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EPIGEAN AND HYPOGEAN FRESHWATER SHRIMPS OF BOHOL ISLAND, CENTRAL PHILIPPINES (CRUSTACEA: DECAPODA: CARIDEA)

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ABSTRACT. **–** The epigean and hypogean freshwater shrimps from Bohol Island, central Philippines, collected during various speleological expeditions by the Philippine, Slovenian and Singaporean scientists between 1995 and 2000 are reported here. The material contains 25 species of caridean shrimps in two families. The Atyidae are represented by 16 species from four genera: *Antecaridina*, *Halocaridinides* and *Atyopsis*, each with one species; and *Caridina*, with 13 species, including seven new taxa. The Palaemonidae are represented by two genera, *Macrobrachium* with eight species and *Palaemon* with one. Detailed descriptions are provided for new and rarely reported species.

KEY WORDS. **–** Bohol, Philippine, freshwater shrimp, Atyidae, Palaemonidae, new species.

INTRODUCTION

The freshwater shrimps of the Philippine Archipelago have been comparatively well studied (Dana, 1852; Cowles, 1915a, 1915b; Blanco, 1935, 1939; Holthuis, 1950; 1978; Johnson, 1962; Chace, 1983; 1997; Balete & Holthuis, 1992; Chace & Bruce, 1993; Sket, 1997; Cai & Anker, 2004; Cai & Shokita, 2006a). Prior to this study, 52 species of freshwater caridean shrimps were reported from the Philippines. The family Atyidae was represented by seven genera with 28 species: *Antecaridina*, *Halocaridinides*, *Atyoida*, *Atyopsis*, *Parisia*, *Edoneus*, with one species each, and *Caridina*, with 22 species. The family Palaemonidae was represented by two genera with 22 species: *Macrobrachium* with 20 species and *Palaemon* with two species. The family Alpheidae was represented by two species of *Potamalpheops*.

The examination of the recent collection from the Bohol Island (Fig. 1), central Philippines, collected by Dr. Boris Sket and his Slovenian colleagues in February 1995 and March 1999, and a joint expedition by the Raffles Museum of Biodiversity Research, the National University of Singapore, and the Department of Biology, University of San Carlos, Cebu, in December 2000, resulted in the identification of 25 species of caridean shrimps: 16 species of Atyidae, including seven new species and nine species of Palaemonidae. In this study, detailed descriptions and illustrations are provided for the new and the rarely reported species, and brief notes are provided for the more common and widely distributed species.

All the specimens discussed in this study were collected from various localities on Bohol Island, the Philippines (Fig. 1). Specimens examined are deposited in the Zoological Reference Collection, the Raffles Museum of Biodiversity Research, the National University of Singapore, Singapore (ZRC); Department of Biology, University of San Carlos, Cebu, Philippines (USC); and Department of Biotechnology, University of Ljubljana, Slovenia (UOL). The abbreviation cl is used for carapace length measured in mm from the post-orbital margin to the posterior margin of the carapace.

SYSTEMATIC ACCOUNT

Atyidae De Haan, 1849

Antecaridina Edmondson, 1954

Antecaridina lauensis (Edmondson, 1935)

Mesocaris lauensis Edmondson, 1935a: 13, Fig. 4 [type locality: Namuka and Wangava Island, Lau Archipelago, Fiji]; Edmondson, 1935b: 4.

Antecaridina lauensis – Edmondson, 1954: 368; Holthuis, 1955: 25, Fig. 8d–f; 1956: 51; 1963: 267; 1965: 4, Figs. 2a–r; 1973: 19; Shokita, 1975: 118; 1979: 201; Suzuki, 1980: 47, Figs. 1–5; Smith & Williams, 1981: 49; Hayashi, 1989a: 378, Figs. 172–174; Sket, 1997: 62; Leberer & Cai, 2003: 355; Cai & Shokita, 2006b: 2124.

Material examined. – One male, cl 2.8 mm, 16 females, cl 1.8–2.6 mm, 12 juveniles, ZRC 2007.0267, Cave Hinaganan, Panglao, coll. Y. Cai et al., 17 Dec.2000; 60 juveniles, UOL, Cave Hinaganan, Panglao, coll. B. Sket, Feb.1995.

Remarks. – *Antecaridina lauensis*, an anchialine species with a wide but disjunct distribution, has been reported from the Lau Archipelago, Fiji Islands, (Edmondson, 1935a, b), Europa Island, Madagascar (Holthuis, 1965), Sinai Peninsular, Red Sea (Holthuis, 1963), Hawaii Island (Holthuis, 1973), Solomon Islands (Smith & Williams, 1981), Guam (Leberer & Cai, 2003) and the Ryukyus (Shokita, 1975; 1979; Suzuki, 1980). It has previously been reported from Bohol by Sket (1997).

Halocaridinides Fujino & Shokita, 1975

Halocaridinides trigonophthalma (Fujino & Shokita, 1975)

Halocaidina (Halocaridinides) trigonophthama Fujino & Shokita, 1975: 106, Figs. 7, 8 [type locality: a well in Okinawa Island, Ryukyus, Japan]; Shokita, 1979: 201.

Palauatya dasyomma Hart, 1980: 481, Figs. 1–31 [type locality: Anguar Island, Palau, Caroline Islands].

Halocaridinides trigonophthalma – Holthuis, 1982: 31, Figs. 3a–u; Gurney, 1984: 591; Hayashi, 1989b: 497, Fig. 177; Shokita, 2003: 249, Fig. 17C; Naruse et al., 2003: 1; Cai & Shokita, 2006b: 2132.

Material examined. – Eight juveniles, incomplete, UOL, Alijauan Bridge, stream, S. Duero, coll. B. Sket, 5 Mar.1999.

Remarks. – The taxonomy of *Halocaridinides trogonophthalma* has recently been discussed by Naruse et al. (2003) and Cai & Shokita (2006b). The present record is based on eight incomplete juvenile specimens, all of which were collected from an interstitial habitat. These specimens, however, clearly show the characteristic of the species, i.e. the extremely short rostrum, the slender pereiopods, the fewer uropodal teeth as well as the short and stout telson. This represents a new record for the Philippines.

Atyopsis Chace, 1983

Atyopsis spinipes (Newport, 1847)

Atya spinipes Newport, 1847: 159 [type locality: Philipine Islands]

Atya moluccensis – De Man, 1902: 893 (not *Atya moluccensis* De Haan, 1849).

Atyopsis spinipes – Chace, 1983: 35, Figs. 20–22; 1997: 4; Cai & Shokita, 2006b: 2133.

Material examined. – Two females, cl 6.0–7.2 mm, ZRC 2007.0268, River outside Inabacan Cave, Antequrra, coll. Y. Cai et al., 16 Dec.2000.

Remarks. – Chace (1997) reported this species from Luzon, Catanduanes, Cebu and a location that probably Mindoro. De Man (1902) reported *Atya moluccensis* from Halmahera, for which, Chace (1983) commentd that De Man's (1902) specimens "probably represent *Atyopsis spinipes*, as indicated by the fewer (3–5) ventral teeth." According to Chace (1983), the most reliable characters used to separate *Atyopsis moluccensis* from *A. spinies* is the large number of ventral rostral teeth as 7–16 (vs. 2–6). *Atyopsis spinipes* occurs from the Philippines and eastern Lesser Sunda Islands (at ca.120°00'E) northwards to Taiwan and Tokuno-shima in the Ryukyus, and eastwards as far as Samoa (Chace, 1983).

Caridina H. Milne Edwards, 1837

Caridina typus H. Milne Edwards, 1837

Caridina typus H. Milne Edwards, 1837: 363 [type locality: unknown]; Holthuis, 1965: 10, Fig. 3; Chace, 1997: 21; Cai & Anker, 2004: 236; Wowor et al., 2004: 341; Fig. 5F; Cai et al., 2006: 412, Figs. 13–15; Cai & Shokita, 2006b: 2134.

Material examined. – One female, cl 3.2 mm, ZRC 2007.0269, river outside Inabacan Cave, Antequrra, coll. Y. Cai et al., 18 Dec.2000; 1 male, cl 4.7 mm, 8 females, cl 2.8–4.0 mm, 2 ovigerous females, cl 6.8–7.2 mm, ZRC 2007.0270, River outside Inabacan Cave, Antequrra, coll. Y. Cai et al., 16 Dec.2000; 1 male, cl 5.7 mm, 3 ovigerous females, cl 6.6–7.8 mm, ZRC 2007.0271, Loboc river, Loboc, coll. Y. Cai et al, 19 Dec.2000.

Remarks. – *Caridina typus* is a very common insular or coastal freshwater species, which is widely distributed in the islands of Indo-West Pacific region.

Caridina villadolidi Blanco, 1939

Caridina typus var. *longirostris* De Man, 1892: 370, Pl. 22: 22f–i [type locality: Palopo, Sulawesi (Celebes), Indonesia].

Caridina villadolidi Blanco, 1939: 389, Pl. 1 [type locality: Laoag River, Luzon, the Philippines] Hung et al., 1993: 485, Fig. 3; Chace, 1997: 21, Fig. 12; Cai & Ng, 2001: 668, Fig. 4; Cai & Shokita, 2006a: 248.

Caridina typus – De Silva, 1982: 135. Figs. 4a–h (not *Caridina typus* H. Milne Edwards, 1837).

Material examined. **–** Ten females, cl 3.3–3.8 mm, ZRC 2007.0272, river outside Inabacan Cave, Antequrra, coll. Y. Cai et al., 16 Dec.2000; 1 male, cl 3.4 mm, 11 females, cl 3.4–4.4 mm, ZRC 2007.0273, river outside Inabacan Cave, Antequrra, coll. Y. Cai et al., 18 Dec.2000; 1 male, cl 4.9 mm, ZRC 2007.0274, Loboc River, Loboc, coll. Y. Cai et al., 19 Dec.2000.

Remarks. **–** *Caridina villadolidi* has been reported from Taiwan (Hung et al., 1993), the Philippines (Blanco, 1939; Chace, 1997; Cai & Shokita, 2006a), Sulawesi and Halmahera in Indonesia (Cai & Ng, 2001), and Sri Lanka (De Silva, 1982, misidentified as *Caridina typus*).

Caridina laoagensis Blanco, 1939

Caridina laoagensis Blanco, 1939: 390, Pl. 2 [type locality: Laoag River, Province of Ilocos Norte, Luzon, the Philippines]; Chace, 1997: 12; Cai & Anker, 2004: 237, Fig. 3; Cai & Shokita, 2006a: 248; Cai & Shokita, 2006b: 2141.

Material examined . **–** Two males, cl 2.6–2.9 mm, 1 female, cl 2.9 mm, 2 ovigerous females, cl 5.6–6.0 mm, ZRC 2007.0275, river outside the Inabacan Cave, Antequrra, coll. Y. Cai et al., 16 Dec.2000; 3 males, cl 3.2–3.7 mm, 2 ovigerous females, cl 6.2–6.3 mm, ZRC 2007.0276, river outside Inabacan Cave, Antequrra, coll. Y. Cai et al., 18 Dec.2000.

Remarks. **–** Chace (1997) commented that *Caridina laoagensis* will eventually fall into synonymy with the variable *C. weberi* De Man, 1892. Cai & Anker (2004) has shown that *C. laoagensis* differs markedly from all subspecies of *C. weberi* and other congeners, and should be regarded as a good species. *Caridina laoagensis* is characterized by its straight rostrum which is slightly crested basally above the orbit, and the pattern of distal spines and setae on the telson, on which, the median plumose seatae are inserted betweem two lateral spines. This is one of the most common species of atyids in the Philippines.

Caridina endehensis De Man, 1892

Caridina brevicarpalis var. *endehensis* De Man, 1892: 399, Pl. 24 Fig. 30e [type locality: Nuawari, near Ende, Flores, Indonesia]; Bouvier, 1925: 34; Roux, 1928: 218; Blanco, 1935: 34, Pl. 2 Fig. 25; Chace, 1997: 8, Fig. 3.

Caridina brevicarpalis – Holthuis, 1978: 38 (not *Caridina brevicarpalis* De Man, 1892).

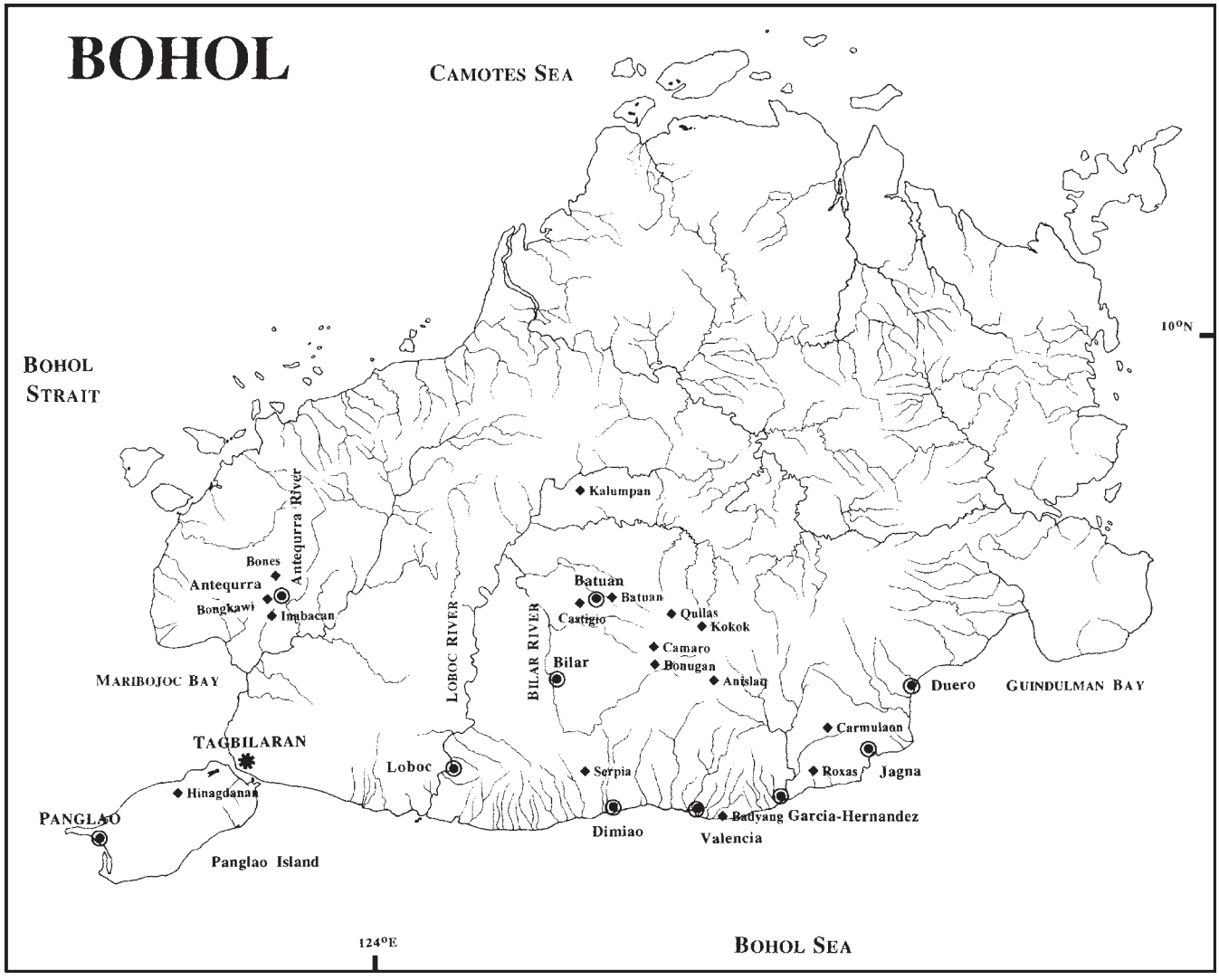

Fig. 1. Map of the Bohol Island, Philippines, showing the collection sites.

Caridina endehensis – Wowor et al., 2004: 341, Fig. 5M; Cai & Shokita, 2006a: 248.

Material examined. – 13 males, cl 3.0–4.2 mm, 25 females, cl 2.7–6.2 mm, 2 ovigerous, females, cl 4.6–6.2 mm, ZRC 2007.0277, river outside Inabacan Cave, Antequrra, coll. Y. Cai et al., 16 Dec.2000; 11 males, cl 3.2–4.6 mm, 13 females, cl 2.9–4.8 mm, 2 ovigerous females, cl 5.3–6.4 mm, ZRC 2007.0278, river outside Inabacan Cave, Antequrra, coll. Y. Cai et al., 18 Dec.2000.

