

**CARIDINA SPONGICOLA, NEW SPECIES, A FRESHWATER SHRIMP
(CRUSTACEA: DECAPODA: ATYIDAE) FROM THE ANCIENT MALILI LAKE
SYSTEM OF SULAWESI, INDONESIA**

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ABSTRACT. – The ancient Malili lake system of Sulawesi, Indonesia, harbours an endemic species flock of atyid shrimps. *Caridina spongicola*, new species, is described from the outlet of Lake Towuti, the largest of the five connected lakes. The new species differs from all other *Caridina* species by a combination of morphological features and a unique colour pattern, and is unusual among atyid shrimps in being associated with an undescribed species of freshwater sponge. The shrimps are most likely commensals: they appear to feed on diatoms accumulating on or within the sponge, and do no harm the host. *Caridina spongicola*, new species, is the second reported atyid shrimp that lives in symbiosis with another organism.

KEY WORDS. – *Caridina*, Malili lake system, Sulawesi, symbiosis, sponge-dweller, taxonomy.

INTRODUCTION

The Malili lake system of Sulawesi, Indonesia (Fig. 1A), harbours an endemic species flock of currently 10 described species of the atyid genus *Caridina* (Woltereck, 1937a, b; Brooks, 1950; Chace, 1997). During intensive collecting from 2003 to 2005, an unidentified species was discovered in Lake Towuti, the largest of the five connected Malili lakes in the central highlands of Sulawesi. It shows an exceptional habitat preference for a currently undescribed species of freshwater sponge, which is endemic to a small area in the outlet bay of Lake Towuti (Fig. 1A). This unusual association, together with morphological characters and diagnostic colour pattern, provide sufficient data for the description of a new species.

Type specimens are deposited in the Museum Zoologicum Bogoriense, Bogor, Indonesia (MZB); Museum für Naturkunde (Museum of Natural History), Berlin, Germany (ZMB); and Zoological Reference Collection of the Raffles Museum of Biodiversity Research, National University of Singapore, Singapore (ZRC). The abbreviation cl is used for the carapace length, measured from the postorbital to the posterior margin of the carapace. All measurements and qualitative characters are from 28 specimens, unless otherwise indicated.

TAXONOMY

FAMILY ATYIDAE DE HAAN, 1849

***Caridina* H. Milne Edwards, 1837**

***Caridina spongicola*, new species**
(Figs. 1-3)

Material examined. – Holotype - ovigerous female (eggs without eyes), cl 2.4 mm (MZB Cru 1559), Indonesia, Sulawesi Selatan, Lake Towuti, west shore, outlet bay, west of Cape Tokaluku, 02°47.261'S 121°23.17'E, coll. T. von Rintelen & K. Zitzler, 29 Jul.2004.

Paratypes – 3 females; cl 2.0-2.4 mm; 2 ovigerous females, cl 2.4-2.8 mm, same data as holotype; 5 males, cl 1.8-2.3 mm (MZB Cru 1560), same data as holotype. 2 ovigerous females (some SEM material), cl 2.4 mm; 11 females (some SEM material), cl 1.9-2.6 mm (ZMB 29027), Indonesia, Sulawesi Selatan, Lake Towuti, west shore, outlet bay, west of Cape Tokaluku, 02°47.32'S 121°23.38'E, coll. T. von Rintelen & K. Zitzler, 21 Sep.2003; 4 males (some SEM material), cl 1.9-2.1 mm (ZMB 29027), same data as previous sample; 9 males, cl 2.1-2.4 mm, 12 females, cl 2.2-2.6 mm, 6 ovigerous females, cl 2.4-2.6 mm (ZRC 2006.0114) Indonesia, Sulawesi Selatan, Lake Towuti, west shore, outlet bay, west of Cape Tokaluku, 02°46.277'S 121°21.83'E, coll. Y. Cai, T. von Rintelen & K. Zitzler, 3 Jan.2005.

