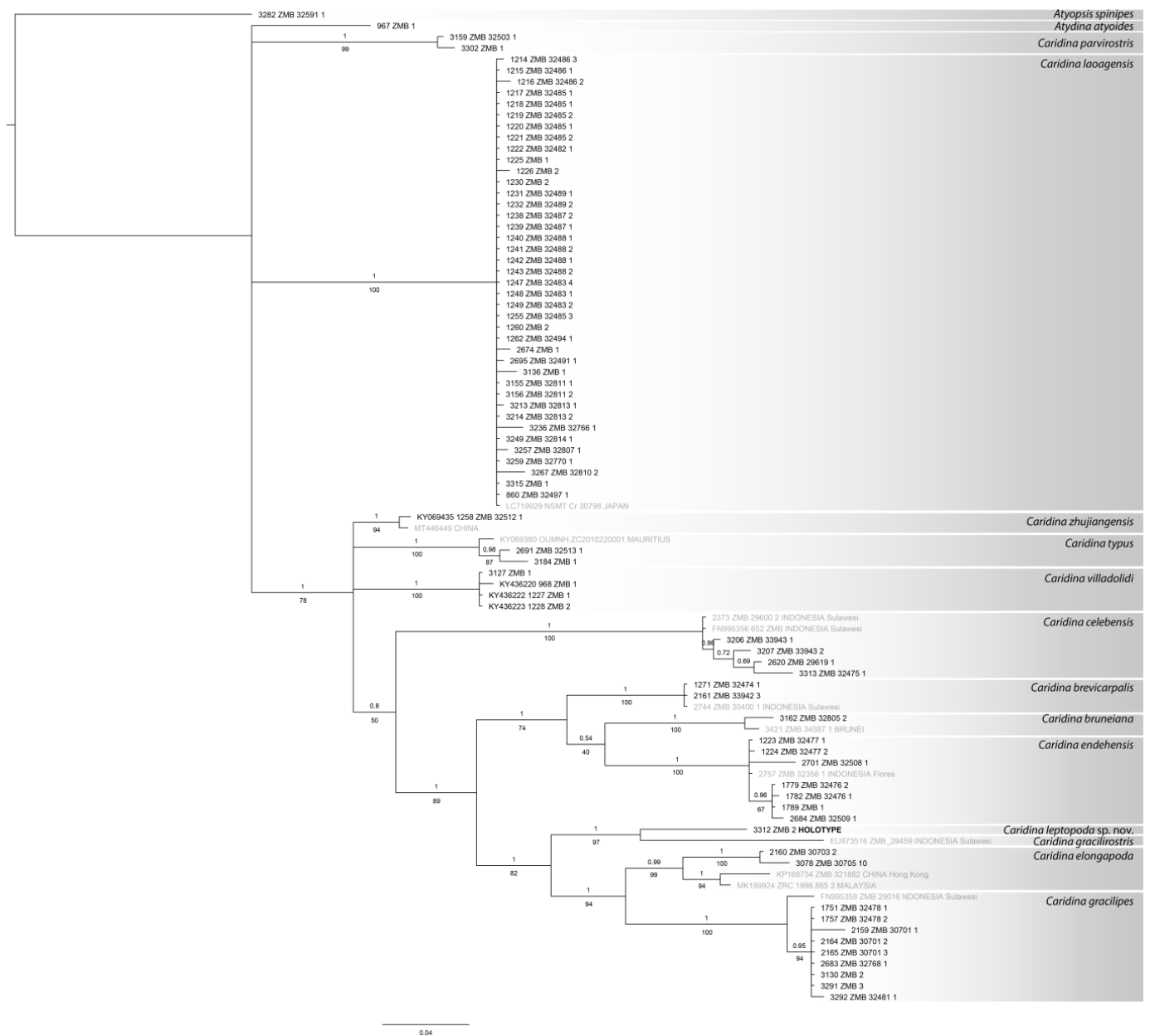
In order to identify species, update previously published descriptions, or describe new species, the specimens were studied under a Leica M205 C stereomicroscope and their appendages were dissected. Images were taken with a Leica DMC6200 and processed through LAS software (v. 4.13) with which measurements were taken following the protocol of Uebeler et al. (2022) [40]. Illustrations were made with Adobe Illustrator (v. 25.4.1) following the digital inking method from Coleman (2003 [41], 2006 [42]).

The following abbreviations are used in the present text: cl, carapace length (mm): measured from the post-orbital margin to the posterior margin of the carapace. P1: first pereopod. P2: second pereopod. P3: third pereopod. P5: fifth pereopod. P11: first pleopod. P12: second pleopod.

## 3. Results

### 3.1. Molecular Study

The phylogenetic analysis performed on the 16S marker (Figure 2) revealed 15 distinct clades corresponding to the morphospecies determined by the morphological study. These 15 morphospecies were supported by the ASAP analysis with a score of 6.5 (Supplementary Material).



**Figure 2.** 16S rRNA Bayesian phylogenetic tree of the species collected from Mindoro. The numbers above the branches show the Bayesian posterior probabilities and under the branches, the ML bootstrap values. The scale bar indicates the substitution rate.

### 3.2. Morphological Study

The morphological study allowed us to recognize the 15 clades as valid species and to produce the following identification key. This key serves for the determination of the species occurring on Mindoro but may also be useful when studying specimens from other Philippine islands.