Remarks. – Holthuis (1978) reported *Caridina brevicarpalis* from Sumba, Lesser Sunda Islands, Indonesia. According to his description, his specimens "can unhesitatingly be brought to ssp. *endehensis*". *Caridina endehensis* has previously been reported from the Philippines by Blanco (1935), Chace (1997) and Cai & Shokita (2006a). It is distributed from Philippines to Flores and Sumba in Indonesia. The prominently elongated rostrum easily separates *C. endehensis* from *C. brevicarpalis* and does not appear to be variable. We therefore follow Cai & Shokita (2006a) and regard the taxon as a full species.

Caridina elongapoda Liang & Yan, 1977

Caridina nilotica elongapoda Liang & Yan, 1977: 220, Figs. 5–8 [type locality: Xinzai, Gulei village, Zhangpu County, Fujian, southern China].
Caridina aff. *brachydactyla* - Yeo et al., 1999: 218, Figs. 10–14; Wowor et al., 2004: Fig. 6B;
Caridina elongapoda Cai & Shokita, 2006a: 249.

Material examined. – Two males, cl 4.1–4.5 mm, 3 ovigerous females, cl 5.6–5.8 mm, ZRC 2007.0279, tributary of Loboc River, Loboc, coll. Y. Cai, 19 Dec.2000; 1 male, cl 4.0 mm, 5 females, cl 2.8–3.4 mm, 3 ovigerous females, cl 5.3–6.4 mm, ZRC 2007.0280, river outside Inabacan Cave, Antequrra, coll. Y. Cai et al., 18 Dec.2000; 6 males, cl 3.1–4.7 mm, 17 females, cl 2.8–4.3 mm, ZRC 2007.0281, river outside Inabacan Cave, Antequrra, coll. Y. Cai et al., 16 Dec.2000.

Remarks. – *Caridina elongapoda* has recently been reported from the Philippines (Cai & Shokita, 2006a). Cai & Shokita (2006a) reassigned the material identified as *Caridina* aff. *brachydactyla* by Yeo et al. (1999) from Pulau Tioman, Malaysia, to this species.Current known distribution is southern China, Malaysia and the Philippines.

Caridina gracilirostris De Man, 1892

Caridina gracilirostris De Man, 1892: 399, Pl. 25 Fig. 31–31d [type locality: Balangnipa, Sulawesi (Celebes) Indonesia]; Bouvier, 1925: 142, Figs. 305–307; Holthuis, 1965: 23, Fig. 7; Tiwari & Pillai, 1971: 83, Fig. 2a, b; Chace, 1997: 10, Fig. 4; Wowor et al., 2004, Fig. 5Q; Cai & Shokita, 2006a: 250; Cai & Shokita, 2006b: 2135; Cai & Ng, 2007: 1586.

Material examined. – Two males, cl 2.5–2.6 mm, 3 females, cl 2.0–3.3 mm, 1 ovigerous female, cl 3.7 mm, ZRC 2007.0282, tributary of Loboc River, Loboc, coll. Y. Cai, 19 Dec.2000.

Remarks. – Cai & Ng (2007) recently reviewed the taxonomy of the *Caridina gracilirostris* species group in detail, referring the form with no appendix interna in endopod of male first pleopod as *C. gracilirostris* sensu stricto and the other, with a distinct appendix interna in the endopod of male first pleopod, as *C. appendiculata* Jalihal & Shenoy, 1998. The specimens from Bohol have no appendix interna on the endopod of the male first pleopod, and are here referred to *C. gracilirostris*. It is an insular or coastal freshwater species commonly distributed in Indo-West Pacific region.

Caridina lobocensis, new species
(Figs. 2–4)

Material examined. – Holotype: male, cl 5.7 mm, USC, tributary of Loboc River, Loboc, coll. Y. Cai, 19 Dec.2000.

Paratypes: Seventy males, cl 3.8–5.3 mm, 19 females, cl 3.9–7.5 mm, 83 ovigerous females, cl 5.3–7.2 mm, ZRC 2007.0283, data same as holotype.

Description. – Rostrum (Figs. 2A, 3A) straight, reaching slightly beyond end of antennular peduncle; rostral formula: 2–4+10–12/3–7. Antennal spine fused with inferior orbital angle. Pterygostomian margin subrectangular.

Sixth abdominal somite 0.44 times of carapace, 1.4 times as long as fifth somite, distinctly shorter than telson. Telson (Figs. 3B, 4A) 2.6 times as long as wide, terminating in a projection, with 3 or 4 pairs of dorsal spinules and 1 pair of dorsolateral spinules; lateral pair of spines distinctly shorter than intermediate pairs of setae. Preanal carina (3I) high, lacking spine.

Eyes developed, anterior end reaching to 0.8 times length of basal segment of antennular peduncle. Antennular peduncle 0.55 times as long as carapace; basal segment of antennular peduncle as long as both of second and third segment lengths, anterolateral angle reaching 0.20 times length of second segment, second segment distinctly longer than third segment. Stylocerite reaching slightly beyond end of basal segment of antennular peduncle. Scaphocerite (Fig. 2B) 2.5 times as long as wide.

Incisor process of mandible (Fig. 2C) ending in irregular teeth, molar process truncated. Lower lacinia of maxillula (Fig. 2D) broadly rounded, upper lacinia elongated, with a number of distinct teeth on inner margin, palp slender. Upper endites of maxilla (Fig. 2E) subdivided, palp short, scaphognathite tapering posteriorly with some long, curved setae at posterior end. Palp of first maxilliped (Fig. 2F) broadly triangular. Second maxilliped (Fig. 2G) typical of genus. Third maxilliped (Fig. 2H) reaching to end of antennular peduncle, with ultimate segment shorter than penultimate segment.

Epipods on first 4 pereiopods. First pereiopod (Figs. 3C, 4D) reaching to end of basal segment of antennular peduncle; merus 1.7–2.1 times as long as broad, slightly longer than

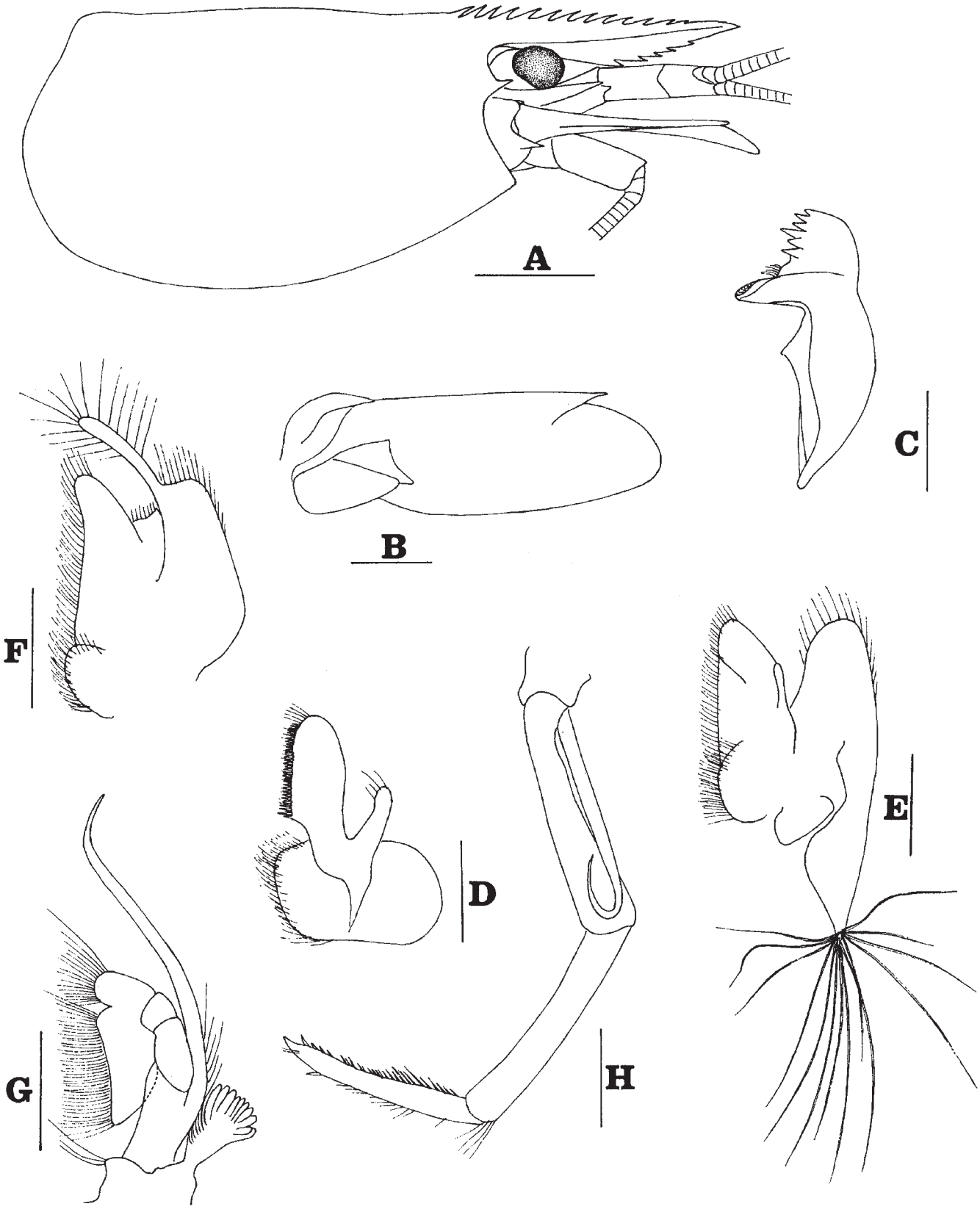

Fig. 2. *Caridina lobocensis*, new species: A, cephalothorax and cephalic appendages, lateral view; B, scaphocerite; C, mandible; D, maxillula; E, maxilla; F, first maxilliped; G, second maxilliped; H, third maxilliped. Scale bars: A = 2 mm, B–H = 1 mm (female, cl 6.9 mm, Paratype, ZRC, Philippines).

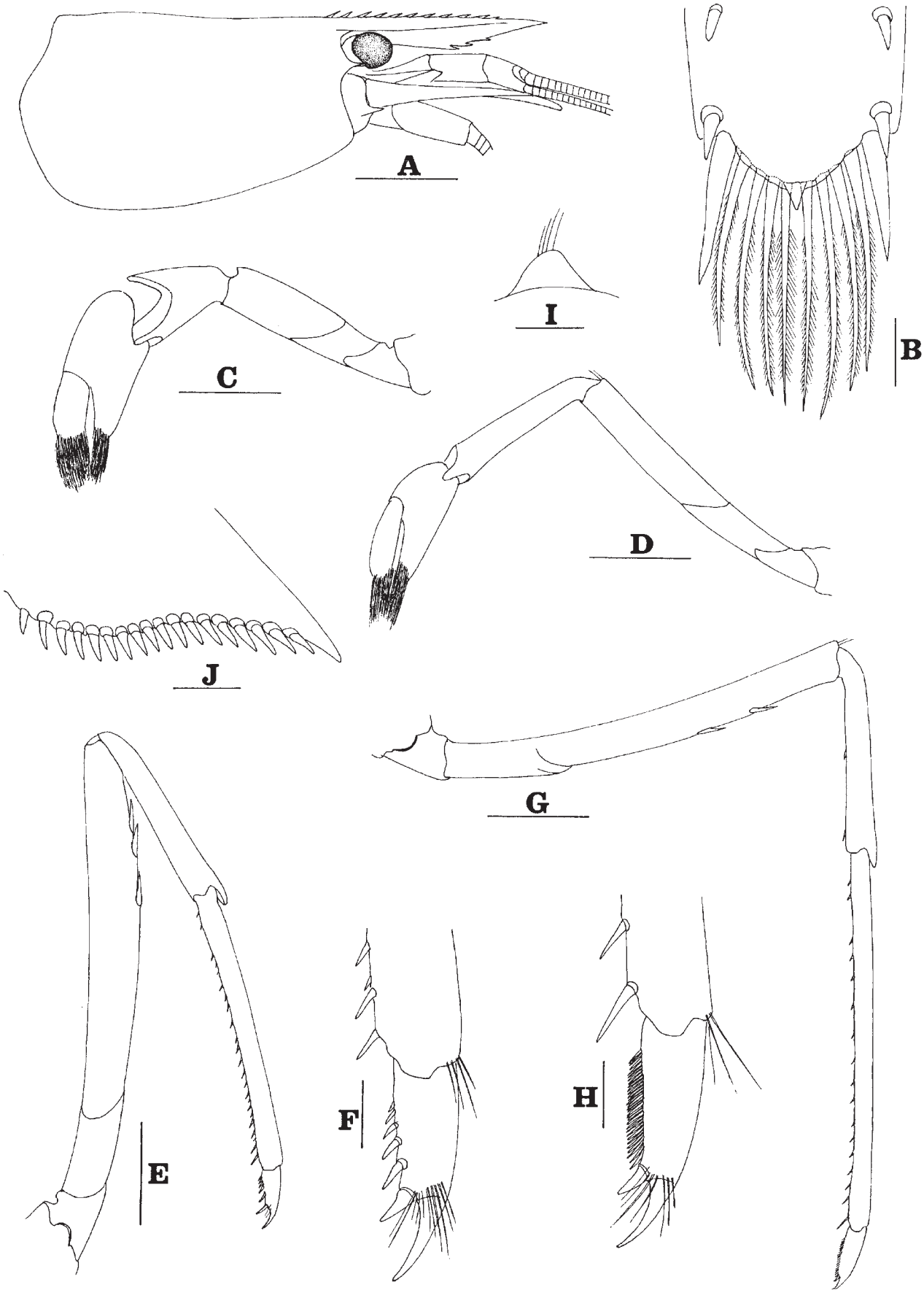

Fig. 3. *Caridina lobocensis*, new species: A, cephalothorax and cephalic appendages, lateral view; B, distal portion of telson; C, first pereiopod; D, second pereiopod; E, third pereiopod; F, dactylus of third pereiopod; G, fifth pereiopod; H, dactylus of fifth pereiopod; I, preanal carina; J, uropodal diaeresis. Scale bars: A = 2 mm, B, F, H, J = 0.2 mm; C–E, G = 1 mm; I = 0.5 mm (male, cl 5.7 mm, paratype, ZRC, Bohol Island, Philippines).