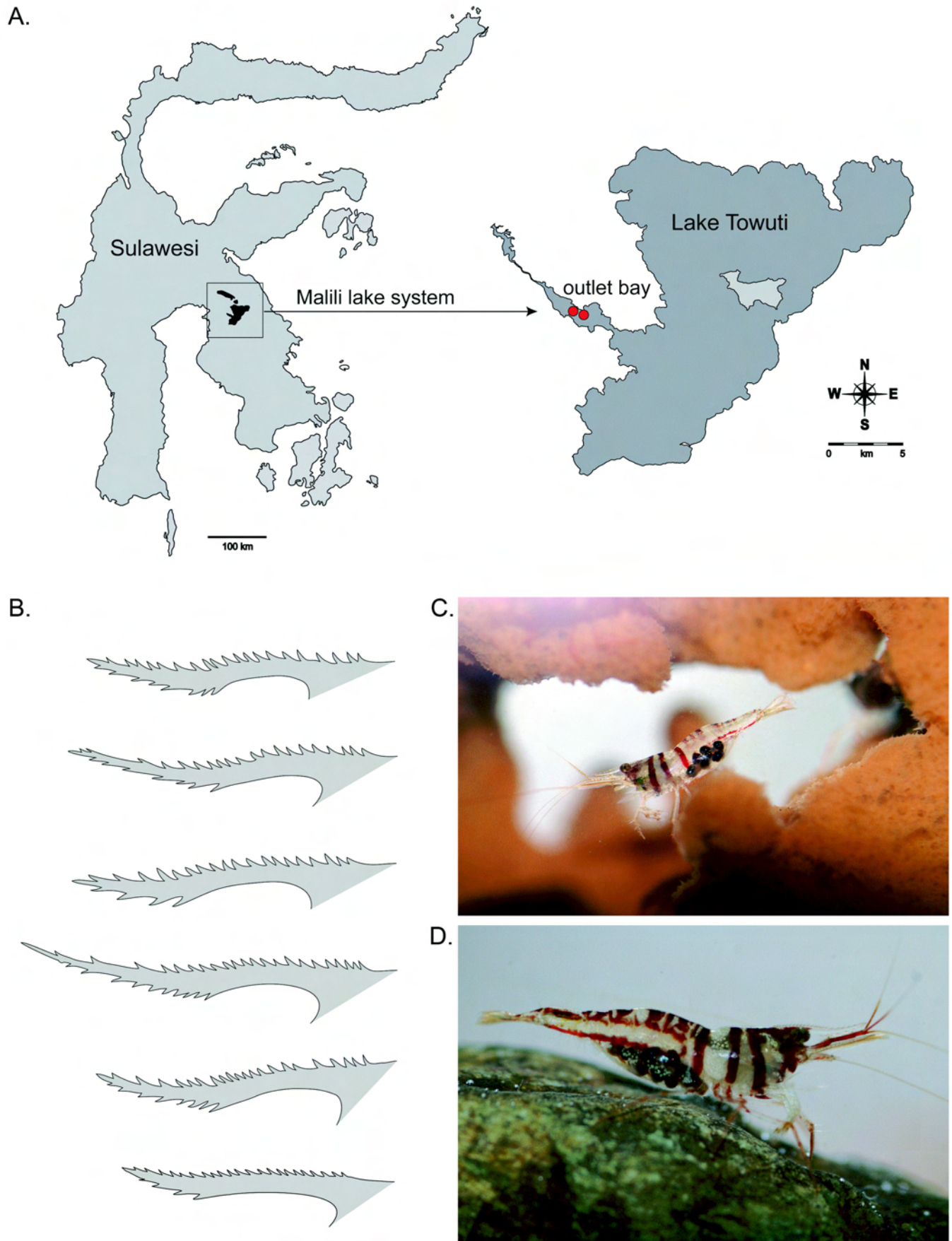


Fig. 1. A, Malili Lake system of Sulawesi: *Caridina spongicola*, new species, collecting sites in the outlet bay of Lake Towuti; B, rostrum variation within a population of *C. spongicola* (ZMB 29027) (scale bar: 1 mm); C, *Caridina spongicola* in its natural habitat; D, colour pattern of *C. spongicola* (ZMB).