1.1 First two pairs of pereopods identical	2 ( <i>Atya</i> group)
1.2 First pair distinctly shorter than second	3
2.1 Carapace with an acute projection on the pterygostomian margin, rostrum with more than two teeth on the ventral margin	<i>Atyopsis spinipes</i>
2.2 Carapace with rounded pterygostomian margin, rostrum with fewer than two teeth on the ventral margin	<i>Atyoida pilipes</i>
3.1 More than six post-orbital teeth situated on the dorsal margin of the rostrum. A long stylocerite, reaching at least to the beginning of the second segment of the antennular peduncle	4 ( <i>C. serratirostris</i> group)
3.2 Fewer than six dorsal rostrum teeth situated on the carapace behind the orbital margin. A long or short stylocerite	5
4.1 Rostrum with 22–26 dorsal teeth and P2 carpus 8.2–10.9 times as long as it is wide	<i>Caridina serratirostris</i>
4.2 Rostrum with 17–22 dorsal teeth and P2 carpus 11.9–12.0 times as long as it is wide.	<i>C. celebensis</i>
5.1 Number of spiniform setae on the uropodal diaeresis 6–10 and a very long and upcurved rostrum with 5–9 dorsal teeth, widely spaced	<i>C. leptopoda</i> sp. nov.
5.2 Number of spiniform setae on the uropodal diaeresis 8–22 and a long or short rostrum with 8–28 dorsal teeth, closely set	6
6.1 Uropodal diaeresis with 14–22 spinules, short rostrum, armed or not, and high unarmed pre-anal carina	7
6.2 Uropodal diaeresis with 8–17 spinules, rostrum variable in shape and length, and low pre-anal carina with or without a spine	13
7.1 Telson with numerous and very long plumose intermediate setae	8 ( <i>C. weberi</i> group)
7.2 Telson with few long intermediate setae	11 ( <i>C. typus</i> group)
8.1 Rostrum without dorsal teeth	<i>Atydina atyoides</i>
8.2 Teeth present on the dorsal margin of the rostrum	9
9.1 Rostrum straight, 9–17 teeth on the dorsal margin	<i>C. laoagensis</i>
9.2 Rostrum bent downwards, 8–10 teeth on the dorsal margin	10
10.1 Outer terminal projection of uropodal diaeresis shorter than the first movable spine	<i>C. parvirostris</i>
10.2 Outer terminal projection of uropodal diaeresis longer than the first movable spine	<i>C. papuana</i>
11.1 Rostrum reaching to or longer than the antennular peduncle	<i>C. villadolidi</i>
11.2 Rostrum shorter than the antennular peduncle	12
12.1 Rostrum reaching the end of the second segment of the antennular peduncle	<i>C. typus</i>
12.2 Rostrum reaching the end of the first segment of the antennular peduncle	<i>C. zhujiangensis</i>
13.1 No subapical teeth on the rostrum, tip of the rostrum rounded, and P1 carpus deeply excavated	14 ( <i>C. brevicarpalis</i> group)
13.2 Subapical teeth often present on the rostrum and tip of the rostrum pointed P1 carpus not deeply excavated	15
14.1 Rostrum overreaching the scaphocerite	<i>C. endehensis</i>
14.2 Rostrum reaching the end of the antennular peduncle	<i>C. brevicarpalis</i>
15.1 Presence of one or few subapical teeth on the rostrum, fewer than two post-orbital teeth	16 ( <i>C. nilotica</i> group)
15.2 No subapical teeth on the rostrum, more than three post-orbital teeth	<i>C. bruneiana</i>
16.1 Distinct projection on the pre-anal carina	<i>C. gracilipes</i>
16.2 Absence of projection, sometimes the presence of a cluster of setae	<i>C. elongapoda</i>

### 3.3. Taxonomy: Updated Checklist of the Species of Atyid Shrimps from Mindoro Island

Family Atyidae De Haan, 1844

“*Atya*” group

Genus *Atyoida* Randall, 1840

*Atyoida pilipes* (Newport, 1847)

Restricted synonymy (see Chace, 1983 for a complete list):



- *Atya pilipes* Newport, 1847 [43]: 160 (Type locality: Apia, Upolu, Samoa).
- *Atyoida pilipes*—Chace, 1983 [44]: 13, figs. 3, 4 (part); 1997: 4.
- *Caridina acuminata* Stimpson, 1860 [45]: 29 (Type locality: Ogasawara (Bonin) Islands, Japan).
- *Caridina brevirostris* Stimpson, 1860 [45]: 29 (Type locality: Okinawa (Loo Choo) Island, Ryukyu Islands, Japan).
- *Atya brevirostris* De Man, 1892 [46]: 360, 520, pl. 21: figs. 21, 21a–d (Type locality: Indonesia, Flores, several localities, and Timor, Koinino (=Kuanino) River near Kupang).
- *Pseudatya beauforti* Roux, 1928 [47]: 209, figs. 1–9 (Type locality: Indonesia, Bacan Island).
- Non *Atya serrata*—Blanco, 1935 [48]: 31.—Estampador, 1937 [18]: 485; 1959 [19]: 19.

Habitat: This species is found in areas with strong currents, usually in the higher course of rivers.

Distribution: Wide distribution in the Pacific Ocean: Japan (Ryukyu), Taiwan, the Philippines, Malaysia, Indonesia, Melanesia, Micronesia, and Polynesia (Samoa and, Marquesas).

Remarks:

Reported from Mindoro under the name *Atya serrata* by Estampador (1937 [18], 1959 [19]). Not represented in our collections.

This species has been assessed as Least Concern for the IUCN Red List (De Grave et al., 2013 [49]).

Genus *Atyopsis* Chace, 1983

*Atyopsis spinipes* (Newport, 1847)

Restricted synonymy (see Chace, 1983 for a complete list):

- *Atya spinipes* Newport, 1847 [43]: 159 (Type locality: Philippine Islands).
- *Atyopsis spinipes*—Chace, 1983 [44]: 35, figs. 20–22.
- *Atya dentiostri* Thallwitz, 1891 [50]: 101 (Type locality: North Celebes).
- *Atya brevirostris* var. *De Mani* Nobili, 1900 [51]: 475, fig. 2. (Type locality: Indonesia, Mentawai Islands, Sipora Island, Sereinu (=Saurenu?) river).
- Non *Atya moluccensis*—Estampador, 1937 [18]: 485; 1959 [19]: 18.

Habitat: This species inhabits areas with strong water currents, usually in the higher course of rivers.

Distribution: On Mindoro: Locality no. 38. Wide distribution in the Pacific Ocean: Japan (Ryukyu), Taiwan, the Philippines, Indonesia, Melanesia, Micronesia, and Samoa.

Remarks:

Reported from Mindoro under the name *Atya moluccensis* by Estampador (1937 [18], 1959 [19]).

This species has been assessed as Least Concern for the IUCN Red List (De Grave et al., 2013 [52]).

“*Caridina*” group

Genus *Caridina* H. Milne Edwards, 1837

“*Caridina nilotica*” species group

*Caridina gracilipes* De Man, 1892

- Restricted synonymy:
- *Caridina Wyckii* var. *gracilipes* De Man, 1892 [46]: 387, pl. 24, figs. 29e–k (Type locality: River near Maros, Sulawesi, Indonesia).
- *Caridina nilotica* var. *gracilipes*—De Man, 1908 [53]: 270, pl. 20, fig. 7.
- *Caridina gracilipes*—Cai and Shokita, 2006 [12]: 250.—de Mazancourt et al., 2018: 438 [54], fig. 6.—Cai, 2020 [55]: 1407, figs. 1–3.
- *Caridina nilotica* var. *bengalensis* De Man, 1908 [53]: 265, pl. 20, figs. 6–6b (Type locality: Port Canning, Lower Bengal, India).

- *Caridina acuticaudata* Dang, 1975 [56]: 70, fig. 4 (Type locality: Boi River, Hoa Binh Province, Vietnam).
- Non-*Caridina longirostris*—Chace, 1997 [20]: 14 (part), fig. 7.

Habitat: This species occurs in the middle to lower course of rivers among submerged vegetation.