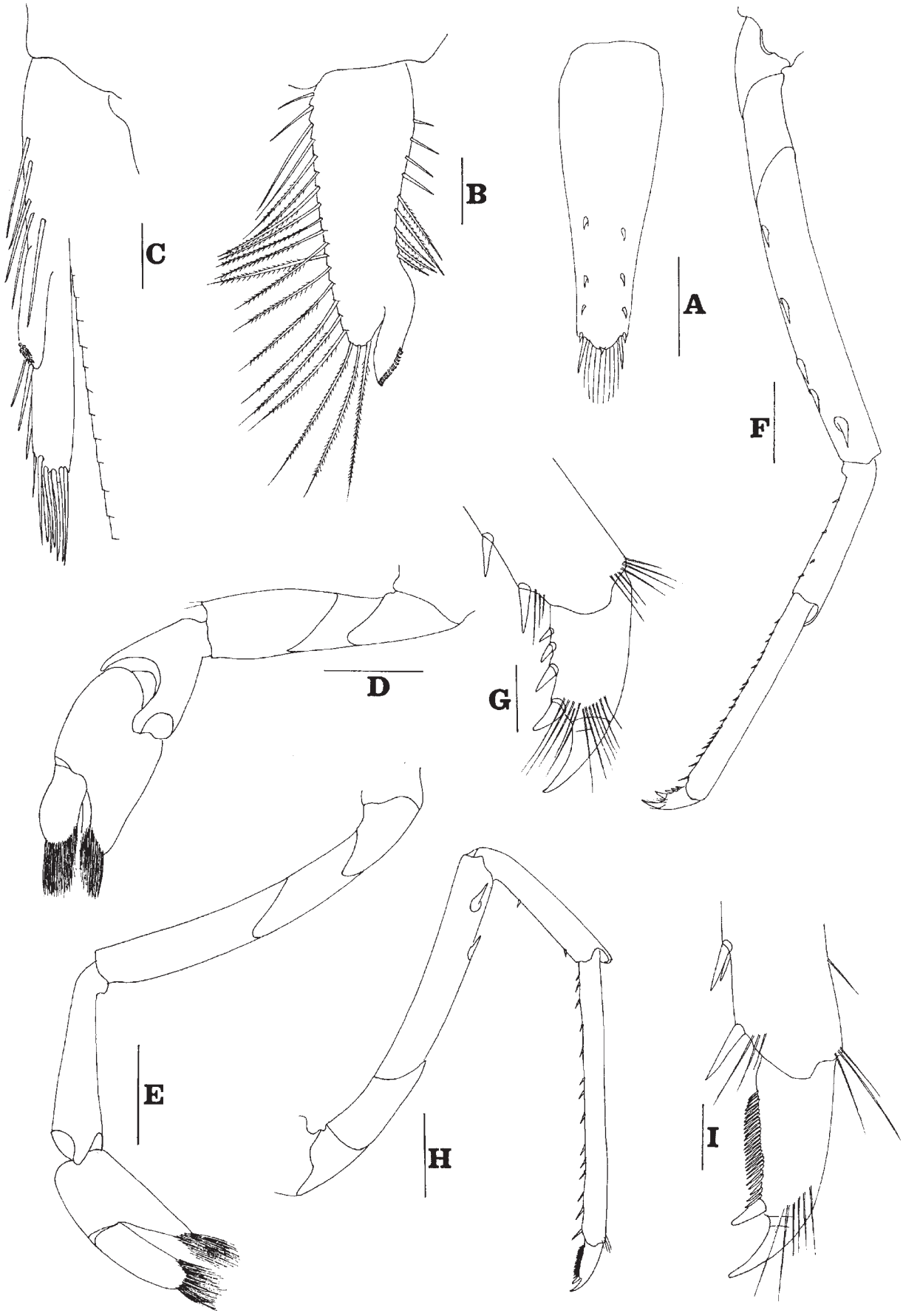

Fig. 4. *Caridina lobocensis*, new species: A, telson; B, endopod of male first pleopod; C, appendix masculina and appendix interna of male second pleopod; D, first pereiopod; E, second pereiopod; F, third pereiopod; G, dactylus of third pereiopod; H, fifth pereiopod; I, dactylus of fifth pereiopod. Scale bars: A, D–F, H = 1 mm; B, C, G, I = 0.2 mm (A–C, male, cl 5.7 mm, paratype, ZRC, Bohol Island, Philippines; D–I, female, cl 6.9 mm, paratype, ZRC, Bohol Island, Philippines).

carpus; carpus excavated anteriorly, shorter than chela, 1.1–1.2 times as long as high; chela 2.2 times as long as broad; fingers distinctly shorter than palm. Second pereiopod (Figs. 3D, 4E) reaching to end of second segment of antennular peduncle; merus as long as carpus, 4.2–5.0 times as long as broad; carpus 1.1 times as long as chela, 2.3–2.4 times as long as high; chela 2.3–2.4 times as long as broad; fingers 1.6 times as long as palm. Third pereiopod (Figs. 3E, F, 4F, G) reaching slightly beyond end of scaphocerite, propodus 9–11 times as long as broad, 5.2–5.7 times as long as dactylus; dactylus 2.7–3.0 times as long as wide (spines included), terminating in 2 very strong claws, with 4–6 accessory spines on its flexor margin. Fifth pereiopod (Figs. 3G, H, 4H, I) reaching beyond end of second segment of antennular peduncle, propodus 13–18 times as long as broad, 5.5–5.6 times as long as dactylus, dactylus 2.7–3.0 times as long as wide (spinules included), terminating in 2 large claws, with 26–30 spinules on its flexor margin.

Endopod of male first pleopod (Fig. 4B) subtriangular, half length of exopod, appendix interna stout, exceeding end of endopod. Appendix masculina of male second pleopod (Fig. 4C) 2/3 length of endopod, with appendix interna reaching base of distal one-third of appendix masculina.

Uropodal diaeresis (Fig. 3J) with 18 movable spinules.

Ovigerous females with eggs sized 0.45 × 0.25 mm.

Habitat. – *Caridina lobocensis*, new species, was collected from a tributary of the Loboc River near Loboc town, Bohol Island in central Philippines. The shrimps were living among submerged grass at edges of the tributary.

Etymology. – The new species is named after its type locality-Loboc River, Bohol Island, the Philippines.

Remarks. – Based on the form of the rostrum, the high preanal carina, the large number of uropodal teeth and the form of the telson, *C. lobocensis*, new species, belongs to the *C. weberi* species group. In the group, it is most similar to *C. okinawa* Cai & Shokita, 2006b, from Okinawa Island of the Ryukyu Islands, southern Japan, in term of the rostral formula, the long stylocerite, the broad scaphocerite, the stout first pereiopod, and its short fingers, and the third to fifth pereiopods ending in two claws. However, it could be easily separated from *C. okinawa* by the well developed eyes (vs. eyes less developed, with a short eye stalk and small cornea) and the longer rostrum which reaches slightly beyond end of antennular peduncle (vs. reach to end of second segment of antennular peduncle) (Figs. 2–4; cf. Cai & Shokita, 2006b: Fig. 12). *Caridina lobocensis* also resembles another Ryukyuan species, *C. macrodentata* Cai & Shokita, 2006b, in the form of the dactylus of the third to fifth pereiopods, Nevertheless, it could be differentiated from the latter by the longer rostrum, which reaches slightly beyond the end of the antennular peduncle (vs. reaches middle of the second segment of the antennular peduncle) and the long stylocerite (reaches to or slightly beyond the end of the basal segment of the antennular peduncle vs. does not reaches) (Figs. 2, 3; cf. Cai & Shokita, 2006b: Figs. 13, 14).

Caridina liaoi, new species
(Figs. 5, 6)

Material examined. – Holotype: Ovigerous female, cl 4.1 mm, USC, Bilar River, Bilar, coll. Y. Cai et al., 19 Dec.2000.

Paratypes: 82 males, cl 2.8–4.3 mm, 112 females, cl 3.7–5.0 mm, 26 ovigerous females, cl 4.2–5.0 mm, ZRC 2007.0284, data same as holotype.

Description. – Rostrum (Figs. 5A, 6A) long, reaching near to or slightly beyond end of scaphocerite; rostral formula: 3–4+13–14/13–15. Antennal spine fused with inferior orbital angle. Pterygostomian margin broadly rounded.

Sixth abdominal somite 0.51 times of carapace, 1.7 times as long as fifth somite, distinctly shorter than telson. Telson (Figs. 6B, C) 3.5 times as long as wide, not terminating in a projection, with 3 or 4 pairs of dorsal spinules and 1 pair of dorsolateral spinules; lateral pair of spines distinctly longer than intermediate pairs of spiniform setae. Preanal carina (Fig. 6K) high, triangular, lacking spine.

Eyes well developed, anterior end reaching to 0.8 times length of basal segment of antennular peduncle. Antennular peduncle 0.74 times as long as carapace; basal segment of antennular peduncle longer than both second and third segment lengths, anterolateral angle reaching 0.20 times length of second segment, second segment distinctly longer than third segment. Stylocerite reaching to 0.8 times length of basal segment of antennular peduncle. Scaphocerite (Fig. 6D) 3.4 times as long as wide.

Incisor process of mandible ending in irregular teeth, molar process truncated. Lower lacinia of maxillula broadly rounded, upper lacinia elongated, with a number of distinct teeth on inner margin, palp slender. Upper endites of maxilla subdivided, palp short, scaphognathite tapering posteriorly with some long, curved setae at posterior end. Palp of first maxilliped broadly triangular. Second maxilliped typical of genus. Third maxilliped reaching to end of antennular peduncle, with ultimate segment as long as penultimate segment.

Epipods on first 4 pereiopods. First pereiopod (Figs. 5B, 6E) reaching to end of basal segment of antennular peduncle; merus 1.9–2.2 times as long as broad, shorter than carpus; carpus excavated anteriorly, shorter than chela, 1.3–1.7 times as long as high; chela 2.3–3.5 time as long as broad; fingers slightly shorter, as long as or distinctly longer than palm. Second pereiopod (Figs. 5C, 6F) reaching to end of second segment of antennular peduncle; merus as long as carpus, 4.2–5.0 times as long as broad; carpus 1.1 times as long as chela, 2.3–2.4 times as long as high; chela 2.3–2.4 times as long as broad; fingers 1.6 times as long as palm. Third pereiopod (Figs. 5D, E, 6G, H) reaching to end of antennular

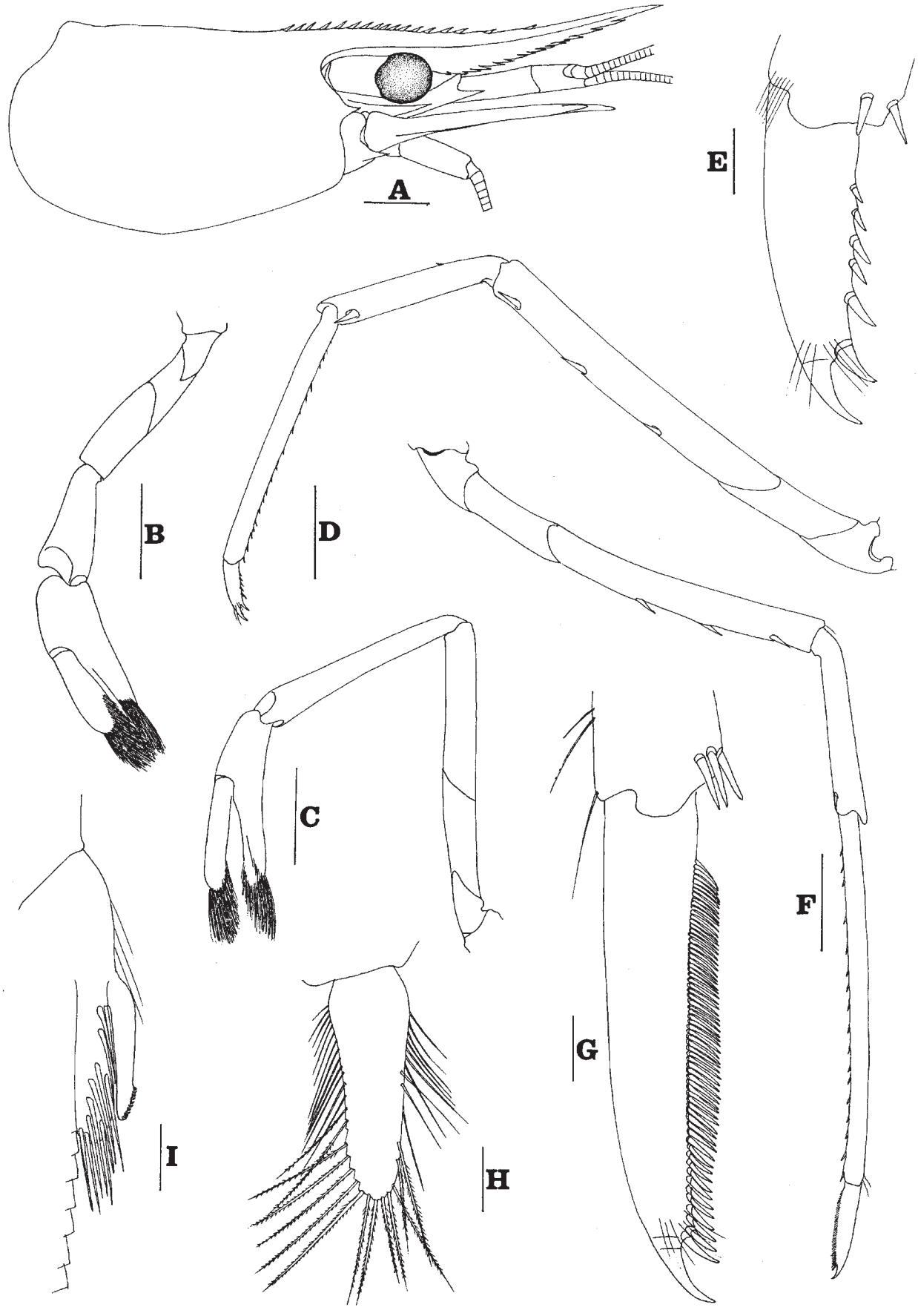

Fig. 5. *Caridina liaoi*, new species. A: cephalothorax and cephalic appendages, lateral view; B, first pereiopod; C, second pereiopod; D, third pereiopod; E, dactylus of third pereiopod; F, fifth pereiopod; G, dactylus of fifth pereiopod; H, endopod of male first pleopod; I, appendix masculina and appendix interna of male second pleopod. Scale bars: A–D, F = 1 mm; E, G = 0.1 mm; H, I = 0.2 mm (male, cl 4.0 mm, paratype, ZRC, Bilar river).

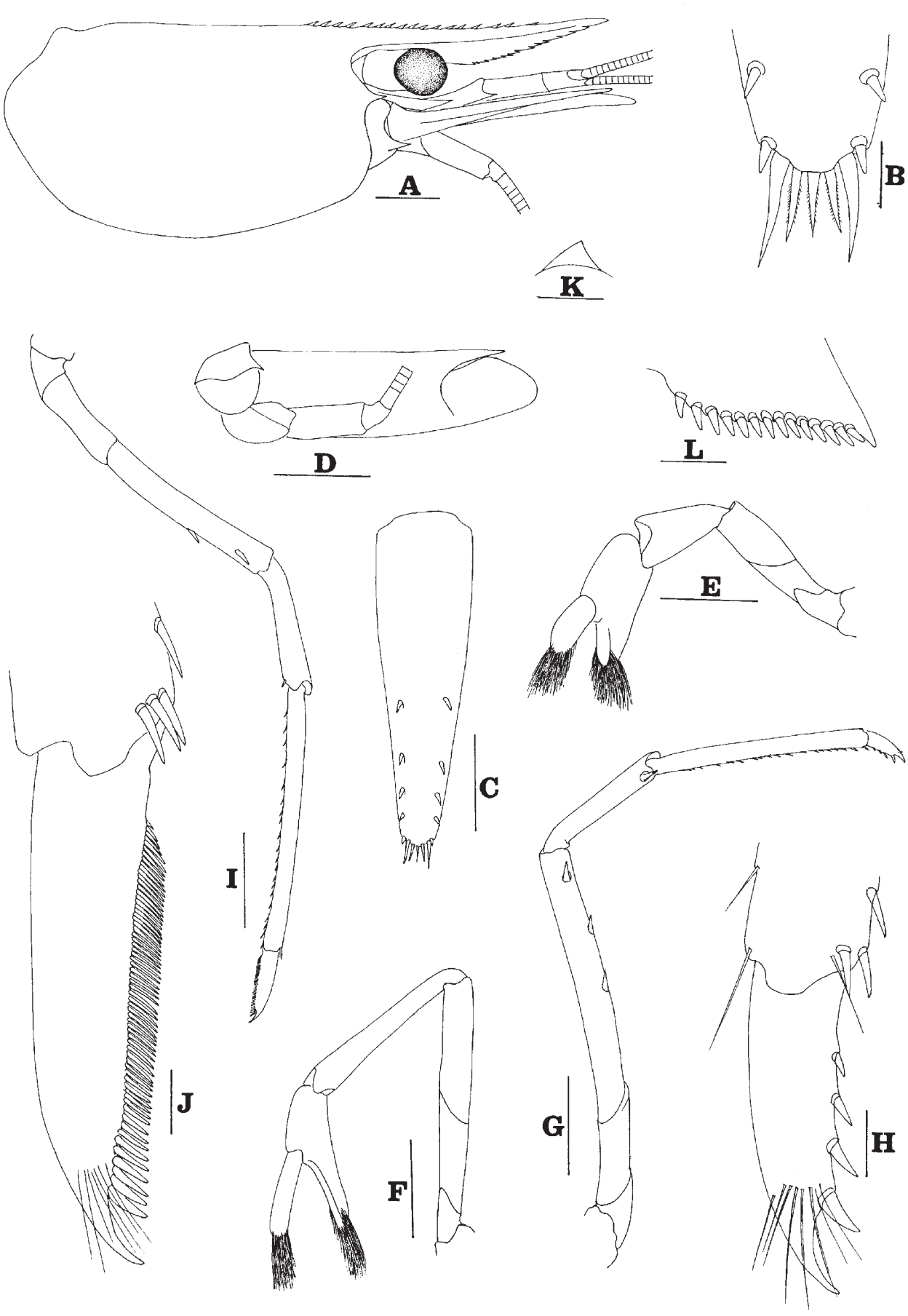

Fig. 6. *Caridina liaoi*, new species, A: cephalothorax and cephalic appendages, lateral view; B, distal portion of telson; C, telson; D, scaphocerite; E, first pereiopod; F, second pereiopod; G, third pereiopod; H, dactylus of third pereiopod; I, fifth pereiopod; J, dactylus of fifth pereiopod; K, preanal carina; L, uropodal diaeresis. Scales: A, C–G, I = 1 mm; B, L = 0.2 mm; H, J = 0.1 mm; K = 0.5 mm. (ovig. females, cl 4.6 mm, paratype, ZRC, Bilar River).

peduncle, propodus 11–12 times as long as broad, 4.5–4.7 times as long as dactylus; dactylus 3.1–3.3 times as long as wide (spines included), with 4–6 accessory spines on flexor margin. Fifth pereiopod reaching to end of second segment of antennular peduncle, propodus 14–18 times as long as broad, 3.6–3.8 times as long as dactylus, dactylus 4.0–4.4 times as long as wide (spinules included), terminating in 1 large claw, with 60–65 spinules on flexor margin.