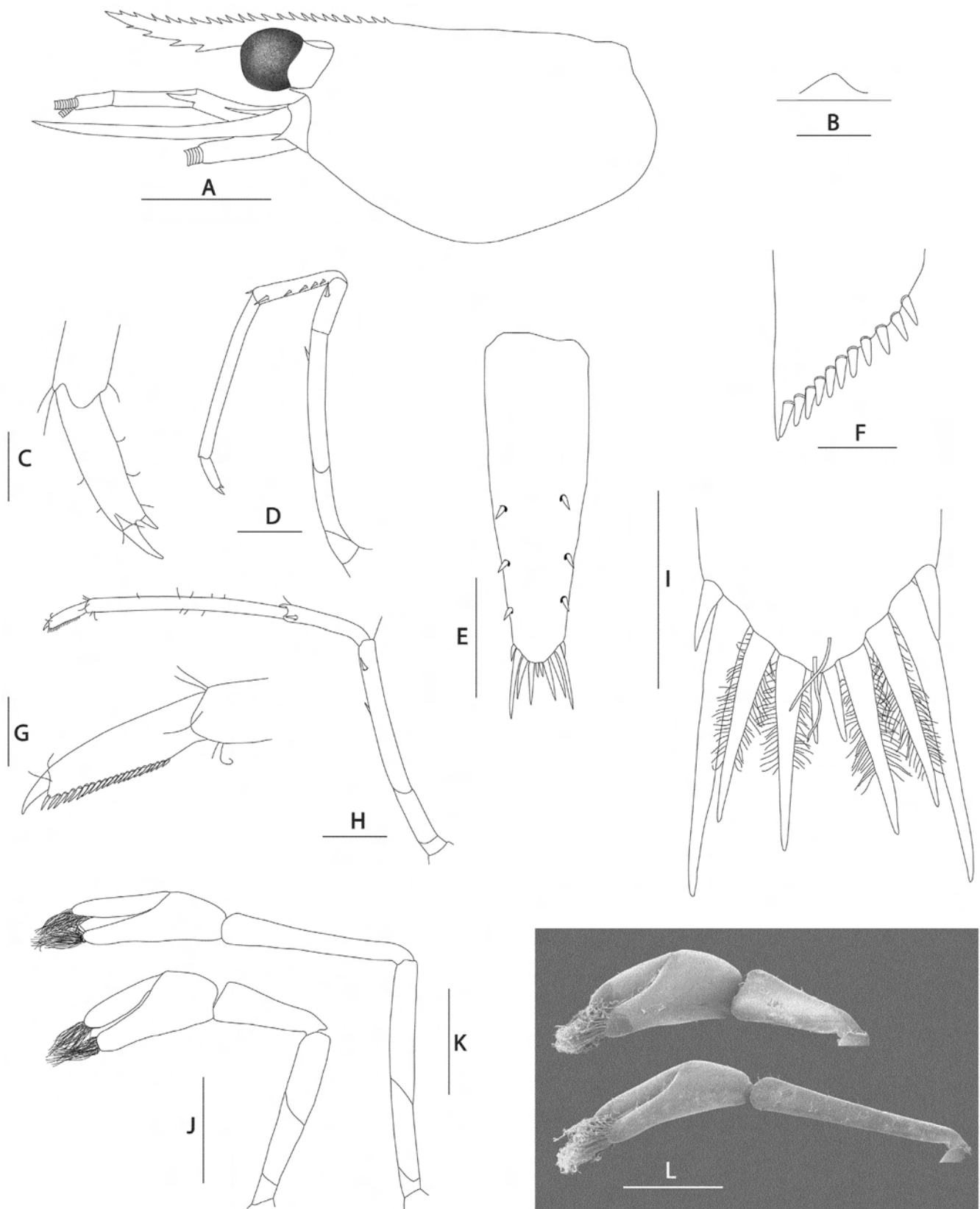


Fig. 2. *Caridina spongicola*, new species, paratype female (cl 2.1mm) (ZMB 29027), Lake Towuti, Sulawesi: A, cephalothorax and cephalic appendages, lateral view; B, preanal carina; C, dactylus of third pereopod; D, third pereopod; E, telson; F, uropodal diaeresis; G, dactylus of fifth pereopod; H, fifth pereopod; I, distal end of telson; J, first pereopod, K, second pereopod; L, SEM images of chela and carpus of first and second pereopods. Scale bars: A = 1 mm; B, D, H-M = 0.5 mm; C, F-G = 0.2 mm.