Distribution: On Mindoro: Localities no. 2, 3, 9, 13, and 39. China (Fujian, Guangdong, Guangxi, and Hainan), Taiwan, Vietnam, Indonesia, Singapore, Malaysia, the Philippines, Papua New Guinea, Solomon Islands, Australia, India, and Sri Lanka.

Remarks:

Previously reported from this island by Cai and Shokita (2006) [12] and by Chace (1997) [20] under the name *Caridina longirostris*. de Mazancourt et al. (2018) [54] and Cai (2020) [55] recently re-described this species in detail. In contrast to the findings of Cai and Shokita (2006) [12] and Cai (2020) [55], male specimens of this species have been found with a fully developed appendix interna on their endopod of the first pleopod. This character should thus be used with caution when identifying species of the *C. nilotica* group.

This species has been assessed as Least Concern for the IUCN Red List (Cai et al., 2013) [57].

*Caridina elongapoda* Liang and Yan, 1977

- *Caridina nilotica elongapoda* Liang and Yan, 1977 [58]: 220, figs. 5–8.—Liang and Zheng, 1988: 15 (Type locality: Xinzai, Gulei village, Zhangpu County, Fujian, southern China).
- *Caridina elongapoda*—Wowor et al., 2004 [59]: 341, fig. 6A, B.—Cai and Shokita, 2006 [12]: 249 (part?).—Cai et al., 2007 [60]: 285; 2009: 68.—Cai, 2014 [61]: 214; 2020 [55]: 1414, fig. 5.—de Mazancourt et al., 2018 [54]: fig. 2.
- *Caridina* aff. *brachydactyla*—Yeo, Cai and Ng, 1999 [62]: 218, figs. 10–14.
- Non *Caridina longirostris*—Chace, 1997 [20]: fig. 6 (part?).

Material examined:

PHILIPPINES—2 specimens; Puerto Galera, small creek; N 13°27'44" E 120°59'11"; 02.07.2017; coll. Freitag; ZMB 30705 (DNA: 3078) and ZMB 30703 (DNA: 2160).

Comparative material:

MALAYSIA: 1 ♂, cl 4.2 mm; Pulau Tioman, Sungai Asah; 24.06.1997; coll. Ng et al.; ZRC 1998.0865.—1 ♀, cl 4.3 mm, same data as for preceding; (ZRC 1998.0865); 1 ♀ ovig., cl 4.3 mm, same data as for preceding (ZRC 1998.0865).

Habitat: This species lives in the lower course of rivers among submerged vegetation.

Distribution: On Mindoro: Localities no. 5 and 37. Southern China, Vietnam, Malaysia, Indonesia, and the Philippines.

Remarks:

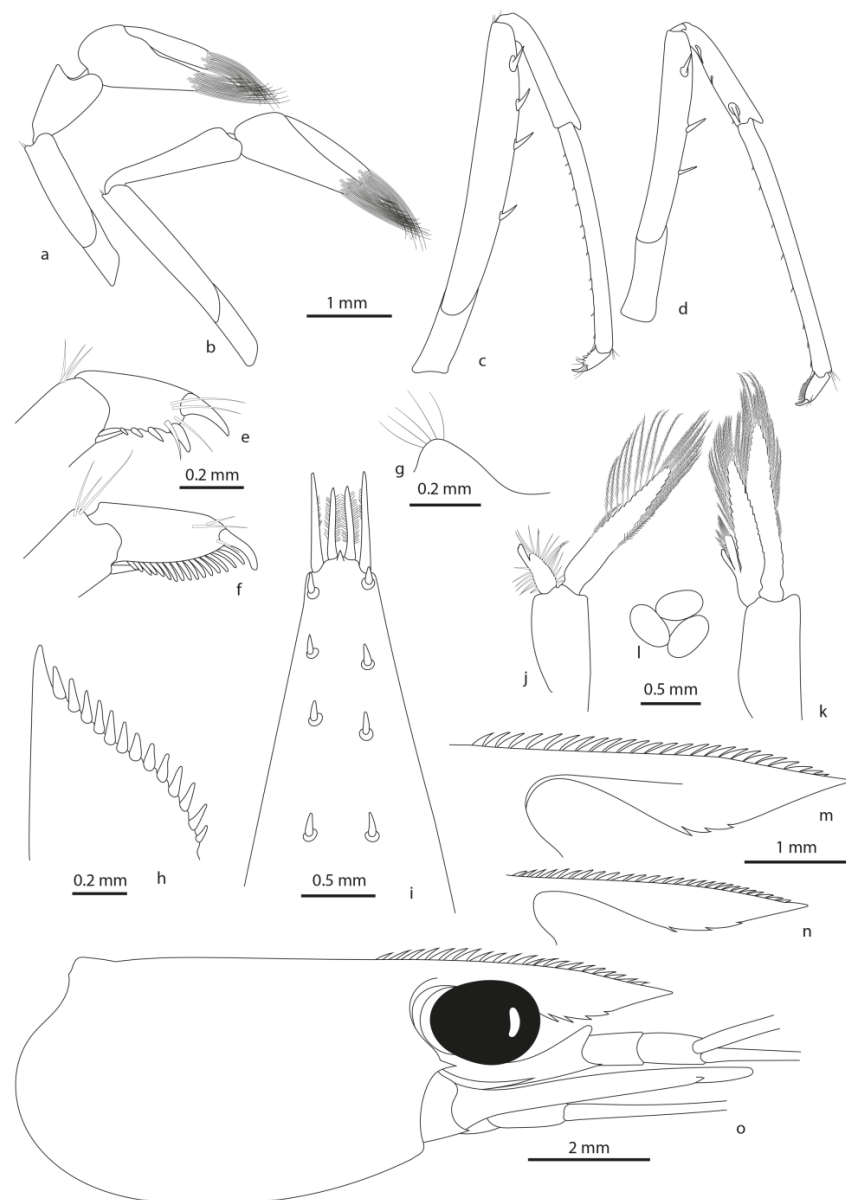
Cai and Shokita (2006) [12] reported this species from Mindoro and provided a diagnosis. Re-examination of specimens cited by Yeo et al. (1999) [62] from Pulau Tioman (Malaysia) confirmed that they are conspecific with our specimens from Mindoro.

This species has been assessed as Least Concern for the IUCN Red List (De Grave, 2013 [63]).

Species group uncertain

*Caridina bruneiana* Choy, 1992

(Figure 3)



**Figure 3.** *Caridina bruneiana*: (a) first pereopod; (b) second pereopod; (c) third pereopod; (d) fifth pereopod; (e) dactylus of the third pereopod; (f) dactylus of the fifth pereopod; (g) pre-anal carina; (h) uropodal diaeresis; (i) telson; (j) first male pleopod; (k) second male pleopod; (l) undeveloped eggs; (m,n) variations of the rostrum; and (o) cephalothorax. Male cl 5.6 mm ZMB 32805-2: (a–i,o); male cl 3.0 mm ZMB 32805-4: (j,k,n); ovigerous female cl 4.4 mm ZMB 32805-1: l, m.