Endopod of male first pleopod (Fig. 5H) sub-rectangular, two-fifth length of exopod, no appendix interna. Appendix masculina of male second pleopod (Fig. 5I) half length of endopod, with appendix interna reaching near end of appendix masculina.

Uropodal diaeresis (Fig. 6L) with 14–16 movable spinules.

Ovigerous females with eggs sized 0.92–0.95 × 0.55–0.60 mm.

Habitat. **–** *Caridina liaoi*, new species, was collected from a tributary of the Bilar River near Bilar town, Bohol Island in central Philippines.

Etymology. **–** The new species is named after Dr. Lawrence Liao, who has been instrumental in helping the first author making collections in the Philippines for the present study.

Remarks.- *Caridina liaoi*, new species, is similar to *C. buhi* Cai & Shokita, 2006a, from Luzon, by the form of pereiopods, but it differs from *C. buhi* by its longer rostrum (reaches to or slightly beyond the anterior margin of the scaphocerite vs. reaches to the end of the second segment of the antennular peduncle or to the end of the antennular peduncle); the more ventral rostral teeth (13–15 vs. 3–7); the telson does not terminate in a projection vs. terminate in a projection; the bigger appendix interna on the male second pleopod (reaches near the end of the appendix masculina vs. reaches the base of the distal two-third length of the appendix masculina) and the distal spines on the telson (lateral spines much longer than the intermediate pairs of spiniform setae vs. lateral spines subequal to intermediate pairs) (Figs. 5, 6; cf. Cai & Shokita, 2006a: Figs. 3, 4).

Caridina boholensis, new species
(Figs. 7, 8)

Material examined. **–** Holotype: Male cl 3.9 mm, USC, Quila Cave, Nueva Vida Norte, Batuan, coll. B. Sket, Feb.1995.

Paratypes: 87 males, cl 3.0–4.2 mm, 115 females, cl 2.7–4.7 mm, 1 ovigerous females, 3.8 mm, eggs 0.75 x 0.50 mm, UOL, data same as holotype; 10 males, cl 3.0–4.2 mm, 10 females, cl 2.7–4.7 mm, 1 ovigerous females, 4.6 mm, eggs 0.75 × 0.50 mm, ZRC 2007.0285, data same as holotype.

Others: Nine males, cl 2.8–3.8 mm, 5 females, cl 37–3.8 mm, 11 juveniles, ZRC 2007.0286, Cave Bones, Canla-As village, Antequrra, coll. Y. Cai et al., 16 Dec.2000; 41 males, cl 2.6–3.5 mm, 38 females, cl 2.9–4.1 mm, ZRC 2007.0287, Cave Bongkawi, Canla-As village, Antequrra, coll. Y. Cai.et al., 16 Dec.2000; 3 males, cl 3.0–3.8 mm, 11 females, cl 2.3–3.8 mm, ZRC 2007.0288, spring outside cave Bones, Canla-As village, Antequrra, coll. P. K. L. Ng & L. Liao, 16 Dec.2000; 6 males, cl 2.8–3.4 mm, ZRC 2007.0289, spring outside Cave Inabacan, Antequrra, coll. Y. Cai et al., 18 Dec.2000; 22 males, cl 3.0–4.0 mm, 37 females, cl 2.2–3.3 mm, 15 juveniles, ZRC 2007.0290, Cave Serpia, Ginguyuran, Dimiao, coll. B. Sket, Feb.1995; 1 juvenile, ZRC 2007.0291, Cave Camulaon, lower part, Cugon, Jagna, coll. B. Sket, Feb.1995; 7 juveniles, ZRC2007.0292 , spring no.1, Roxas Park, Garcia-Hernandez, coll. B. Sket, Feb.1995; 4 juveniles, ZRC 2007.0293, spring no. 2, Roxas Park, Garcia-Hernandez, coll. B. Sket, Feb.1995; 6 juveniles, ZRC 2007.0294, spring Anislaq, outside, Valencia, coll. B. Sket, Feb.1995; 2 juveniles, ZRC 2007.0295, spring below Cave Serpia, Ginguyuran, Dimiao, B. Sket, Feb.1995; 23 juveniles, ZRC 2007.0296, spring Anislaq, outside, Velencia, coll. B. Sket, Feb.1995.

Description. **–** Rostrum (Figs. 7A, 8A) very short, reaching near end of basal segment of antennular peduncle; unarmed dorsally or armed dorsally with indistinct small teeth, unarmed ventrally. Antennal spine indistinct, fused with inferior orbital angle. Pterygostomian margin broadly rounded.

Sixth abdominal somite 0.45 times of carapace, 1.8 times as long as fifth somite, as long as telson. Telson (Figs. 7B, C) 2.8 times as long as wide, not terminating in a projection, with 3 or 4 pairs of dorsal spinules and 1 pair of dorsolateral spinules; lateral pair of spines distinctly longer than intermediate pairs. Preanal carina high, sub-triangular, lacking spine.

Eyes reduced, anterior end reaching to 0.3–0.4 times length of basal segment of antennular peduncle. Antennular peduncle 0.64 times as long as carapace; basal segment of antennular peduncle shorter than both second and third segment lengths, anterolateral angle reaching 0.20 times length of second segment, second segment distinctly longer than third segment. Stylocerite reaching to 0.8 times length of basal segment of antennular peduncle. Scaphocerite (Fig. 7D) 3.5 times as long as wide.

Incisor process of mandible (Fig. 7E) ending in irregular teeth, molar process truncated. Lower lacinia of maxillula (Fig. 7F) broadly rounded, upper lacinia elongated, with a number of distinct teeth on inner margin, palp slender. Upper endites of maxilla (Fig. 7G) subdivided, palp short, scaphognathite tapering posteriorly with some long, curved setae at posterior end. Palp of first maxilliped (Fig. 7H) broadly triangular. Second maxilliped (Fig. 7I) typical of genus. Third maxilliped (Fig. 7J) reaching to end of antennular peduncle, with ultimate segment slightly shorter than penultimate segment.

Epipods on first four pereiopods. First pereiopod (Figs. 7K, 8B) reaching beyond end of basal segment of antennular peduncle; merus 2.3 times as long as broad, shorter than carpus; carpus excavated anteriorly, shorter than chela, 2.0 times as long as high; chela 2.3 times as long as broad; fingers slightly longer than palm. Second pereiopod (Figs.

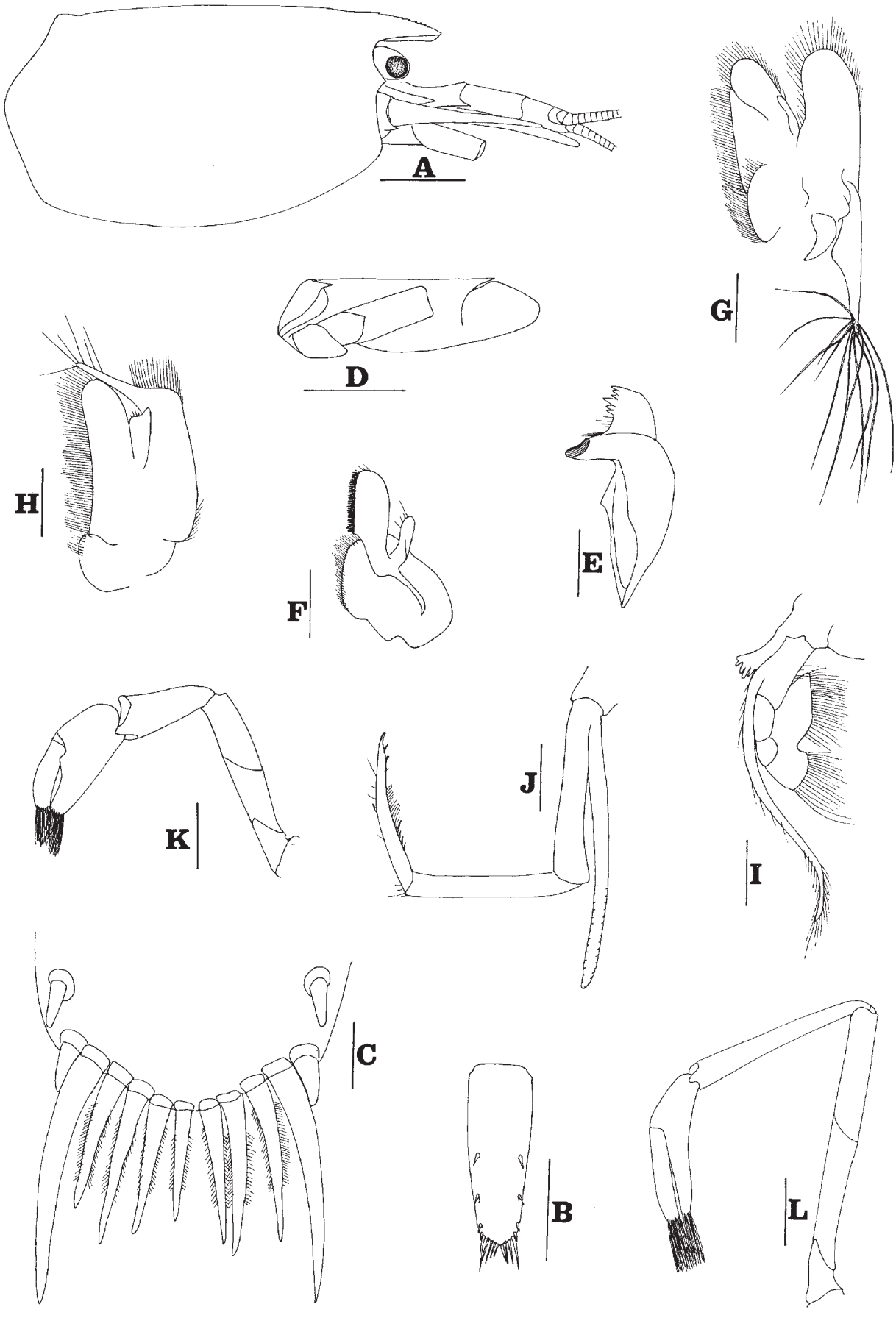

Fig. 7. *Caridina boholensis*, new species: A, cephalothorax and cephalic appendages, lateral view; B, telson; C, distal portion of telson; D, scaphocerite; E, mandible; F, maxillula; G, maxilla; H, first maxilliped; I, second maxilliped; J, third maxilliped; K, first pereiopod; L, second pereiopod. Scale bars: A, B, D = 1 mm, E–L = 0.5 mm, C = 0.1 mm (male, cl 3.7 mm, paratype, ZRC, Cave Bongkawi, Antequrra).

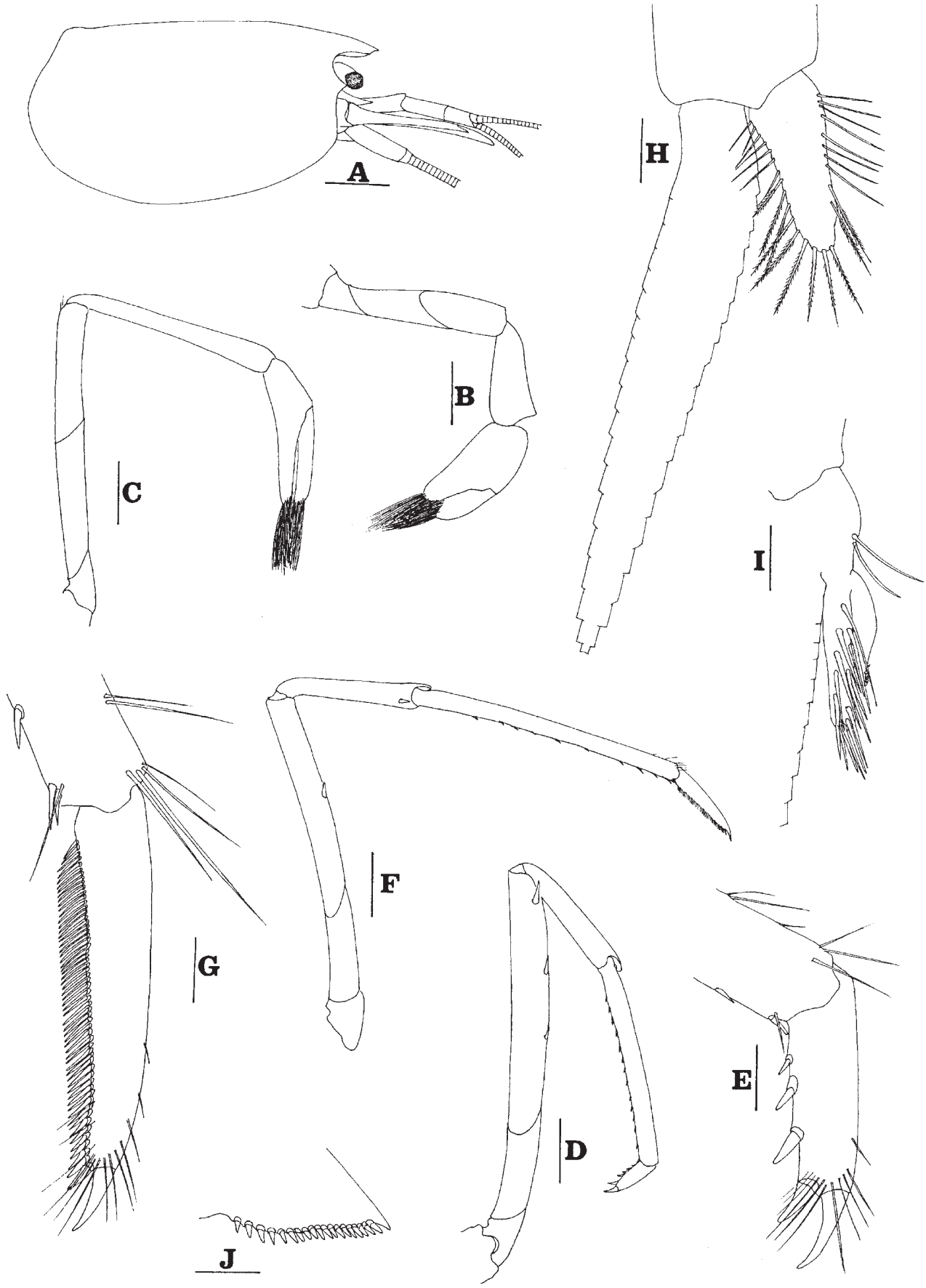

Fig. 8. *Caridina boholensis*, new species: A, cephalothorax and cephalic appendages, lateral view; B, first pereiopod; C, second pereiopod; D, third pereiopod; E, dactylus of third pereiopod; F, fifth pereiopod; G, dactylus of fifth pereiopod; H, male first pleopod; I, appendix masculina and appendix interna of male second pleopod; J, uropodal diaeresis. Scale bars: A = 1 mm; B–D, F = 0.5 mm; E, G = 0.1 mm; H–J = 0.2 mm (A–C, ovig. females, cl 3.8 mm, paratype, ZRC; D–J, male, cl 3.7 mm, paratype, ZRC, Cave Bongkawi, Antequrra).

7L, 8C) reaching to end of scaphocerite; merus distinctly shorter than carpus, 4.4 times as long as broad; carpus 1.2 times as long as chela, 6.9 times as long as high; chela 3.7 times as long as broad; fingers 1.6 times as long as palm. Third pereiopod (Figs. 8D, E, 9E, F) reaching beyond end of scaphocerite by length of dactylus, propodus 10 times as long as broad, 3.7 times as long as dactylus; dactylus 3.0 times as long as wide (spines included), with 4 or 5 accessory spines on flexor margin. Fifth pereiopod (Figs. 8F, G, 9G, H) reaching to end of scaphocerite, propodus 15 times as long as broad, 3.6 times as long as dactylus, dactylus 3.4 times as long as wide (spinules included), terminating in 1 large claw, with 62 spinules on flexor margin.