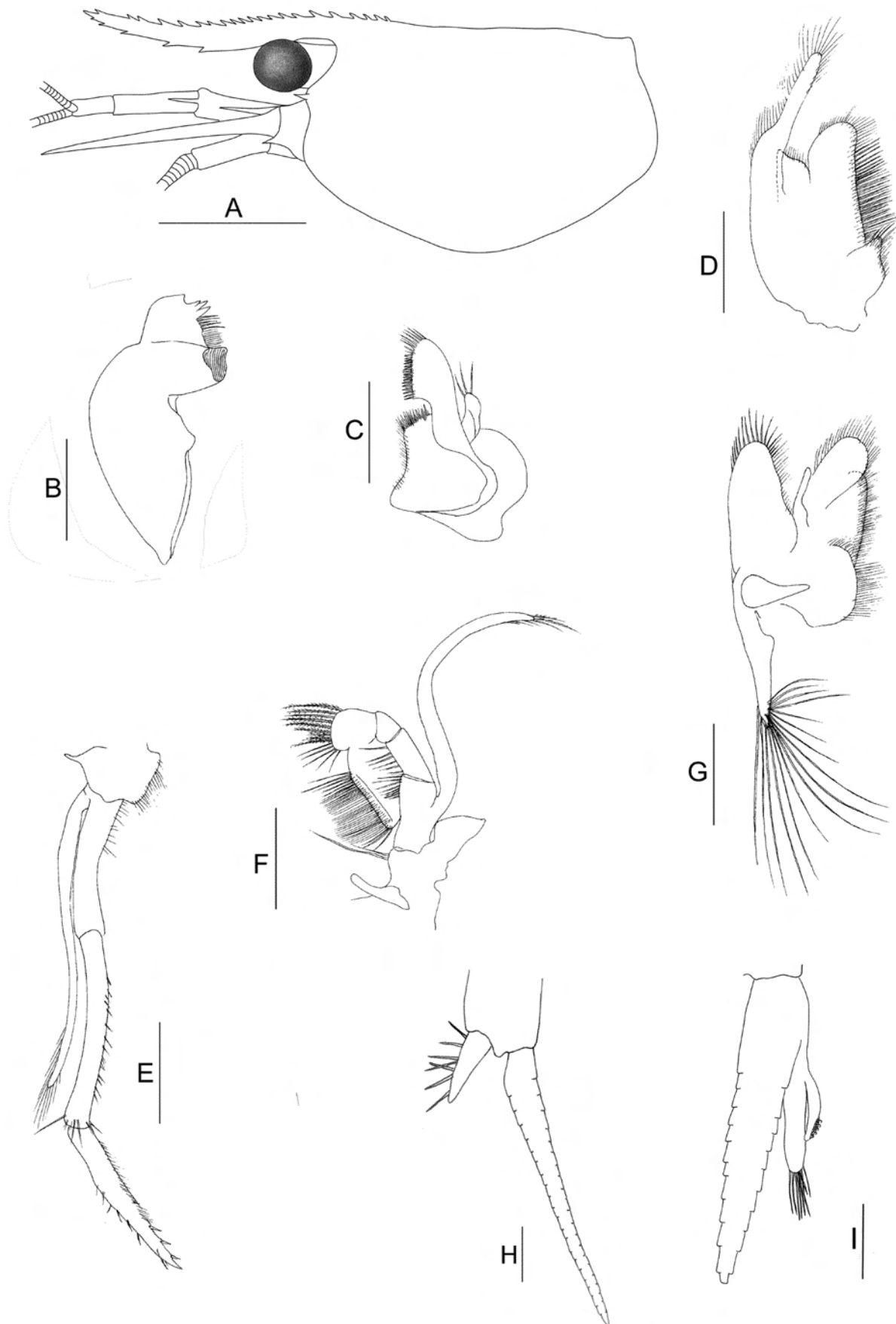


Fig. 3. *Caridina spongicola*, new species, paratype female (cl 2.6 mm) (ZMB 29027), Lake Towuti, Sulawesi. A, cephalothorax and cephalic appendages; lateral view; B, mandible; C, maxillule; D, first maxilliped; E, third maxilliped; F, second maxilliped; G, maxilla; H, male first pleopod; paratype male (cl 1.9 mm) (ZMB 29027); I, male second pleopod; paratype male (cl 1.9 mm) (ZMB 29027). Scale bars: A = 1 mm; B-G = 0.5 mm; H, I = 0.2 mm.