In order to account for the morphological variability across its range, *C. bruneiana* Choy, 1992 is re-described here based on specimens from Mindoro. This re-description combined with the DNA analysis enabled us to remove all remaining doubts regarding the validity of this species.

- *Caridina bruneiana* Choy, 1992 [64]: 49, Figs. 1–4 (Type locality: Negara Brunei Darussalam, on the upper reaches of Temburong River at Batang Duri, 04°36'05" N 115°06'45" E, altitude approx. 33 m).
- *Caridina bruneiana*—Wowor et al., 2004 [59]: 343 (key), Fig. 7A–C; Cai et al., 2007 [60]: 284.

#### Material examined:

PHILIPPINES—2 ♂ cl 2.8–3.1 mm, 2 ♀ ov. cl 4.3–4.4 mm; Roxas, Baroc River, Oriental Mindoro; 12.6169, 121.4031; 02.04.2013; coll. Freitag; ZMB 32805 (DNA 3161 and 3162).

## Comparative material:

*Caridina bruneiana* Choy, 1992

BRUNEI—3 specimens; Temburong River tributary Sungai Seluju, small tributary near UBD field station; 4.5638, 115.1486; 90 m a.s.l.; 10.2018; coll. H. Freitag; ZMB 34587 (DNA 3421 and 3423).

*Caridina sumatrensis* De Man, 1892

INDONESIA—Syntype, 1♀, cl 4.9 mm; Sumatra, Batak land, near Deli; 12.1890; coll. C. Moesch; MNHN-IU-2015-1758.—1 ♀ovig., cl 5.1 mm; Java; NMB 6.II.b.—Non type, 1♀, cl 6.0 mm; ca. 5 km. S from Deli Tua, Sungai Seruai, Deli, N. E. Sumatra; 16.11.1984; coll. M. Kottelat; RMNH.CRUS.D.54754.

## Description:

Cephalothorax. Antennal spine below the suborbital angle. Pterygostomian margin blunt. Rostrum (Figure 3m–o): straight or slightly bent downward, 0.7–0.9 of cl, shorter or as long as the antennular peduncle, armed with 21–26 teeth on the dorsal margin, 3–4 of them situated on the carapace behind the orbital margin, ventral margin with 3–4 teeth. Rostral formula: (3–4) 21–26/3–4.

Eyes well developed, anterior end reaching to 0.68 length of the basal segment of the antennular peduncle. Antennular peduncle 0.71(♀)–0.85(♂) times as long as the carapace. Second segment shorter or the same length as the third. Stylocerite reaching the middle of the basal segment of the antennular peduncle.

Pereiopods. Epipods on the first four pereiopods. P1 (Figure 3a): chela 2.2 times as long as wide, movable finger 4.1–4.8 times as long as wide, 1.6–1.8 times length of palm; carpus 1.8–2.2 times as long as wide. P2 (Figure 3b) more slender and longer than P1 with chela 2.6 times as long as wide: movable finger 4.6–6.2 times as long as wide, 1.7–2.1 times the length of the palm; carpus 3.7–4.7 times as long as wide. P3 (Figure 3c): slender, dactylus (Figure 3e) short, 2.8–3.0 times as long as wide (terminal spiniform seta included) with 4 spiniform setae on the flexor margin in addition to the terminal spiniform seta; propodus 12.7–14.0 times as long as wide, 5.3–6.5 times as long as the dactylus. P5 (Figure 3d): dactylus (Figure 3f) short, 2.4–3.1 times as long as wide with 16–21 spiniform setae on the flexor margin; propodus 16.1–17.2 times as long as wide and 6.0–9.1 times as long as the dactylus.

Abdomen. Third abdominal somite with moderately convex dorsal profile. Sixth abdominal somite about 0.52–0.61 the carapace length and 1.45–1.75 times as long as the fifth somite, reaching 0.7–0.95 times the length of the telson.

Telson (Figure 3i) with 2–4 pairs of dorsal spinules and one pair of dorsolateral spinules; posterior margin with a median process, rounded with 2–4 intermediate plumose setae shorter than the lateral ones, which bear thin lateral setulae on the inner margin.

PL1 (Figure 3j): Endopod of male triangular, 2.2–2.4 times as long as wide, reaching 0.27–0.34 times the exopod, with an appendix on the subdistal outer margin which reaches beyond the distal end of the endopod by half of its length.

PL2 (Figure 3k): Appendix masculina on the second pleopod reaching 0.51 times the length of the endopod; appendix interna reaching 0.35 times the appendix masculina.

Preanal carina (Figure 3g) unarmed, higher in females than in males, with few long setae.

Uropodal diaeresis (Figure 3h) weakly sigmoid, with 12–14 spinules.

Eggs (Figure 3l) small, 0.34–0.43 × 0.22–0.24 mm (undeveloped).

Habitat: This species is found in the middle course of rivers.

Distribution: Known from Brunei, Singapore, and Mindoro Island (the Philippines).

## Remarks:

A combination of morphological characters makes the placement of this species within a species group difficult. Indeed, it can be brought close to the *C. nilotica* group as redefined by de Mazancourt et al. (2020) [65] with its antennal spine inferior to the suborbital angle, its sixth abdominal somite longer than half the carapace length, and its triangular endopod of the first male pleopod and its uropodal diaeresis with fewer than 15 spinules. However, the absence of apical teeth on the dorsal margin of its rostrum, its high pre-anal

carina, and the absence of a dorsal hump on its third abdominal segment are characters more typical of the *C. weberi* and *C. typus* groups as defined by the same authors (de Mazancourt et al., 2020) [65]. Its telson, however, is unique by the setation on its distal margin with few intermediate plumose setae shorter than the lateral ones. Finally, its position within the molecular phylogeny presented here is poorly resolved, advocating further for its distinctiveness from all the other species groups.

From the high number of post-orbital teeth on the dorsal margin of the rostrum (3–4), this new species resembles *Caridina sumatrensis*, reported by Cai and Shokita (2006) [12] from Palawan Island. However, it can be easily distinguished by its antennal spine which is placed below the orbital angle (vs. fused), its higher number of dorsal teeth on the rostrum 21–26 (vs. 15–22), the lower number of intermediate plumose setae on the distal margin of the telson 2–4 (vs. 4–5) and intermediate setae being shorter than lateral ones (vs. intermediate longer than lateral), and the lower number of spinules on the diaeresis 12–14 (vs. 18–19). The probable sexual dimorphism of the pre-anal carina is interesting to note; the examination of more specimens from other localities will allow us to confirm it.