Endopod of male first pleopod (Fig. 8H) sub-triangular, a quarter length of exopod, no appendix interna. Appendix masculina of male second pleopod (Fig. 8I) half length of endopod, with appendix interna 0.4 times length of appendix masculina.

Uropodal diaeresis (Fig. 8J) with 17 movable spinules.

Ovigerous females with eggs sized 0.75–0.85 × 0.50–0.60 mm.

Habitat. – *Caridina boholensis*, new species, was collected from several locations of subterranean water in Bohol, either from cave streams or spring water near caves.

Etymology. – The new species is named after its type locality-Bohol Island, the Philippines.

Remarks. – *Caridina boholensis*, new species, is most similar to *C. cebuensis* Cai & Shokita, 2006, from Cebu Island, central Philippines. However, it could be differentiated by the much reduced eyes, the slender carpus of first pereiopods (2.0 times as long as high vs. 1.6 times in *C. cebuensis*) and the slender carpus of second pereiopod (6.9 times as long as high vs. 4.4 times). *Caridina boholensis* is the most common subterreanean *Caridina* species in Bohol Island.

Caridina valencia, new species
(Fig. 9)

Material examined. – Holotype: Male, cl 3.5 mm, USC, spring Anislaq, outside, Valencia, coll. B. Sket, Feb.1995.

Paratypes: 5 males, cl 2.5–3.6 m, 92 juveniles, UOL, data same as holotype.

Others: 1 juvenile, UOL, spring Badyang, cave, Valencia, coll. B. Sket, Feb.1995; 1 male, cl 3.1 mm, 1 female, cl 2.8 mm, 1 female (damaged), 1 juvenile, UOL, Cave Castigio, Batuan, coll. B. Sket, Feb.1995; 4 males, cl 2.2–2.4 mm, 15 females, cl 2.0–3.1 mm, 2 ovigerous females, cl 2.8–3.1 mm, ZRC 2007.0297, spring below Cave Serpia, Ginguyuran, Dimiao, coll. B. Sket, Feb.1995; 1 male, cl 3.6 mm, 8 juveniles, ZRC 2007.0298, spring Anislaq, cave, Valencia, coll. B. Sket, Feb.1995.

Description. – Rostrum (Fig. 9A) short, reaching near end of basal segment of antennular pedunlcle; unarmed. Antennal spine fused with inferior orbital angle. Pterygostomian margin sub-rectangular.

Sixth abdominal somite 0.43 times of carapace, 1.8 times as long as fifth somite, slightly shorter than telson. Telson (Fig. 9B) 2.7 times as long as wide, not terminating in a projection, with 4 pairs of dorsal spinules and 1 pair of dorsolateral spinules; lateral pair of distal spines distinctly longer than intermediate pairs. Preanal carina low, sub-triangular, lacking spine.

Eyes well developed, anterior end reaching to 0.7 times length of basal segment of antennular peduncle. Antennular peduncle 0.63 times as long as carapace; basal segment of antennular peduncle distinctly longer than both second and third segment lengths, anterolateral angle reaching 0.20 times length of second segment, second segment distinctly longer than third segment. Stylocerite reaching to 0.7 times length of basal segment of antennular peduncle. Scaphocerite 3.6 times as long as wide.

Incisor process of mandible ending in irregular teeth, molar process truncated. Lower lacinia of maxillula broadly rounded, upper lacinia elongated, with a number of distinct teeth on inner margin, palp slender. Upper endites of maxilla subdivided, palp short, scaphognathite tapering posteriorly with some long, curved setae at posterior end. Palp of first maxilliped rounded, exopod with short flagellum. Endopod of second maxilliped slender. Third maxilliped reaching beyond end of scaphocerite, with ultimate segment slightly longer than penultimate segment.

Epipods on first 4 pereiopods. First pereiopod (Fig. 9C) stout, reaching to end of second segment of antennular peduncle; merus 1.6 times as long as broad, slightly shorter than carpus; carpus excavated anteriorly, shorter than chela, 1.3 times as long as high; chela 1.6 times as long as broad; fingers slightly shorter than palm. Second pereiopod (Fig. 9D) reaching beyond end of scaphocerite; merus distinctly shorter than carpus, 3.3 times as long as broad; carpus 1.2 times as long as chela, 4.5 times as long as high; chela 2.5 times as long as broad; fingers 1.5 times as long as palm. Third pereiopod (Figs. 9E, F) reaching beyond end of scaphocerite by length of dactylus, propodus 10 times as long as broad, 4.3 times as long as dactylus; dactylus 3.0 times as long as wide (spines included), with 5 or 6 accessory spines on flexor margin. Fifth pereiopod (Figs. 9G, H) reaching beyond end of scaphocerite, propodus 15 times as long as broad, 3.0 times as long as dactylus, dactylus 3.5 times as long as wide (spinules included), terminating in 1 claw, with 56 spinules on flexor margin.

Endopod of male first pleopod (Fig. 9I) triangular, one-third length of exopod, no appendix interna. Appendix masculina of male second pleopod (Fig. 9J) half length of endopod, with appendix interna half length of appendix masculina, reaching near end of appendix masculina.

Uropodal diaeresis (Fig. 9K) with 17 movable spinules.

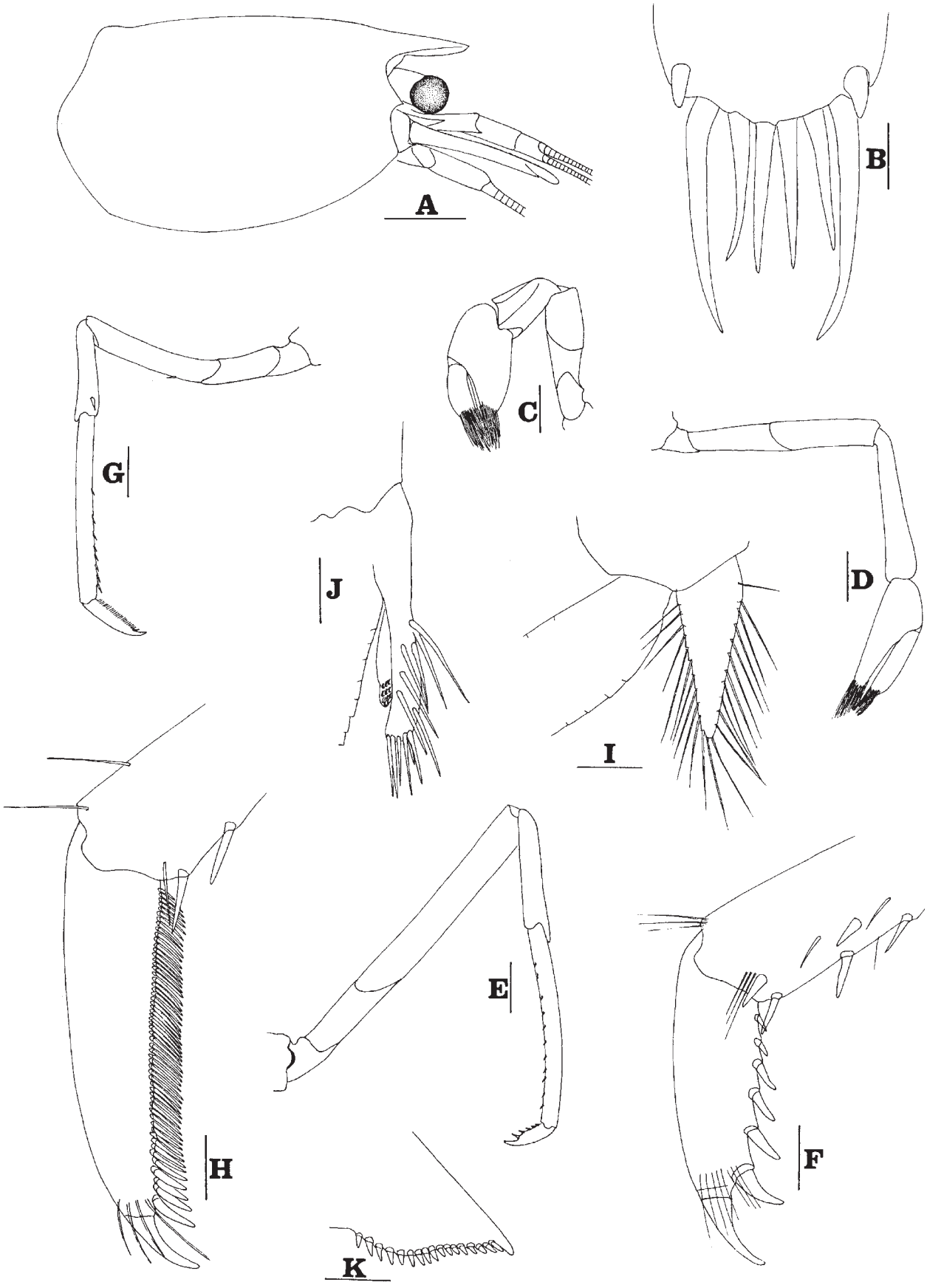

Fig. 9. *Caridina valencia*, new species: A, cephalothorax and cephalic appendages, lateral view; B, distal portion of telson; C, first pereiopod; D, second pereiopod; E, third pereiopod; F, dactylus of third pereiopod; G, fifth pereiopod; H, dactylus of fifth pereiopod; I, endopod of male first pleopod; J, appendix masculina and appendix interna of male second pleopod; K, uropodal diaeresis. Scale bars: A = 1 mm; B, F, H = 0.1 mm; C–E, G = 0.5 mm; I–K = 0.2 mm. (males, cl 3.4 mm, paratype, ZRC, spring Anislaq, outside Cave Anislaq, Valencia).

Ovigerous females with egg sized 0.90 × 0.65 mm.

Habitat. – *Caridina valencia*, new species, was collected from several caves in the southern part of Bohol Island, central Philippines.

Etymology. – The new species is named after its type locality-Valencia Town, Bohol Island, Philippines. The name is used as a noun in apposition.

Remarks. – *Caridina valencia*, new species, morphologically resembles *C. cebuensis* Cai & Shokita, 2006a, from Cebu Island, central Philippines. But it could be easily differentiated from *C. cebuensis* by the much stouter carpus of the first pereiopod (1.3 times as long as high vs. 1.6 times); the slender scaphocerite (3.6 times as long as broad vs. 3.1 times); and more spinules on the dactylus (56 vs. 39) (Fig. 9; cf. Cai & Shokita, 2006a: Figs. 1, 2).

Caridina batuan, new species
(Fig. 10)

Material examined. – Holotype: Ovigerous female, cl 4.2 mm, eggs 0.8 × 0.5 mm, USC, Cave Castigio, Batuan, coll. B. Sket, Feb.1995.

Paratypes: One male, cl 4.1 mm, ZRC 2007.0299, same data as holotype; 4 males, cl 2.2–3.7 mm, 5 females, cl 2.5–3.6 mm, 4 juveniles, UOL, Cave Kalumpan, Behind-the-Clouds, Batuan, coll. B. Sket, Feb.1995; 1 female, 1 juvenile, UOL, Spring Badyang, cave, Valencia, coll. B. Sket, Feb.1995; 2 females, cl 1.9–2.3 mm, ZRC 2007.0300, Cave Bonugan, Batuan, coll. B. Sket, Feb.1995; 2 juveniles, UOL, Alijauan Bridge, stream, S. Duero, coll. B. Sket, 5 Mar.1999.

Description. – Rostrum (Fig 10A) short, reaching slightly beyond end of basal segment of antennular pedunlcle; rostral formula: 0–2+7–12/0–4. Antennal spine distinct, fused with inferior orbital angle. Pterygostomian margin broadly rounded.

Sixth abdominal somite 0.50 times of carapace, 1.9 times as long as fifth somite, slightly shorter than telson. Telson (Fig. 10B, C) 2.9 times as long as wide, not terminating in a projection, with 4 or 5 pairs of dorsal spinules and 1 pair of dorsolateral spinules; lateral pair of spines distinctly longer than intermediate pairs. Preanal carina low, sub-triangular, lacking spine.

Eyes reduced, anterior end reaching to 0.4 times length of basal segment of antennular peduncle. Antennular peduncle 0.63 times as long as carapace; basal segment of antennular peduncle shorter than both second and third segment lengths, anterolateral angle reaching 0.20 times length of second segment, second segment distinctly longer than third segment. Stylocerite reaching to 0.7 times length of basal segment of antennular peduncle. Scaphocerite 3.4 times as long as wide.

Incisor process of mandible ending in irregular teeth, molar process truncated. Lower lacinia of maxillula broadly rounded, upper lacinia elongated, with a number of distinct teeth on inner margin, palp slender. Upper endites of maxilla subdivided, palp short, scaphognathite tapering posteriorly with some long, curved setae at posterior end. Palp of first maxilliped rounded. Podobranch of second maxilliped reduced to a lamina. Third maxilliped reaching to end of scaphocerite, with ultimate segment as long as penultimate segment.

Epipods on first 4 pereiopods. First pereiopod (Fig. 10D) reaching end of antennular peduncle; merus 2.1 times as long as broad, slightly shorter than carpus; carpus excavated anteriorly, shorter than chela, 1.6 times as long as high; chela 2.1 times as long as broad; fingers slightly shorter than palm. Second pereiopod (Fig. 10E) reaching beyond end of scaphocerite by length of chela; merus distinctly shorter than carpus, 4.5 times as long as broad; carpus 1.3 times as long as chela, 5.3 times as long as high; chela 2.6 times as long as broad; fingers 1.3 times as long as palm. Third pereiopod (Figs. 10F, G) reaching beyond end of scaphocerite by length of dactylus and half of propodus, propodus 11 times as long as broad, 4.3 times as long as dactylus; dactylus 3.3 times as long as wide (spines included), with 4 or 5 accessory spines on flexor margin. Fifth pereiopod (Figs. 10H, I) reaching beyond end of scaphocerite by length of dactylus, propodus 15 times as long as broad, 4.4 times as long as dactylus, dactylus 3.7 times as long as wide (spinules included), terminating in 1 claw, with 44 spinules on flexor margin.

Endopod of male first pleopod sub-triangular, a quarter length of exopod, no appendix interna. Appendix masculina of male second pleopod half length of endopod, with appendix interna half length of appendix masculina, reaching near end of appendix masculina.

Uropodal diaeresis (Fig. 10J) with 20 movable spinules.

Ovigerous females with eggs sized 0.80 × 0.50 mm.

Habitat. – *Caridina batuan*, new species, was collected from several caves in southern part of the Bohol Island, central Philippines.

Etymology. – The new species is named after its type locality-Batuan, Bohol Island, the Philippines. The name is used as a noun in apposition.

Remarks. – *Caridina batuan*, new species, is morphologically similar to *C. minidentata* Cai & Anker, 2004, from west Samar, the Philippines. However, it can be distinguished from *C. minidentata* by the more developed rostral teeth, the much reduced eyes, the lower preanal carina and the larger number of spinules on diaeresis (20 vs. 16) (Fig. 10; cf. Cai & Anker, 2004: Figs. 4, 5).