Comparative material examined. – *Caridina lingkonae* Woltereck, 1937: 2 females, cl 3.5-3.8 mm, 3 ovigerous females (ZRC), Lake Towuti, Watidi, 4 km east of Timampu, Sulawesi, Indonesia, coll. M. Kottelat & A. Werner, 15 Mar. 1989; 2 females, cl 2.8-4.0 mm, ZRC, Lake Towuti, estuary of Sungei Batuopa, about 2 km south of Timampu, Sulawesi, Indonesia, coll. M. Kottelat & A. Werner, 14 Mar. 1989.

Description. – Rostrum straight and slender (Fig. 1B, 2A, 3A), anterior third slightly upturned, reaching to or slightly beyond third segment of antennular peduncle, 0.9-1.0 times as long as carapace, armed dorsally with 11-19 + 3-5 teeth, posterior to orbital margin, armed ventrally with 4-10 teeth, dorsal anterior teeth less densely spaced. Antennal spine situated below inferior orbital angle. Pterygostomian angle broadly rounded.

Eyes (Figs. 2A, 3A) well developed, anterior end reaching to or beyond half length of basal segment of antennular peduncle. Antennular peduncle 0.8-0.9 times as long as carapace (n=10), second segment slightly shorter than basal segment, about twice as long as third segment. Stylocerite reaching well beyond half length of basal segment of antennular peduncle, but not reaching end of basal segment. Scaphocerite slender, 3.5-4.8 times as long as wide (n=7).

Sixth abdominal somite 0.5-0.7 times length of carapace, 1.5-2.0 times as long as fifth somite (n=21), 0.7-1.0 times length of telson. Telson (Figs. 2E, I) 2.8-4.1 times as long as wide (n=13), distal margin rounded, without projection, with 3-4 pairs of spinules and 1 pair of dorsolateral spinules; distal end with 4 pairs of spines, lateral pair distinctly longer than intermediate pairs, median pair shortest. Preanal carina (Fig. 2B) rounded, without spine. Uropodal diaeresis (Fig. 2F) with 10-12 movable spinules (n=12).

Incisor process of mandible (Fig. 3B) ending in irregular teeth, molar process truncated. Lower lacinia of maxillule (Fig. 3C) broadly rounded, upper lacinia elongated, with a number of distinct teeth on inner margin, palp slender. Upper endites of maxilla (Fig. 3G) subdivided, palp elongate, scaphognathite tapering posteriorly. Palp of first maxilliped (Fig. 3D) truncate, ending in triangular shape. Podobranch of second maxilliped (Fig. 3F) reduced to small lamina. Third maxilliped (Fig. 3E) with ultimate segment slightly shorter than penultimate segment.

Chela of first pereopod (Fig. 2J) 0.5-0.9 mm, distinctly stouter and shorter (mean length 0.6 mm) than chela of second pereopod (mean length 0.8 mm, n=26) (Fig. 2K), Carpus of first pereopod 0.4-0.8 mm, 0.7-1.3 times as long as chela, Chela of second pereopod 0.7-1.0 mm, Carpus of second pereopod distinctly longer than carpus of first pereopod (0.9-1.4 mm), 1.2-1.4 times as long as chela. Third pereopod (Figs. 2C, D) terminating in one claw with 1-2 accessory spines on flexor margin (n=7), fifth pereopod (Figs. 2G, H) terminating in one claw with 21-31 spinules on flexor margin (n=7).

Endopod of male first pleopod (Fig. 3H) without appendix interna, appendix interna of male second pleopod (Fig. 3I) not reaching end of appendix masculina.

Ovigerous females with 12-18 eggs (n=4 females); egg size 0.8-0.9 x 0.4-0.6 mm (n=53, eggs with and without eyes); sex ratio females/males 2.1.