This is the first record of this species from the Philippines. It was originally described from Brunei and later found in Singapore (Cai et al., 2007 [60]). Since this species produces small-sized eggs, it is likely amphidromous and thus expected to have a wide distribution.

This species has been assessed as Least Concern for the IUCN Red List (De Grave and Cai, 2013 [66]).

*“Caridina brevicarpalis”* species group

*Caridina brevicarpalis* De Man, 1892

- *Caridina brevicarpalis* De Man, 1892 [46]: 365 (key), 397–399, pl. 24, fig. 30a–e (Type locality: River near Palopo, Luwu, Sulawesi, Indonesia).
- *Caridina brevicarpalis*—Ortmann, 1894 [67]: 11; 1894 [68]: 402 (key), 404.—Roux, 1904 [69]: 553.—Bouvier, 1912 [70]: 919; 1913 [71]: 463; 1925 [72]: 178–180, figs. 372–374.—Roux, 1928 [47]: 200–201.—Cai and Shokita, 2006 [12]: 248.—Page et al., 2007 [73]: 649, 653, fig. 2 (part, Borneo specimen).—de Mazancourt et al., 2017 [74]: 226, fig. 4 (part, Indonesian specimen).
- *Caridina brevicarpalis brevicarpalis*—Chace, 1997 [20]: 8.

Habitat: This species prefers the lower course of rivers, sometimes in brackish conditions.

Distribution: On Mindoro: Localities no. 8, 9 and 13. Known with certainty from Indonesia (Sulawesi, Borneo, Ambon, and Waigeo) and the Philippines (Palawan, Mindanao, and Mindoro).

Remarks:

Measurements of our specimens from Mindoro fit within the variation reported in the original description of the type specimens by De Man (1892) [46] and the DNA sequences cluster with sequences from specimens collected in Sulawesi, the type locality of *C. brevicarpalis*. Cai and Shokita (2006) [12] reported this species for the first time from the Philippines and Mindoro and treated it as distinct from *Caridina endehensis* (see next species).

This species has been assessed as Least Concern for the IUCN Red List (De Grave et al., 2013 [75]).

*Caridina endehensis* De Man, 1892

- *Caridina brevicarpalis* var. *endehensis* De Man, 1892 [46]: 399, pl. 24, fig. 30e (Type locality: River Ba near Endeh, Flores, Indonesia).
- *Caridina brevicarpalis* var. *endehensis*—Bouvier, 1925 [72]: 34.—Roux, 1928 [47]: 218.—Blanco, 1935 [48]: 34, pl. 2, fig. 25.—Chace, 1997 [20]: 8, fig. 3.
- *Caridina endehensis*—Wowor et al., 2004 [59]: 341, fig. 5M.—Cai and Shokita, 2006 [12]: 248.—Karge and Klotz, 2007 [76]: 70.—Cai et al., 2009 [13]: 67.

Habitat: This species prefers the lower course of rivers, sometimes in brackish conditions.

Distribution: On Mindoro: Localities no. 7, 8, 13, 16 and 18. Indonesia (Flores, Sulawesi, and Sumba) and the Philippines.

Remarks:

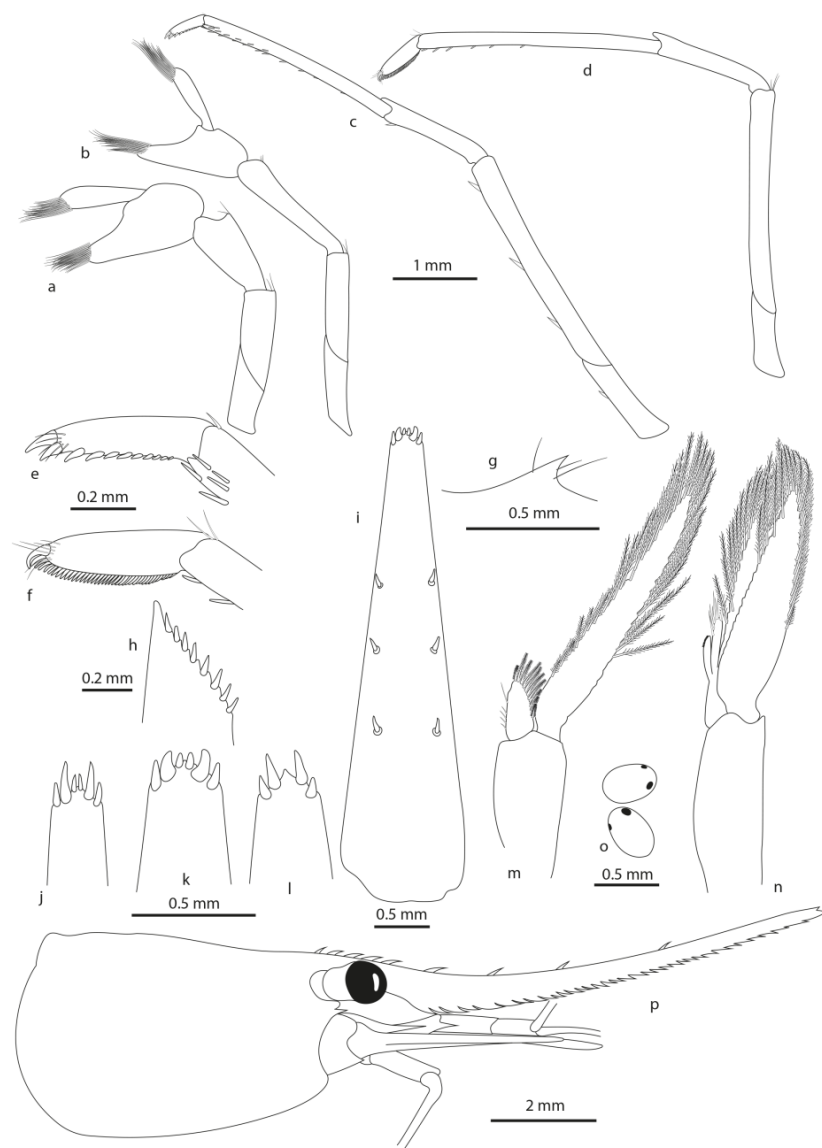
Our specimens from Mindoro agree well with the original description of the type specimens by De Man (1892) [46]. This species seems more common than the previous one and has been abundantly documented from the Philippines for a long time (see Blanco, 1935 [48]; Estampador, 1937 [18]; 1959 [19]; Chace, 1997 [20]; Cai and Shokita, 2006 [12]; Cai et al., 2009 [13]).

This species has been assessed as Least Concern for the IUCN Red List (De Grave et al., 2013 [77]).

*“Caridina gracilirostris”* species group

*Caridina leptopoda* sp. nov.