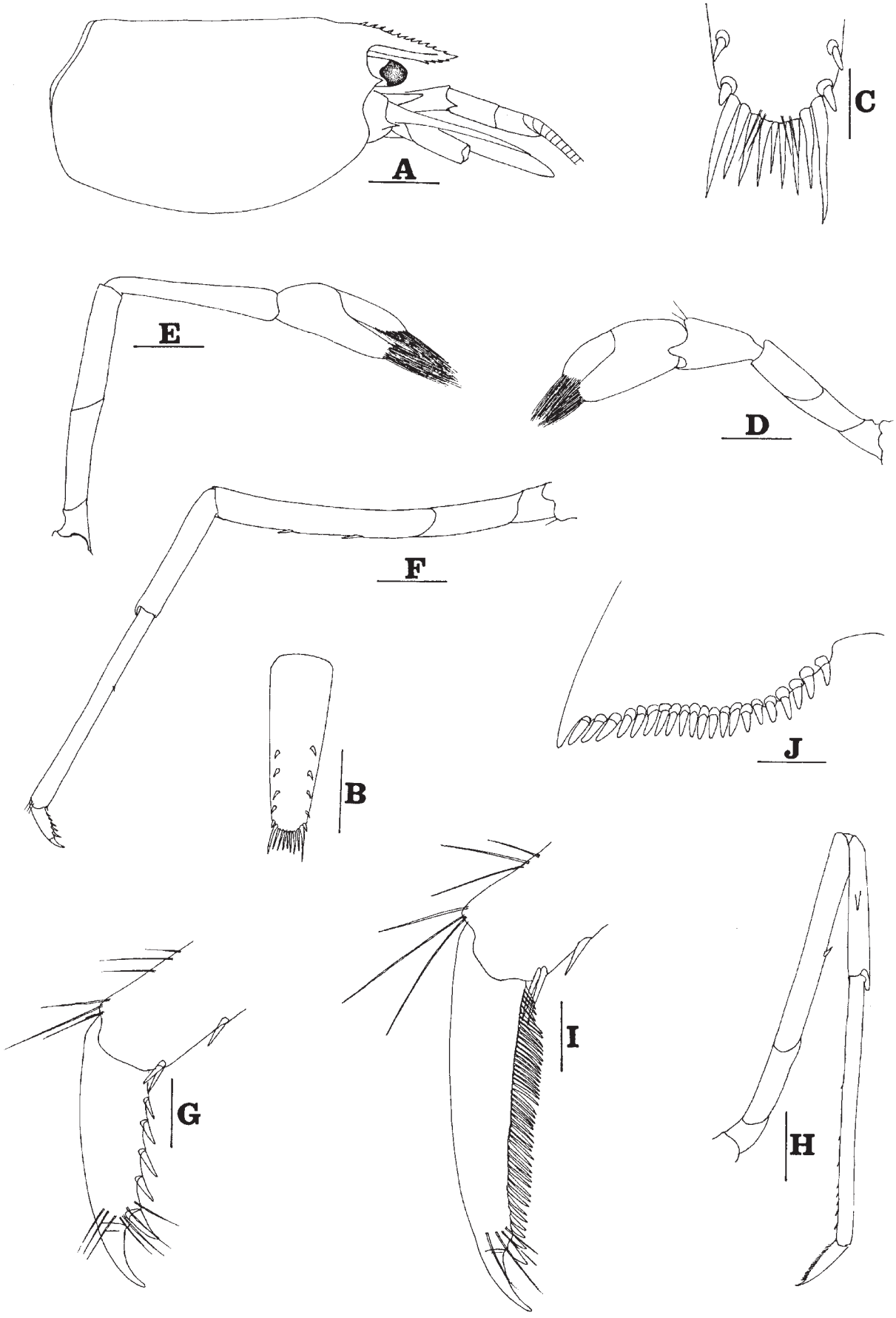

Fig. 10. *Caridina batuan*, new species: A, cephalothorax and cephalic appendages, lateral view; B, telson; C, distal portion of telson; D, first pereiopod; E, second pereiopod; F, third pereiopod; G, dactylus of third pereiopod; H, fifth pereiopod; I, dactylus of fifth pereiopod; J, uropodal diaeresis. Scale bars: A, B = 1 mm; C = 0.2 mm, D–F, H = 0.5 mm; G, I, J = 0.1 mm (female, cl 3.0 mm, holotype, USC, Cave Kalumpan, Batuan).

Caridina anislaq, new species
(Fig. 11)

Material examined. – Holotype: Male, cl 3.4 mm, USC. Spring Anislaq, outside Cave Valencia, Valencia, coll. B. Sket, Feb.1995.

Paratypes: 10 males, cl 2.2–3.4 mm, 9 females, cl 2.2–5.4 mm, ZRC 2007.0301, data same as holotype; 1 male, cl 2.4 mm, ZRC 2007.0302, Spring Anislaq, Cave Valencia, Valencia, coll. B. Sket, Feb.1995.

Description. – Rostrum (Fig. 11A) short, reaching slightly beyond end of basal segment of antennular pedunlcle; rostral formula: 3–6+6–11/1–6. Antennal spine fused with inferior orbital angle. Pterygostomian margin broadly rounded.

Sixth abdominal somite 0.48 times of carapace, 1.9 times as long as fifth somite, slightly shorter than telson. Telson (Fig. 11B, C) 3.2 times as long as wide, not terminating in a projection, with 3 pairs of dorsal spinules and 1 pair of dorsolateral spinules; lateral pair of distal spines distinctly longer than intermediate pairs. Preanal carina low, sub-triangular, lacking spine.

Eyes well developed, anterior end reaching to 0.7 times length of basal segment of antennular peduncle. Antennular peduncle 0.70 times as long as carapace; basal segment of antennular peduncle as long as both second and third segment lengths, anterolateral angle reaching 0.20 times length of second segment, second segment distinctly longer than third segment. Stylocerite reaching to 0.7 times length of basal segment of antennular peduncle. Scaphocerite 3.6 times as long as wide.

Incisor process of mandible ending in irregular teeth, molar process truncated. Lower lacinia of maxillula broadly rounded, upper lacinia elongated, with a number of distinct teeth on inner margin, palp slender. Upper endites of maxilla subdivided, palp short, scaphognathite tapering posteriorly with some long, curved setae at posterior end. Palp of first maxilliped rounded, exopod with short flagellum. Podobranch of second maxilliped reduced to a lamina. Third maxilliped reaching beyond end of scaphocerite, with ultimate segment slightly longer than penultimate segment.

Epipods on first 4 pereiopods. First pereiopod (Fig. 11D) stout, reaching to middle of second segment of antennular peduncle; merus 1.2 times as long as broad, slightly shorter than carpus; carpus strongly excavated anteriorly, much shorter than chela, as long as high; chela 2.1 times as long as broad; fingers shorter than palm. Second pereiopod (Fig. 11E) reaching to end of scaphocerite; merus distinctly shorter than carpus, 3.3 times as long as broad; carpus slightly shorter or as long as chela, 3.9 times as long as high; chela 2.4 times as long as broad; fingers 1.5 times as long as palm. Third pereiopod (Figs. 11F, G) reaching beyond end of scaphocerite by length of 1/3 of propodus, propodus 12 times as long as broad, 4.9 times as long as dactylus; dactylus 2.5 times as long as wide (spines included), with 4 accessory spines on flexor margin. Fifth pereiopod (Figs. 11H, I) reaching to end of antennular peduncle, propodus 12 times as long as broad, 3.3 times as long as dactylus, dactylus 3.5 times as long as wide (spinules included), terminating in 1 claw, with 51 spinules on flexor margin.

Endopod of male first pleopod (Fig. 11J) triangular, one-third length of exopod, no appendix interna. Appendix masculina (Fig. 11K) of male second pleopod half length of endopod, with appendix interna half length of appendix masculina, reaching near end of appendix masculina.

Uropodal diaeresis (Fig. 11L) with 17 movable spinules.

Habitat. – *Caridina anislaq*, new species, was collected from Spring Anislaq, near Cave Valencia, Valencia, Bohol Island, central Philippines.

Etymology. – The new species is named after its type locality-Spring Anislaq, Bohol Island, the Philippines, used as a noun in apposition.

Remarks. – *Caridina anislaq*, new species, is morphologically similar to *C. batuan*, new species, in the form of rostrum. However, it could be easily separated from *C. batuan* by the larger number of the post orbital rostral teeth (3–6 vs. 0–2), the stouter merus (1.2 times as long as broad vs. 2.1 times) and the carpus of the first pereiopod (as long as high vs. 1.6 times as long as high) and the shorter flagellum of exopod of the first maxilliped (Figs. 10, 11).

Caridina camaro, new species
(Fig. 12)

Material examined. – Holotype: Female, cl 4.3 mm, USC, Cave Camaro, Batuan, coll. B. Sket, Feb.1995.

Paratypes: Six more or less damaged specimens, ZRC 2007.0303, data same as holotype.

Description. – Rostrum (Fig. 12A) short, reaching slightly beyond end of basal segment of antennular pedunlcle; rostral formula: 2+10/5. Antennal spine fused with inferior orbital angle. Pterygostomian margin broadly rounded.

Sixth abdominal somite 0.48 times of carapace, 1.8 times as long as fifth somite, slightly shorter than telson. Telson (Figs. 12B, C) 2.7 times as long as wide, not terminating in a projection, with 4 or 5 pairs of dorsal spinules and 1 pair of dorsolateral spinules; lateral pair of distal spines distinctly longer than intermediate pairs. Preanal carina low, sub-triangular, lacking spine.

Eyes reduced, anterior end reaching to 0.4 times length of basal segment of antennular peduncle. Antennular peduncle 0.60 times as long as carapace; basal segment of antennular peduncle distinctly as long as both second and third segment lengths, anterolateral angle reaching 0.20 length of second segment, second segment distinctly longer than third segment. Stylocerite reaching to 0.7 times length of basal

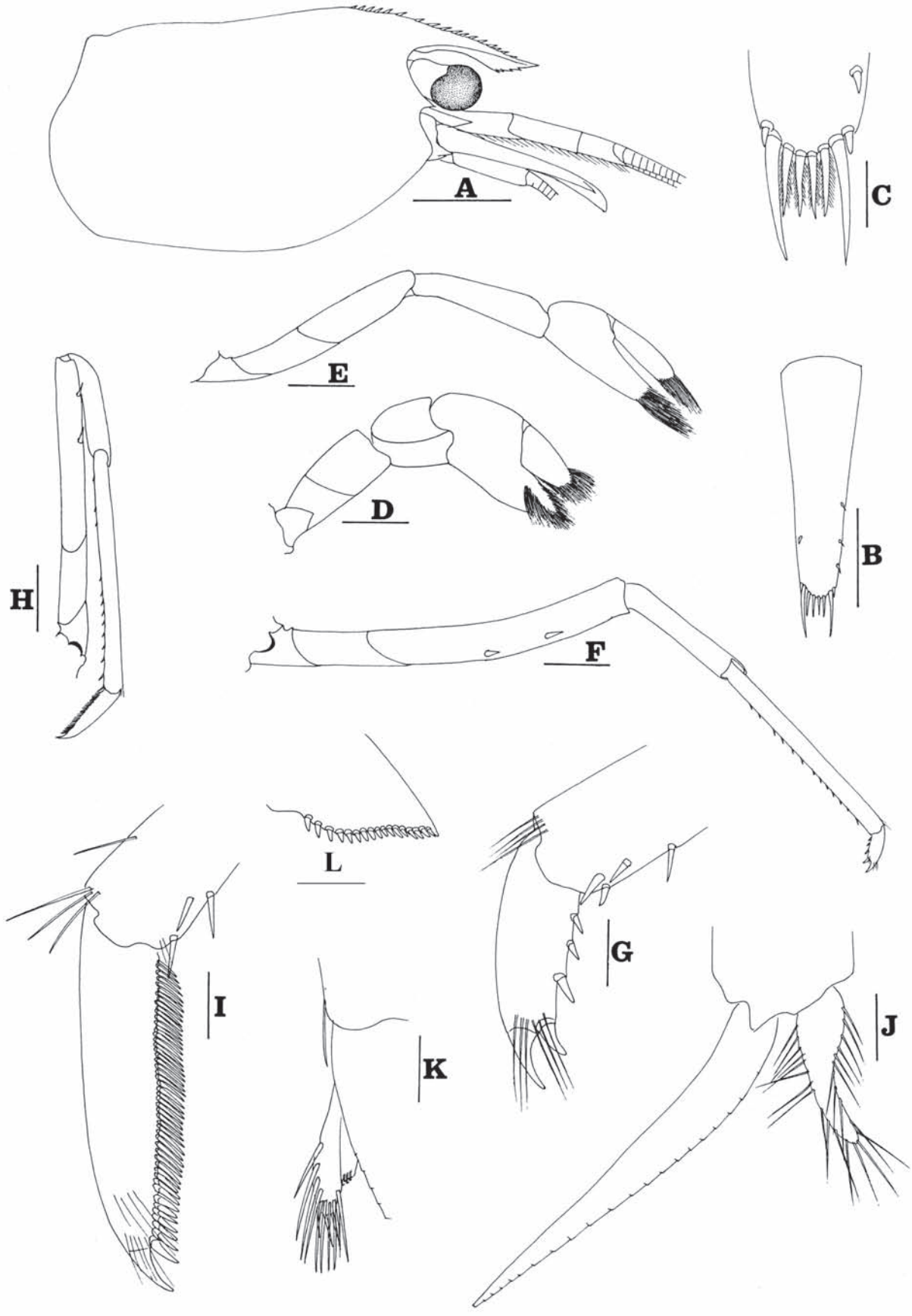

Fig. 11. *Caridina anislaq*, new species: A, cephalothorax and cephalic appendages, lateral view; B, telson; C, distal portion of telson; D, first pereiopod; E, second pereiopod; F, third pereiopod; G, dactylus of third pereiopod; H, fifth pereiopod; I, dactylus of fifth pereiopod; J, endopod of male first pleopod; K, appendix masculina and appendix interna of male second pleopod; L, uropodal diaeresis. Scale bars: A, B = 1 mm; C = 0.2 mm, G, I = 0.1 mm; D–F, H, L = 0.5 mm (males, cl 3.4 mm, paratype, ZRC, spring Anislaq, outside Cave Anislaq, Valencia).

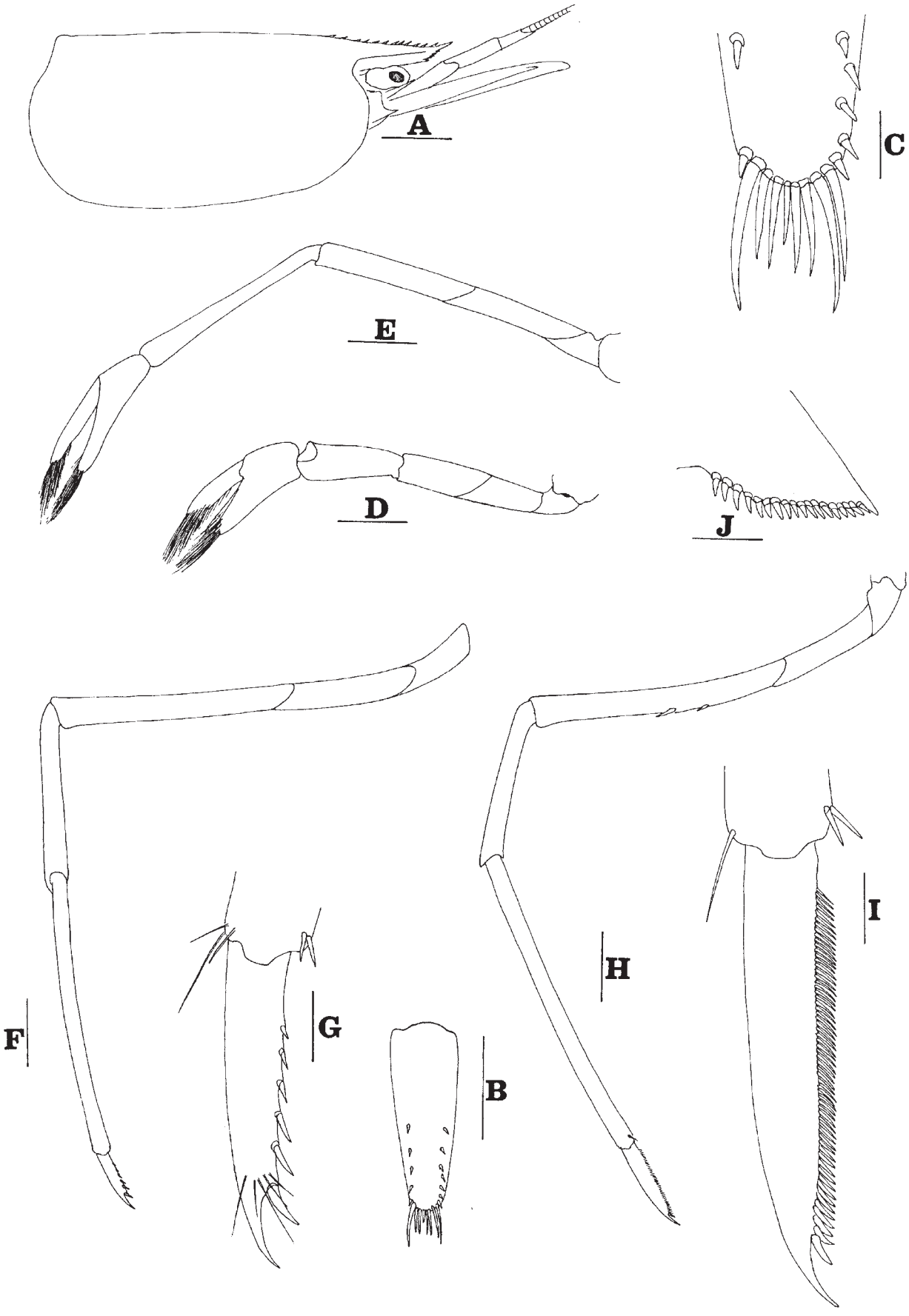

Fig. 12. *Caridina camaro*, new species: A, cephalothorax and cephalic appendages, lateral view; B, telson; C, distal portion of telson; D, first pereiopod; E, second pereiopod; F, third pereiopod; G, dactylus of third pereiopod; H, fifth pereiopod; I, dactylus of fifth pereiopod; J, uropodal diaeresis. Scale bars: A, B = 1 mm; C = 0.2 mm; D–F, H = 0.5 mm; G, K = 0.1 mm; B, F, H = 0.1 mm; C–E, G = 0.5 mm; I, J = 0.2 mm (females, cl 4.3 mm, holotype, USC, Cave Camaro, Batuan).

segment of antennular peduncle. Scaphocerite 3.2 times as long as wide.