Distribution. – *Caridina spongicola* is endemic to Lake Towuti within the Malili lake system.

Habitat. – During an extensive substrate specific sampling in the Malili lake system in 2003 and 2004, *Caridina spongicola* was found unexceptionally with a currently undescribed freshwater sponge that, according to a preliminary study, belongs to the common Spongillidae (C. Eckert, pers. comm.) (Fig. 1C). It grows in the outlet of Lake Towuti at depths of 2-5 m. The shrimp either occurs on the sponge or dwells inside its osculae.

Biology. – A preliminary gut content analysis was carried out to investigate the shrimps' diet. None of the six dissected guts contained traces of poriferean spicules. The spicules are presumably too big (0.2-0.3 mm; C. Eckert, pers. comm.) to be consumed by the shrimps. On the other hand, a variety of different diatoms, which possibly accumulate on or within the sponge, were found in the guts. These findings suggest that the shrimps do not feed on sponge's tissue and thus do not parasitize their hosts. Instead, they appear to be commensals using the sponge's cavities as shelter and the inherent accumulation of diatoms as a food supply.

Colour pattern. – Carapace with three transversal dark brown bands (Fig. 1C, D), first two usually joint at dorsal surface to form a n-shaped band in lateral view; anterior part of cephalothorax, antennular peduncle, bases of antennae and posterior rostrum similarly pigmented, whereas anterior rostrum, antennae and distal antennules mostly unpigmented; first and second pereopod white with light brown setae, other pereopods white with brown bands; abdomen with a conspicuous white stripe expanding laterally along each side, dorsally densely covered with dark brown bands except for a white patch on third sternum, ventrally uniformly brown; uropods with a characteristic brown band on distal endopod, endopod and exopods with white-pigmented tips, respectively; pleopods and telson colourless; eggs usually dark brown. This colour pattern remains visible even if the shrimps are under stress though the intensity of the colour merely fades.

Etymology. – The name *spongicola*, the combination of two Latin words, *spongia*, sponge, and *cola*, dweller, refers to the unexceptional occurrence on sponges.

Remarks. – With respect to the shape of the rostrum, *Caridina spongicola* is at first sight morphologically similar to *C. lingkonae*, which was described from Lake Towuti (Woltereck, 1937a), but can be distinguished by a lower number of ventral teeth in *C. spongicola* (4-10 vs. 8-16 in *C. lingkonae*), a shorter rostrum in *C. lingkonae* compared to the length of the antennular peduncle (usually reaching beyond vs. reaching to antennular peduncle in *C. spongicola*). It differs further from *C. lingkonae* by the ratio of the sixth abdominal segment to cl (0.5-0.7 vs. 0.81-0.97 in *C.*

lingkoniae) (Woltereck, 1937b), the stouter first two pereopods, and the number of accessory spines (1-2 vs. 7-8 in *C. lingkoniae*) and spinules (21-31 vs. 48-52 in *C. lingkoniae*) on the dactylus of the third and fifth pereopods, respectively.

The rostrum of *C. spongicola* displays a high degree of variation within the populations (Fig. 1B). However, certain qualitative characters, i.e. the general shape or the arrangement of the rostral teeth, are constant not only in *C. spongicola*, but in all currently described Malili lakes species (see Woltereck, 1937a; b; Zitzler, pers. observ.). When alive, the atyid shrimps of the Malili Lake system may be easily recognized by their distinctive, conspicuous and usually species-specific live colour patterns (K. Zitzler, unpubl. data).

So far, *C. spongicola* is the only freshwater shrimp that associates with sponges. Interestingly, in the East African Lake Tanganyika, another atyid shrimp, *Limnocaridina iridinae*, appears to be associated, presumably also commensally, with a bivalve, *Iridina* sp. (Roth-Woltereck, 1958). The two associations may be even seen as a nice example of ecological convergence between atyid shrimps of the Great Rift lakes in eastern Africa and the Malili Lake system in Sulawesi.

Compared to other *Caridina* species, *C. spongicola* is also rather small (cl 1.8-2.8 mm). The medium egg size (0.8-0.9 x 0.4-0.6 mm) and small numbers of eggs (12-18) suggests an abbreviated larval development, which is typical for lacustrine species.

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