(Figure 4)



**Figure 4.** *Caridina leptopoda* sp. nov.: (a) first pereopod; (b) second pereopod; (c) third pereopod; (d) fifth pereopod; (e) dactylus of third pereopod; (f) dactylus of fifth pereopod; (g) pre-anal carina; (h) uropodal diaeresis; (i) telson; (j–l) variations of the telson; (m) first male pleopod; (n) second male pleopod; (o) developed eggs; and (p) cephalothorax. Female paratype cl 5.5 mm: (a–i,k,p); male paratype cl 4.2 mm ZMB 29569-2: (j,m,n); ovigerous female paratype cl 4.8 mm ZMB 29569-1: (l,o).



- Non *Caridina gracilirostris*—Estampador, 1937 [18]: 485 (part?); 1959 [19]: 19 (part?).—Chace, 1997 [20]: 10 (part).

Material examined:

Holotype: PHILIPPINES—1 ♀, cl 5.9 mm; Municipality Victoria, Bgy. Malayas, W coast Naujan Lake, littoral Vallisneria beds, Oriental Mindoro; 13.1497, 121.3133; 22.02.2010; coll. Freitag, Pangantihon; NMCR-12001 (DNA 3311).

Paratypes: PHILIPPINES—1 ♀, cl 5.5 mm; same data as for holotype (DNA 3312).—1 ♀ ov., cl 4.8 mm, 1 ♂, cl 4.2 mm, 1 specimen; Imugaan River, W-coast Fabrica, Fabrica/Sagay Municipality, Negros Occidental; 10.8824; 123.3552; coll. Richter, Stelbrink; NMCR-12002 (1 ♂), ZMB 29569 (DNA 925, 926 and 927).

Description:

Cephalothorax. Antennal spine distinctly below the suborbital angle. Pterygostomian margin rounded. Rostrum (Figure 4p): long, curved upward, 1.6–1.8 of cl, much longer than the scaphocerite, armed with 8–11 teeth on the dorsal margin, 0–1 of them situated on the carapace behind the orbital margin, unarmed part length 0.5–0.8 of the armed part, ventral margin with 25–33 teeth. Rostral formula: (0–1) 8–11/25–33.

Eyes well developed, anterior end reaching 0.51 the length of the basal segment of the antennular peduncle. Antennular peduncle 0.76(♀)–0.94(♂) times as long as the carapace. Second segment longer than the third. Stylocerite 0.85–0.95 of the basal segment of the antennular peduncle.

Pereiopods. Epipods on first four pereiopods. P1 (Figure 4a): chela 2.1–2.2 times as long as wide, movable finger 3.5–3.8 times as long as wide, 1.2–1.4 times the length of the palm; carpus 1.9–2.2 times as long as wide. P2 (Figure 4b) more slender and longer than P1 with chela 2.3–2.6 times as long as wide: movable finger 4.1–5.3 times as long as wide, 1.5–1.8 times the length of the palm; carpus 3.6–5.2 times as long as wide. P3 (Figure 4c): slender, dactylus (Figure 4e) long, 3.5–5.1 times as long as wide (terminal spiniform seta included) with 10–11 spiniform setae on the flexor margin including the terminal spiniform seta; propodus 13.8–16.9 times as long as wide, 4.0–4.3 times as long as the dactylus. P5 (Figure 4d): dactylus (Figure 4f) 3.9–6.3 times as long as wide with 40–42 spiniform setae on the flexor margin; propodus 15.3–19.5 times as long as wide, 3.8–4.3 times as long as the dactylus.

Abdomen. Third abdominal somite with moderately convex dorsal profile. Sixth abdominal somite about 0.71 times the carapace length and 2.4–2.6 times as long as the fifth somite, reaching 0.98 the length of the telson.

Telson (Figure 4i–l) with 3–4 pairs of dorsal spinules and one pair of dorsolateral spinules; posterior margin with a median process, triangular with 1–2 pairs of lateral setae and 0–1 pair of short intermediate simple setae shorter than the lateral ones.

Pl1 (Figure 4m): Endopod of male triangular, 1.96 times as long as wide, reaching 0.22 time the exopod, without an appendix.

Pl2 (Figure 4n): Appendix masculina on the second pleopod reaching 0.53 the length of the endopod; appendix interna reaching 0.38 time the appendix masculina.

Preanal carina (Figure 4g) armed with an acute spine.

Uropodal diaeresis (Figure 4h) straight and short, with 7–8 spinules.

Eggs (Figure 4o) small, 0.43–0.44 × 0.27–0.28 mm (developed).

Habitat: This species is found in the lower course of rivers, sometimes in brackish conditions.

Distribution: On Mindoro: Locality no. 17. Known only from the Philippines (Mindoro, Negros).

Etymology: From the Greek *leptos*, “slender”, and *podos*, “foot”, referring to its long third and fifth pereiopods.

Remarks:

Reported from Mindoro as *Caridina gracilirostris* by Chace (1997) [20]. This new species indeed resembles *C. gracilirostris* as re-described by de Mazancourt et al. (2020) [65] from its long rostrum with few post-orbital teeth, its short P1 carpus, and its spine on the pre-anal

carina but it can be easily distinguished by its longer P3 dactylus 3.5–5.1 (vs. 3.3–3.8) times as long as wide with more spiniform setae on its P3 dactylus 10–11 (vs. 7–10) and P5 dactylus 40–42 (vs. 26–33) and its longer P3 propodus 15.8–16.9 (vs. 11.7–14.0) times as long as wide. It also looks like *Caridina neglecta* from its long rostrum and its spine on the pre-anal carina but can be easily distinguished by the absence of appendix interna on the endopod of its first male pleopod, its shorter P1 and P2 carpi 1.9–2.2 (vs. 2.3–3.1) and 3.6–5.2 (vs. 5.2–6.4) times as long as wide, respectively, and its longer P3 dactylus 4.8–5.1 (vs. 3.3–4.7) with more spiniform setae 10–11 (vs. 5–7). This new species is also similar to *Caridina gracilima* as re-described by Cai and Ng (2007) [78] from its long dactyli on pereopods 3 and 5 but they can be separated by its higher number of teeth on the ventral margin of its rostrum 25–33 (vs. 19–24), the presence of a spine on its pre-anal carina (vs. absent), and its smaller eggs  $0.43\text{--}0.44 \times 0.27\text{--}0.28$  mm (vs.  $0.55\text{--}0.66 \times 0.35\text{--}0.40$  mm). None of our male specimens show an appendix interna on the endopod of the first pleopod, whereas Chace (1997) [20] found a rudimentary one on three of the eight males he examined. One can hypothesize variation of this character depending on the breeding season of the species since Chace's specimens were collected in December whereas ours were collected in May.