Incisor process of mandible ending in irregular teeth, molar process truncated. Lower lacinia of maxillula broadly rounded, upper lacinia elongate, with a number of distinct teeth on inner margin, palp slender. Upper endites of maxilla subdivided, palp short, scaphognathite tapering posteriorly with some long, curved setae at posterior end. Palp of first maxilliped rounded, exopod with short flagellum. Podobranch of second maxilliped reduced to a lamina. Third maxilliped slender, with ultimate segment as long as penultimate segment.

Epipods on first 4 pereiopods. First pereiopod (Fig. 12D) slender, merus 2.4 times as long as broad, shorter than carpus; carpus excavated anteriorly, shorter than chela, 1.8 to 3.0 times as long as high; chela 2.7 times as long as broad; fingers 1.4 times as long as palm. Second pereiopod (Fig. 12E) elongated and slender, merus distinctly shorter than carpus, 6.0 times as long as broad; carpus 1.5 times as long as chela, 7.7 times as long as high; chela 3.7 times as long as broad; fingers 1.9 times as long as palm. Third pereiopod (Figs. 12F, G) with propodus 16 times as long as broad, 4.4 times as long as dactylus; dactylus 5.6 times as long as wide (spines included), with 6 accessory spines on flexor margin. Fifth pereiopod (Figs. 12H, I) with propodus 15 times as long as broad, 3.3 times as long as dactylus, dactylus 5 times as long as wide (spinules included), terminating in 1 claw, with 60 spinules on flexor margin.

Uropodal diaeresis (Fig. 12J) with 17 movable spinules.

***Habitat.* –** *Caridina camaro*, new species, was collected from the subterranean stream in Cave Camaro, Bohol Island, central Philippines.

***Etymology.* –** The new species is named after its type locality—Cave Camaro, Bohol Island, the Philippines. The name is used as a noun in apposition.

Remarks.- With regard to the slender pereiopods, *Caridina camaro*, new species, is morphologically similar to *C. liaoi*, new species. It can be easily differentiated from the latter species by the reduced eyes, and the much shorter rostrum. Compared with all the other cave species in Bohol, *C. camaro* has more elongated carpus of the first pereiopods, hence, could readily be distinguished from *C. valencia*, *C. batuan* and *C. anislaq* (1.8–3.0 times as long as high vs. 1.0–1.6 times in the latter three species). It can be separated from *C. boholensis* by the slender dactylus of third pereiopod (5.6 times as long as wide vs. 3.0 times)

Palaemonidae Rafinesque, 1815

***Macrobrachium* Bate, 1868**

***Macrobrachium rosenbergii rosenbergii* (De Man, 1879)**

Palaemon Rosenbergii De Man, 1879: 167 [type locality: Andai, New Guinea (Irian Jaya), Indonesia].
Palamon carcinus rosenbergi – Ortmann, 1891: 701.
Palaemon (Eupalaemon) carcinus – De Man, 1902: 763 (not *Cancer carcinus* Linnaeus, 1758).
Macrobrachium rosenbergii – Holthuis, 1950: 111 (part); Johnson, 1960: 260, Fig. 1; Chace & Bruce, 1993: 36, Fig. 15; Short, 2004: 44, Fig. 16 (part).
Macrobrachium rosenbergii rosenbergii – Johnson, 1973: 277; Holthuis, 1995: 148; Cai & Ng, 2001: 674; Cai & Shokita, 2006a: 263.

***Material examined.* –** One dried male, cl 103 mm, ZRC 2000.2407, purchased from a fishermen who collected from the Loboc River in the 1980s Y. Cai, 19 Dec.2000; 1 molted cast, 2 juveniles, coll. Y. Cai et al., Loboc River, Loboc, 19 Dec.2000.

***Remarks*. –** Only one molted cast and two juveniles are available for the presnt study. Judging by the form of the rostrum of the larger specimen, which is only slightly beyond the end of scaphocerite and has a rostral formula as 2+11/9. It apparently belongs to the eastern subspecies, i.e. *Macrobrachium rosenbergii rosenbergii*.

***Macrobrachium latidactylus* (Thallwitz, 1891)**

Palaemon latidactylus Thallwitz, 1891: 97 [type locality: Celebes (=Sulawesi), Indonesia]; Thallwitz, 1892:17, Fig. 3.
Palaemon (Macrobrachium) latidactylus – De Man: 1902: 805.
Palaemon lampropus De Man, 1892: 493, Pl. 29 Fig. 49 [type locality: Celebes and Timor, Indonesia]; Kemp, 1918: 267.
Macrobrachium latidactylus – Holthuis, 1950: 239, Fig. 50; 1980: 97; Costa, 1979: 57; Naiyanetr, 1980: 17; Yeo et al., 1999: 236; Cai et al., 2004: 584; Short, 2004: 80, Fig. 31; Cai & Anker, 2004: 258; Wowor et al., 2004: 349, Fig 10E; Cai & Shokita, 2006a: 266.

***Material examined.* –** 5 males, cl 7.3–15.1 mm, 5 females, cl 6.0–11.5 mm, ZRC 2007.0304, River outside Inabacan Cave, Antequrra, coll. B. Sket, 23 Feb.1999; 1 male, cl 15 mm, ZRC 2007.0305, Alijanan Bridge, stream, S. Duero, coll. B. Sket, 5 Mar.1999; 1 male, cl 10 mm, 1 female, cl 11 mm, ZRC 2007.0306, River outside Inabacan Cave, Antequrra, coll. Y. Cai et al., 16 Dec.2000; 2 males, cl 12.8–13.5 mm, 1 female, cl 8.4 mm, ZRC 2007.0307, River outside Inabacan Cave, Antequrra, coll. Y. Cai et al., 18 Dec.2000.

***Remarks* . –** *Macrobrachium latidactylus* has been reported from Sri Lanka (Costa, 1979), Indonesia, the Philippines, Malaysia, southern Thailand (Holthuis, 1950; Johnson, 1963; Chace & Bruce, 1993; Yeo et al., 1999), Hainan (Yu, 1936; Liu et al., 1990), Taiwan (Hwang & Yu, 1982; Shy & Yu, 1998), the Ryukyu Islands (Shokita, 1979) and Australia (Short, 2004).

Marobrachium australe (Guérin-Méneville, 1838)

Palaemon australis Guérin-Méneville, 1838: 37 [type locality: Tahiti, French Polynesia].
Palaemon sundaicus Heller, 1862: 415, Pl. 2 Figs. 38, 39 [type locality: Java, Indonesia].
Palaemon dispar Von Martens 1868: 41 [type locality: Pulau Adonara, east of Flores, Indonesia].
Palaemon (Eupalaemon) dispar – De Man, 1902: 766.
Macrobrachium australis – Holthuis, 1950: 124, Figs. 27–30; Chace & Bruce, 1993: 23, Fig. 2; Cai & Ng, 2001: 683, Fig. 14a–d; Cai & Anker, 2004: 258; Cai & Shokita, 2006a: 263.

Material examined. – 3 males, cl 17.0–24 mm, 6 ovigerous females, 15.7–19.7 mm, ZRC 2007.0308, Loboc River, Loboc, coll Y. Cai et al., 19 Dec.2000.

Remarks. – The species has a wide distribution in the Indo-West Pacific, from Madagascar to Polynesia (Holthuis, 1950; Chace & Bruce, 1993).

Macrobrachium lar (Fabricius, 1798)

Palaemon Lar Weber, 1795: 94 [nomen nudum]
Palaemon Lar Fabricius, 1798: 402 [type locality: in India orientali Dom. Daldorf]; Cowles, 1914: 380, Pl. 2 Fig. 7.
Palaemon (Eupalaemon) lar – De Man, 1902: 774.
Macrobrachium lar – Holthuis, 1950: 176, Fig. 37; Chace & Bruce, 1993: 30, Fig. 9; Yeo et al., 1999: 236; Cai & Ng, 2001: 683, Fig. 14e; Wowor & Choy, 2001: 285; Cai & Ng, 2002: 75; Cai & Anker, 2004: 256; Cai et al., 2004: 585; Wowor et al., 2004: 353, Fig. 14; Short, 2004: 75, Fig. 29.

Material examined. – One male, cl 22.6 mm, ZRC 2007.0309, Loboc River, Loboc, coll. Y. Cai et al., 19 Dec.2000.

Remarks. – *Macrobrachium lar* is a well known species, widely distributed throughout the Indo-West Pacific. However, it seems rather rare in Bohol.

Macrobrachium scabriculum (Heller, 1862)

Palaemon scabriculus Heller, 1862: 527 [type locality: Sri Lanka].- Henderson & Matthai, 1910: 296, Pl.17 Figs. 7a–c, Pl. 18 Figs. 7a–p.
Macrobrachium scabriculum – Holthuis, 1950: 224; Chace & Bruce, 1993: 37; Johnson, 1973: 15; Yeo et al., 1999: 231, Figs. 18; 19; Wowor & Choy, 2001: 286; Cai & Ng, 2002: Fig. 16; Wowor et al., 2004: 350, Fig. 12I; Cai & Shokita, 2006a: 266.

Material examined. – One male, cl 19.5 mm, 1 ovigerous female, 24 mm, ZRC 2007.0310, Loboc River, Loboc, coll. Y. Cai et al., 19 Dec.2000.

Remarks. – *Macrobrachium scabriculum* was reported recently from Mindanao (Cai & Shokita, 2006a). This is the second record for the species to occur in the Philippines.

Macrobrachium horstii (De Man, 1892)

Palaemon (*Parapalaemon*) *Horstii* De Man 1892: 460, Pl. 27: Fig. 39 [type locality: River at Polopo, central Celebes (Sulawesi), Indonesia].
Macrobrachium horstii - Holthuis, 1950: 203, Fig. 42; Chace & Bruce, 1993: 27; Cai & Ng, 2001: 679, Fig. 10; Wowor et al., 2004: 349, Fig. 9L.

Material examined. – 1 male, cl 13.6 mm, 1 female, cl 16.8 mm, 1 ovigerous female, cl 12.0 mm, ZRC 2007.0311, River outside Inabacan Cave, Antequrra, coll. Y. Cai et al., 16 Dec.2000; 1 male, 3 ovigerous females, cl 13.6 mm, ZRC 2007.0312, River outside Inabacan Cave, Antequrra, coll. Y. Cai et al., 18 Dec.2000; 2 females, cl 13.6, 6 ovigerous females, cl 11.0–13.8 mm, ZRC 2007.0313, Loboc River, Loboc, coll. Y. Cai et al., 19 Dec.2000.

Remarks. – *Macrobrachium horstii* has previously been reported from Leyte, the Philippines (Cai & Ng, 2001). It is currently known from the Philippines and eastern Indonesia.

Macrobrachium placidulum (De Man, 1892)

Palaemon (*Macrobrachium*) *placidulus* De Man, 1892: 489, Pl. 28 Fig. 48 [type localities: Celebes (Sulawesi), Pulau Selajar, Flores, and Timor].
Macrobrachium placidulum – Holthuis, 1950: 253, Fig. 51c; Chace & Bruce, 1993: 35, Fig. 14; Cai & Shokita, 2006a: 264.
Macrobrachium placidum – Shokita, 1979: 275.
Macrobrachium horstii – Hwang & Yu, 1982: 164, Fig. 5 (not *Palaemon* (*Parapalaemon*) *Horstii* De Man 1892).
Macrobrachium cf *horstii* – Shy & Yu, 1998: 30.

Material examined. – One male, cl 14.2 m, ZRC 2007.0314, Alijanan Bridge, stream, S. Duero, coll. B. Sket, 5 Mar.1999; 3 males, cl 15.3–17.4 mm, ZRC 2007.0315, river outside Inabacan Cave, Antequrra, coll. Y. Cai et al., 16 Dec.2000; 1 male, cl 8.4 mm, 1 female, cl 10.3 mm, ZRC 2007.0316, river outside Inabacan Cave, Antequrra, coll. Y. Cai et al., 18 Dec.2000.

Remarks. – *Macrobrachium placidulum* is a common freshwater species in the Philippines. It is distributed from Ryukyu Islands, Taiwan, the Philippines, Palau, and eastern Indonesia, to New Guinea, as well as Fiji (Chace & Bruce, 1993; Choy, 1984).

Macrobcrachium equidens (Dana, 1852)

Palaemon equidens Dana, 1852: 26 [type locality: Singapore].
Palaemon sundaicus – Cowles, 1914: 355, Pl. 2 Fig. 3 (not *Palaemon sundaicus* Heller, 1862).
Macrobrachium equidens – Holthuis, 1950:162, Fig. 36; 1980: 90; Liu et al., 1990: 110, Fig. 8; Chace & Bruce, 1993: 25, Fig. 4; Yeo et al., 1999: 226; Wowor & Choy, 2001: 282; Cai & Anker, 2004: 389; Cai et al., 2004: 589; Wowor et al., 2004: 349, Fig. 10H; Short, 2004: 26, Figs. 8, 9; Cai & Shokita, 2006a: 265.

Material examined. – 1 male, cl 7.5 mm, ZRC, River outside Inabacan Cave, Antequrra, coll. Y. Cai et al., 16 Dec.2000; 1 male, cl 10.5 mm, 1 female, cl 10.0 mm, ZRC, Loboc River, Loboc, coll. Y. Cai et al., 19 Dec.2000.

***Remarks.* –** *Marcobrachium equidens* is a brackish water species, with gravid females and smaller specimens being commonly found in mangrove creeks. It is known from a very wide area in the Indo-West Pacific, from Madagascar to the Solomon Islands and Fiji (Choy, 1984; Chace & Bruce, 1993; Short, 2004). However, a recent molecular analysis results (Liu et al., 2007) show that the incongruence of non-monophyly of *M. equidens*, in 16S, COI and 16S+COI analyses, implied the existence of a cryptic species in the Philippines and Taiwan.

Palaemon Weber, 1795

Palaemon concinnus Dana, 1852

Palaemon concinnus Dana, 1852: 587 [type locality: Fiji Islands]; Holthuis, 1950: 61, Fig. 12; Chace & Bruce, 1993: 40; Cai & Ng, 2001: 686, Fig. 14f; Cai & Shokita, 2006a: 267.

***Material examined.* –** 2 males, cl 7.0–7.6 mm, 1 female, cl 9.2 mm, ZRC 2007.0317, tributary of Loboc River, Loboc, coll. Y. Cai et al., 19 Dec.2000.

***Remarks.* –** *Palaemon concinnus* has a wide distribution in the Indo-West Pacific, from South Africa, Indonesia, Philippines to Marshall Islands and Tuamotu Archipelago in French Polynesia (Chace & Bruce, 1993). The species is commonly found in brackish to fresh water in the lower reaches of rivers.

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LITERATURE CITED

Balete, D. S., & L. B. Holthuis, 1992. Notes on the cave shrimp *Edoneus atheatus* Holthuis, 1978, with an account of its type locality of habits (Decapoda, Caridea, Atyidae). *Crustaceana*, **62**: 98–101.

Bate, C. S., 1868. On a new genus, with four new species of freshwater prawns. Proceedings of the Zoological Society of London, 1868: 363–368, Pls. 30, 31.

Blanco, G. J., 1935. The Atyidae of Philipines. *Philippine Journal of Science*, **56**: 29–30.

Blanco, G. J., 1939. Four new Philippine species of fresh-water shrimps of the genus *Caridina. Philippine Journal of Science*, **70**: 389–395, Pls. 1–3.

Bouvier, E. L., 1925. Recherches sur la morphologie, les variations, la distribution géographique des crevettes des la famille des Atyidés. *Encyclopédie Entomologique*, series A, **4**: 1–370, Figs. 1–761.