*“Caridina weberi”* species group

*Caridina laoagensis* Blanco, 1939

- *Caridina laoagensis* Blanco, 1939 [79]: 390, pl. 2 (Type locality: Laoag River, Laoag, Ilocos Norte Province, Luzon, the Philippines).
- *Caridina laoagensis*—Chace, 1997 [20]: 12, fig. 5.—Cai and Anker, 2004 [15]: 237, fig. 3.—Cai and Shokita, 2006 [12]: 248; 2006 [80]: 2141.—Cai et al., 2009 [13]: 67.—Inui et al., 2019 [81]: 3.—Dwiyanto et al., 2021 [82]: 339, fig. 2G, H.

Habitat: This species is found in the middle to lower course of rivers.

Distribution: On Mindoro: Localities no. 4, 5, 8, 10, 13, 14, 19–27, 29–36, 38, and 40. The Philippines, Indonesia, Taiwan, and Japan (Ryukyu).

Remarks:

This species seems to be the most common in the localities sampled for the present study as in the rest of the Philippines according to Cai et al. (2009) [13].

This species has been assessed as Least Concern for the IUCN Red List (De Grave and Cai, 2013 [83]).

*Caridina papuana* Nobili, 1905

- *Caridina Weberi* var. *papuana* Nobili, 1905 [84]: 481, Pl. 12, fig. 1a,b (Type locality: Small forest stream, Stephansort, Madang Province, Papua New Guinea).
- *Caridina Weberi* var. *papuana*—Bouvier, 1925 [72]: 246.
- *Caridina weberi* var. *papuana*—Roux, 1917 [85]: 591; 1928 [47]: 204
- *Caridina weberi papuana*—Roux, 1934 [86]: 221.
- *Caridina* cf. *weberi papuana*—de Mazancourt et al., 2017 [74]: fig. 4.
- *Caridina* sp. *Sol 1*—Page et al., 2007 [73]: 649, fig. 2.
- *Caridina papuana*—de Mazancourt et al., 2019 [87]: 166, figs. 2–5; 2020 [65]: 46, figs. 2N, 14, 26E.

Habitat: This species is found in the middle to lower course of rivers.

Distribution: On Mindoro: Localities no. 4, 5, 6, 8, 10, and 14. Papua New Guinea (Papua, New Hanover, and Manus), Indonesia (Papua, Sulawesi, and Ceram), the Solomon Islands (Choiseul), the Philippines (Mindoro), and Taiwan.

Remarks:

This species is reported herein for the first time from the Philippines. De Mazancourt et al. (2020) [65] recently re-described this species in detail and designated a lectotype among its syntypes.

This species has been assessed as Least Concern for the IUCN Red List (De Grave et al., 2013 [88]).

*Caridina parvirostris* De Man, 1892

- *Caridina parvirostris* De Man, 1892 [46]: 375, pl. 22, fig. 24 (Type locality: River near Bombang (=Boba?), Flores Island, Indonesia).
- *Caridina parvirostris*—Ortmann, 1894 [68]: 404.—Bouvier, 1905 [89]: 76 (key); 1913 [71]: 465 (key).—de Mazancourt et al., 2019 [87]: 822, 834; 2020 [65]: 54, 60.
- *Caridina Weberi* var. *parvirostris*—Bouvier, 1925 [72]: 244, figs. 567–570.

Habitat: This species is found in the middle to lower course of rivers.

Distribution: On Mindoro: Localities no. 1, 8, and 10. Indonesia (Flores, Sulawesi, and Sumba) and the Philippines.

Remarks:

This species is also reported herein for the first time from the Philippines. It was previously known from Indonesia only (Flores, Sulawesi, and Sumba islands). Our specimens agree well with the original description and figures provided by De Man (1892) [46].

This species has been assessed as Data Deficient for the IUCN Red List (De Grave et al., 2013 [90]).

Genus *Atydina* Cai, 2010

*Atydina atyoides* (Nobili, 1900)

- *Caridina atyoides* Nobili, 1900 [51]: 478.—Bouvier, 1905 [89]: 78 (key); 1925 [72]: 256, figs. 587–592.—Roux, 1928 [47]: 205.—Chace, 1997 [20]; 7.
- *Atydina atyoides*—Cai, 2010 [91]: 76, figs. 1, 2.

Material examined:

PHILIPPINES—1 specimen; small mountain river NE of summit, Ulasan, Bgy. Harrison, Paluan, Mt. Calavite, Occidental Mindoro; 13.4542, 120.425; 10.09.1998; coll. Freitag; ZMB (DNA 967).

Comparative material:

INDONESIA—Holotype: 1♂, cl 6.5 mm; Si Oban, Sipura Island, Mentawai Archipelago; coll. E. Modigliani; MSNG.—1♂, cl 10.7 mm and 1♀, cl 9.4 mm; River Teobak, Western Ceram, Moluccas; 02.1910; coll. de Beaufort; RMNH.CRUS.D.202877.

Habitat: This species is found in the middle course of rivers.

Distribution: On Mindoro: Locality no. 1. Indonesia (Si Oban and Ceram) and the Philippines.

Remarks:

New record for the Philippines. Despite being immature, our specimens agree well with the measurements of the holotype and the specimens from Ceram re-described by Cai (2010) [91]. Both molecular and morphological data point towards placing this species within the *Caridina weberi* species group. The taxonomy of the genus *Caridina* is under revision, it is still not clear whether the genus *Atydina* should become a junior synonym of *Caridina* or be extended to cover the entire *Caridina weberi* species group erected to generic status. For the time being, we choose to keep the status quo, awaiting the formal revision.

This species has been assessed as Data Deficient for the IUCN Red List (De Grave et al., 2013 [92]).

“*Caridina serratirostris*” species group

*Caridina celebensis* De Man, 1892

- *Caridina serratirostris* var. *celebensis* De Man, 1892 [46]: 385, pl. 23, figs. 28f–h (Type locality: River near Palopo, Luwu, Sulawesi, Indonesia).
- *Caridina serratirostris* var. *celebensis*—Bouvier, 1925 [72]: 220.
- *Caridina serratirostris koterai* Kamita, 1951 [93]: 75, pl. 5, figs. A–G.

- *Caridina serratirostris celebensis*—Kamita, 1961 [94]: 74.—Fujino, 1972 [95]: 8, fig. 12.—Shokita, 1975 [96]: 119.
- *Caridina celebensis*—Hayashi, 1989 [97]: 376, figs. e, g.—Shokita, 2003 [98]: 250, fig. 19K.—Cai and Shokita, 2006 [12]: 247; 2006 [80]: 2140.—Karge and Klotz, 2007 [76]: 90.—Page et al., 2007 [73]: fig. 2.—von Rintelen et al., 2008 [99]: 2244, fig. 4.—de Mazancourt et al., 2020 [65]: 71, figs. 2B, 24.
- *Caridina leptocarpa* Liang and Zheng, 1988 [100]: 15, figs. 1–91 (type locality: Fuzhou, 26°N 119°E, Min River, Fujian Province, China).
- *Caridina leptocarpa*—Liang and Zhou, 1993 [101]: 231.
- *Paracaridina leptocarpa*—Liang, 2004 [102]: 318, fig. 155.
- Non *Caridina serratirostris*—Chace, 1997 [20]: 19, fig. 11.

Habitat: This species is found in the lower course of rivers with marine influence.

Distribution: On Mindoro: Localities no. 3, 8, 9, and 15. Japan, China, Taiwan, the Philippines, Malaysia, Indonesia, and the Solomon Islands.

Remarks:

de Mazancourt et al. (2020) [65] recently re-described this species in detail. Interestingly, *Caridina serratirostris*, a very common species related to *C. celebensis* is not represented in our collections from Mindoro but was reported by Cai and Shokita (2006) [12] from Mindanao and Palawan. Records of *C. serratirostris* by Chace (1997) [20] from various islands in the Philippines seem to be *C. celebensis* instead.

This species has been assessed as Least Concern for the IUCN Red List (De Grave et al., 2013 [103]).

“*Caridina typus*” species group

*Caridina typus* H. Milne Edwards, 1837

Restricted synonymy:

- *Caridina typus* H. Milne Edwards, 1837 (in H. Milne Edwards, 1834–1840) [104]: 363, pl. 25bis, figs. 4, 5 (Type locality: Unknown, likely Mauritius).
- *Caridina typus*—Bernardes et al., 2017 [105]: 1 (part, ARC clade).—de Mazancourt et al., 2017 [74]: 226, fig. 4; 2019 [87]: 167, figs. 2–5; 2020 [65]: 34, figs. 2D, 10.
- *Caridina typus* forme *typica* Bouvier, 1925 [72]: 250, figs. 272–295.
- *Caridina exilirostris* Stimpson, 1860 [45]: 29 (Type locality (neotype): Okuma River, Okinawa Island, Ryukyu Islands, Japan).
- *Caridina siamensis* Giebel, 1863 [106]: 329 (Type locality: Siam).
- *Caridina typus* forme *caledonica* Bouvier, 1925 [72]: 253, figs. 296–297 (Type locality: New Caledonia).

Habitat: This species is found from the lower to the higher course of rivers.

Distribution: On Mindoro: Localities no. 5, 12, and 14. Widespread in the Indo-Pacific region from South Africa to Fiji and Australia to Japan.

Remarks:

de Mazancourt et al. (2020) [65] recently re-described this species based on specimens from most of its distribution range.

This species has been assessed as Least Concern for the IUCN Red List (De Grave, 2013 [107]).

*Caridina zhujiangensis* Chen, Chen and Guo, 2018

- *Caridina zhujiangensis* Q.-H. Chen, W.-J. Chen and Guo, 2018 [108]: 319, figs. 4–6 (Type locality: Near the Resort Hotel, Dong’ao Island, Guangdong Province, China (E 113°42’03”, N 22°01’06”, al. 19 m, stn. 4)).
- *Caridina zhujiangensis*—Xu et al., 2020 [109]: 21, figs. 6, 7.—Chen et al., 2020 [110]: 18, figs. 6, 7.—Feng et al., 2021 [111]: 34, fig. 2.
- Non *Caridina typus*—Bernardes et al., 2017 [105]: 1 (part, TAL clade).

Habitat: This species is found from the lower to the higher course of rivers.

Distribution: On Mindoro: Locality no. 28. China (Guangdong), Vietnam, Thailand, Malaysia, the Philippines (Mindanao, Mindoro, Samar, Luzon, and Palawan), and Indonesia (Sulawesi, Taliabu, and Papua).

Remarks:

Bernardes et al. (2017) [105] reported this single specimen from Mindoro under the name *Caridina typus*, belonging to their clade TAL. Recently published mitochondrial DNA sequences from specimens of *C. zhujiangensis* from the type locality (Xu et al., 2020 [109]) allowed us to confirm the identity of this specimen.

This species' status has not been assessed for the IUCN Red List yet.

*Caridina villadolidi* Blanco, 1939

- *Caridina villadolidi* Blanco, 1939 [79]: 389, pl. 1, figs. 1–9 (Type locality: Laoag River, Laoag, Ilocos Norte Province, Luzon, the Philippines).
- *Caridina villadolidi*—Hung et al., 1993 [112]: 485, figs. 1B, 3.—Chace, 1997 [20]: 21, fig. 12.—Shy and Yu, 1998 [113]: 62.—Cai and Ng, 2001 [114]: 668, fig. 4a–e.—Liang, 2004 [102]: 156, fig. 74.—Cai and Shokita, 2006 [12]: 248.—Cai et al., 2009 [13]: 66.—Bernardes et al., 2017 [105]: sup. fig. 2.—Vijayamma et al., 2021 [115]: 404 (key).
- *Caridina typus* var. *longirostris* De Man, 1892 [46]: 370: pl. 22, fig. 22f–I (junior homonym of *Caridina longirostris* H. Milne Edwards, 1837) (Type locality: River near Reo, Flores, Indonesia; River near Palopo, Sulawesi, Indonesia; Benteng, Saleyer, Indonesia).

Habitat: This species is found in the lower course of rivers.

Distribution: On Mindoro: Localities no. 2, 4, 36, and 38. The Philippines, Indonesia, Taiwan, and Sri Lanka.

Remarks:

This species has been assessed as Least Concern for the IUCN Red List (De Grave et al., 2013 [116])

#### 4. Discussion

All of the species reported so far from Mindoro Island have small eggs and therefore have a supposedly amphidromous lifecycle (Hancock, 1998 [117]; Han et al., 2011 [118]). Indeed, with few exceptions, most of the species reported in the present work have a rather large known distribution in other islands of the Philippines and even other countries. This contrasts with the atyid fauna of other islands with a number of endemic species of *Caridina* producing large eggs, such as Bohol (Cai et al., 2009 [13]), Samar (Cai and Anker, 2004 [15]), or the neighboring island of Luzon with its endemic genus *Edoneus* (Cai and Husana, 2009 [16]). It is important to note, however, that most of these endemic species are stygobiotic and that on Mindoro, only surface waters have been sampled for atyids. These differences in life history have implications for the conservation of these species. The four species of *Edoneus* endemic to Luzon are listed by the IUCN as Critically Endangered (*E. atheatus*) or at least Vulnerable (De Grave et al., 2013 [119]), whereas in contrast, all the species listed in the present study are either listed as Least Concern or Data Deficient.

**Supplementary Materials:** The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/arthropoda1040015/s1>. References [120–122] are listed in the Supplementary Materials..

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