Cai, Y. & A. Anker, 2004. On a collection of freshwater shrimps from the Philippines, with descriptions of five new species. *Tropical Zoolology*, **17**: 233–266.

Cai, Y., P. Naiyanetr & P. K. L. Ng, 2004. The freshwater prawns of the genus *Macrobrachium* Bate, 1868, of Thailand (Crustacea: Decapoda: Palaemonidae). *Journal of Natural History*, **38**: 581–649.

Cai, Y., & P. K. L., Ng, 2001. The freshwater decapod crustaceans of Halmahera, Indonesia. *Journal of Crustacean Biology*, **21**: 665–695, Figs. 1–19.

Cai, Y. & P. K. L. Ng, 2002. The freshwater palaemonid prawns (Crustacea: Decapoda: Caridea) of Myanmar. *Hydrobiologia*, **487**: 59–83.

Cai, Y. & P. K. L. Ng, 2007. A revision of the *Caridina gracilirostris* De Man, 1892, species group, with descriptions of two new taxa (Decapoda; Caridea; Atyidae). *Journal of Natural History*, **41**(25–28): 1585–1602.

Cai, Y. & S. Shokita, 2006a. Report on a collection of freshwater shrimps (Crustacea: Decapoda: Caridea) from the Philippines, with descriptions of four new species. *Raffles Bulletin of Zoology*, **54**: 245–270.

Cai, Y., & S, Shokita, 2006b. Atyid shrimps of the Ryukyu Islands, Southern Japan (Crustacea: Decapoda: Atyidae). *Journal of Natural History*, **40**(38–40): 2123–2172.

Cai, Y., P. K. L. Ng, S. Shokita & K. Satake, 2006. Revision of the Japanese atyid shrimps (Decapoda: Caridea) first described by William Stimpson, 1860. *Journal of Crustacean Biology*, **26**(3): 392–419.

Chace, F. A. Jr., 1983. The *Atya*-like shrimps of the Indo-pacific Region (Decapoda: Atyidae). *Smithsonian Contributions to Zoology*, **384**: 1–54, 24 figures.

Chace, F. A., Jr., 1997. The Caridean shrimps (Crustacea: Decapoda) of the Albatross Philippine expedition 1907–1910. Part 7: Families Atyidae, Eugonatonotidae, Rhynchocinetidae, Bathypalaemonellidae, Processidae, and Hippolytidae. *Smithsonian Contributions to Zoology*, **58**: 1–106, Figs.1–29.

Chace, F. A. Jr. & A. J. Bruce, 1993. The Caridean shrimps (Crustacea: Decapoda) of the Albatross Philippine expedition 1907–1910. Part 6: Superfamily Palaemonoidea. *Smithsonian Contributions to Zoology*, **543**: i–vii + 1–152, Figs. 1–23.

Choy, S., 1984. On the freshwater palaemonid prawns from the Fiji Islands (Decapoda, Caridea). *Crustaceana*, **47**: 269–277.

Costa, H. H., 1979. The Palaemonidae of the inland water of Sri Lanka. *Ceylon Journal of Science (Biological Science), new series*, **13**: 39–64, 6 text figures, 2 plates.

Cowles, R. P., 1914. Palaemons of the Philippines. *Philippine Journal of Science*, (D), **9**(4): 319–403, 1 figure, Pls. 1–3.

Cowles, R. P., 1915a. The habitats of some tropical crustacean II. *Philippine Journal of Science*, **10**: 11–17, Figs. 1, 2, Pls. 1–3.

Cowles, R. P., 1915b. Are *Atya spinipes* Newport and *Atya armata* Milne Edwards Synonyms for *Atya moluccensis* De Haan? *Philippine Journal of Science*, **10**: 147–153, Fig. 1.

Dana, J. D., 1852. Crustacea, Part 1. In United States Expedition during the years 1838, 1839, 1840, 1841, 1842, under the command of Charles Wilkes, U. S. N., **13**: 1–685. Atlas (1855): 27 pp, 96 plates. Philadelphia.

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*. Lugduni-Batavorum. [Leiden]: i–xxxi, ix–xvi, 1–243, Pls. A–J, l–Q, 1–55, circ. tab. 2.

De Man, J. G., 1879. On some species of the genus *Palaemon* Fabr. with descriptions of two new forms. *Notes from the Royal Zoological Museum of the Netherlands, Leyden*, **1**: 165–184.

De Man, J. G., 1892. Decapoden des Indischen Archipels, in Max. Weber (ed.), *Zoologische Ergebnisse einer Reise in Niederländisch Ost-Indien*, **2:** 265–527, Pls. 15–29.

De Man, J. G., 1902. Die von Herrn Professor Kükenthal im Indischen Archipel gesammelten Dekapoden und Stomatopoden. In: W. Kükenthal, Ergebnisse einer zoologischen Forschungsreise in den Molukken und Borneo. *Abhandlungen der Senckenbergischen Naturforschenden Gesellschaft*, **25**: 467–929, Pls. 18–20.

De Silva, K. H. G. M., 1982. Studies on Atyidae (Decapoda, Caridea) of Sri Lanka. I. On a new species, a new subspecies and two species new to Sri Lanka. *Crustaceana*, **43**: 127–141.

Edmondson, C. H., 1935a. New and rare Polynesian Crustacea. *Bernice P. Bishop Museum Occasional Papers*, *Honolulu***, 11**: 1–19, Figs. 1–6.

Edmondson, C. H., 1935b. Atyidae of southern Polynesia. *Bernice P. Bishop Museum Occasional Papers*, *Honolulu*, **10**: 1–40.

Edmondson, C. H., 1954. Substitute for an invalid generic name in the Crustacea. *Pacific Science*, **8**: 368.

Fabricius, J. C. 1798. *Supplementum Entomologiae Systematicae*. Hafniae. 572 pp.

Fujino, T. & S. Shokita, 1975. Report on some atyid shrimps (Crustacea, Decapoda, caridea) from the Ryukyus Islands, *Bulletin of Science and Engineering Division, University of the Ryukyus, (Mathmatics and Natatural Science)*, **18**: 93–113.

Guérin-Méneville, F. E., 1829–1838. Crustacés, Arachnides et Insectes. In L. J. Duperrey (ed.), Voyage autour du monde, excuté par ordre du Roi, sur la corvette de Sa Majesté, La Coquille, pendant les annes 1822, 1823, 1924 et 1825. Zoologie 2 (no. 2, sect. 1): 1–47 (Crustacés), 48–319 (Arachnides et Insectes), Pls. 1–5 (Crustaces), 1–21 (Insectes). Paris: Arthus Bertrand.

Gurney, A. R., 1984b. *Halocaridinides fowleri* (Gordon) comb. nov.: a redescription of *Parisia* (?) *fowleri* Gordon in Gordon and Monod 1968 (Decapoda: Caridea: Atyidae) from Zanzibar. *Journal of Natural History*, **18:** 591–598, Figs. 1a–g, 2a–g, 3a–f.

Hart, C. W., 1980. A new atyid shrimp, *Palauatya dasyomma*, from Palau, Caroline Islands, *Proceedings of the Biological Society of Washington*, **93**(2): 481–489.

Hayashi, K.-I., 1989a. Prawns, shrimps and lobsters from Japan (49), Family Atyidae-Genus *Caridina* (3) and *Antecaridina*. *Aquabiology*, **64**, 11: 376–379, Figs. 171a–g, 172, 173a–e, 174. (in Japanese).

Hayashi, K.-I., 1989b. Prawns, shrimps and lobsters from Japan (50), Family Atyidae-Genus *Paratya* and *Halocaridinides*. Aquabiology, **65**, 11: 497–501, Figs. 175, 176a–l, 177, 178a–c. (in Japanese).

Heller, C., 1862. Neue Crustaceen gesammelt wahrend der Weltumseglung der k.k. Fregatte Novara: Zweiter vorläufiger Bericht. *Verhandlungen des Kaiserlich-Königlichen Zoologisch-botanischen Gesellschaft in Wien*, **12**: 519–528.

Henderson, J. R. & G. Matthai, 1910. On some cartain of of *Palaemon* from South India. *Records of Indian Museum*, **4**: 277–305, Pls. 15–18.

Holthuis, L. B., 1950. Subfamily Palaemonidae. The Palaemonidae collected by the Siboga and Snellius Expeditions with remarks on other species. I. The Decapoda of the Siboga Expedition. Part X. *Siboga Expeditie*, **39**(a9): 1–268, Figs. 1–52.

Holthuis, L. B., 1955. The recent genera of the caridean and stenopodidean shrimps (Class Crustacea: Order Decapoda: Supersection Natantia) with keys for their determination. *Zoologische Verhandelingen*, Leiden, **26**: 1–157, Figs. 1–105.

Holthuis. L. B., 1956. An enumeration of the Crustacea Decapoda Natantia inhabiting subterranean waters. *Vie et Milieu*, **7**: 43–76.

Holthuis, L. B., 1963. On red coloured shrimps (Decapoda, Caridea) from tropical land-locked salt water pools. *Zoolologische Mededelingen*, *Leiden*, **38**: 261–279.

Holthuis, L. B., 1965. The Atyidae of Madagasca, *Mémoires du Muséum national d'Histoire Naturelle*, *series A (Zoologie)*, **33**: 1–48, Figs. 1–17.

Holthuis, L. B., 1973. Caridean shrimps found in land-locked saltwater pools at four Indo-West Pacific localities (Sinai Peninsula, Funafuti Atoll, Maui and Hawaii Islands), with the description of one new genus and four new species. *Zoologische Verhandelingen*, *Leiden*, **128**: 1–48.

Holthuis, L. B. 1978. Zoological results of the British Speleological Expedition to Papua New Guinea 1975. 7. Cavernicolous shrimps (Crustacea, Decapoda, Natantia) from New Ireland and the Philippines. *Zoolologische Mededelingen*, *Leiden*, **53**: 209–224.

Holthuis, L. B., 1982. Notes on Indo-West Pacific Crustacea Decapoda II. The genus *Halocaridinides* Fujino and Shokita and its type species *H. trigonophthalma* (Fujino and Shokita). *Crustaceana*, **42**(1): 31–36.

Holthuis, L. B., 1995. Notes on Indo-West Pacific Crustacea Decapoda III to IX. *Zoölogische Mededeelingen*, Leiden, **69**: 139–151.

Hung, M.S., T.Y. Chan, & H.P. Yu, 1993. Atyid shrimps (Decapoda, Caridea) of Taiwan, with descriptions of three new species. *Journal of Crustacean Biology*, **13**: 481–503, Figs. 1–14.

Hwang, J. J. & H. P. Yu, 1982. Studies on the freshwater shrimps of the genus *Macrobrachium* (Crustacea, Decapoda, Palaemonidae) from Taiwan. *Quarterly Journal of Taiwan Museum*, **25**: 157–180.

Jalihal D. R. & S. Shenoy, 1998. Taxonomic revision of some Indian prawn species of genus *Caridina* H. Milne Edward, 1837 (Atyidae), *Proceedings and abstracts of the Fourth Internatinal Crustacean Congress*, Melbourne, Australia: 128–129.

Johnson, D. S., 1960. Sub-specific and infra-specific variation in some freshwater prawns of the Indo-Pacific region. *Proceedings of the Centenary and Bicentenary congress of Biology*, Singapore,1958: 259–267, Figs. 1–5.

Johnson, D. S., 1962. On a new species of *Macrobrachium* (Decapoda, Caridea). *Crustaceana*, **4**: 307–310, Fig. 1.

Johnson, D. S., 1963. Distribution and other notes on some fresh-water prawns (Atyidae and Palaemonidae) mainly from the Indo-west Pacific region. *Bulletin of the National Museum*, Singapore, **32**: 5–30, Fig. 1–5.

Johnson, D. S., 1973. Notes on some species of the genus *Macrobrachium* (Crustacea: Decapoda: Caridea: Palaemonidae).

Journal of Singapore National Academy of Science, **3**: 273–291.

Kemp, S., 1918. Zoological results of a tour in the Far East Crustacea Decapoda Stomatopoda, *Memoirs of the Asiatic Socciety of Bengal*, **6**: 219–297.

Leberer, T. & Y. Cai, 2003. Shrimps of the family Atyidae from Guam, Mariana Islands. *Micronesica*, **35–36**: 355–360.

Liang, X. -Q. & S. -L. Yan, 1977. New species and subspecies of *Caridina* (Decapoda, Caridea) from Fukien, China. *Acta Hydrobiologia Sinica*, **6**: 219–225, Figs. 1–13. (in Chinese with English abstract)

Linnaeus, C., 1758. *Systema Naturae per Regna Tria Naturae, Secundum Classes, Ordines, Genera, Species, cum Characteribus, Differentiis, Synonymis, Locis.* Holmiae. Edition 10, volume 1: iii + 824 pp.

Liu, M. Y., Cai, Y. X. & C. S. Tzeng, 2007. Molecular systematics of the freshwater prawn genus *Macrobrachium* Bate, 1868 (Crustacea: Decapoda: Palaemonidae) from mtDNA sequences, with emphasis on East Asian species. *Zoological Studies*, **46**(3): 272–289.

Liu, R., Liang, X.& S. Yan, 1990. A study of the Palaemonidae (Crustacea Decapoda) from China I. *Macrobrachium*, *Leander* and *Leandrites*. *Transactions of the Chinese Crustacean Society*, **2**: 102–134, Figs. 1–24. (In Chinese with English abstract)

Milne Edwards, H., 1837, *Histoire naturelle des Crustacés, comprenant l'anatomie, la physiologie et la classification de ces animaux*, **2**, 1–532, atlas, Pls. 1–14.

Naiyanetr, P., 1980. *Crustacean fauna of Thailand (Decapoda and Stomatopoda)*. Department of Biology, Faculty of Science, Chulalongkorn University, Bangkok, Thailand, 73 pp. (In Thai)

Naruse, T., M. Toda & S. Shokita, 2003. A record of *Halocaridinides trigonophthealma* (Atyidae) from Hatoma Island, Yaeyama Group, Southern Ryukyus, Japan. *Cancer*, **12**: 1–6. (In Japanese with English abstract)

Newport, G., 1847. Note on the genus *Atya* of Leach, with descriptions of four apparently new species, in the cabinets of the British Museum. *Annals and Magazine of Natural History*, **19**: 158–160, Pl. 8, Fig. 1.

Ortmann, A., 1891. Versuch einer Revision der Gattungen *Palaemon* sens. strict. und Bithynis. Die Decapoden-Krebse des Strassburger Museums, mit besonderer Berücksichtigung der von Herrn Dr. Döderlein bei Japan und bei den Liu-Kiu-Inseln gesammelten und z. Z. im Strassburger Museum aufbewahrten Formen. II. Theil. *Zoologische Jahrbücher Abteilung für Systematik, Geographie und Biologie der Thiere*, **5**: 693–750, Pl. 47.

Rafinesque, C. S., 1815. Analyse de la Nature Tableau de l'Univers et corps organizes. 224 pp.

Roux, J, 1928. Notes carcinologiques de l'Archipel indo-australien. I. Décapodes Macroures d'eau douce de l'Archipel Indo-Australien. *Treubia*, **10**: 197–216, Figs. 1–9.

Shokita, S., 1975. The distribution and speciation of the inland water shrimps and prawns from the Ryukyu Islands-I. *Bulletin of Science & Engineering Division, University of Ryukyus, Mathmatics and Natural Science*, **18**: 115–136. (In Japanese with English abstract)

Shokita, S., 1979. The distribution and speciation of the inland water shrimps and prawns from the Ryukyu Islands-II. *Bulletin of College of Science, University of Ryukyus*, **28**: 193–278. (In Japanese with English abstract)

Shokita, S., 2003, Atyidae, *In*: Nishida, M., Shikatani N. & S. Shokita (Eds.), *The flora and fauna of inland waters in the Ryukyu Islands*, Tokai University Press, Tokyo, Japan. Pp. 249–254. (In Japanese)

Short, J. W., 2004. A revision of Australian river prawns, *Macrobrachium* (Crustacea: Decapoda: Palaemonidae). *Hydrobiologia*, **525**: 1–100.

Shy, J. Y & H. P. Yu, 1998. *Freshwater shrimps of Taiwan*. National Museum of Marine Biology and Aquarium. 103 pp. (In Chinese)

Sket, B., 1997. Hypogean aquatic fauna in Bohol Island, Philippines. Our Caves. *Bulletin of the Speleology Association of Slovenia*, **39**: 62–67.

Smith, M. J. & W. D. Williams, 1981. The occurrence of *Antecaridina lauensis* (Edmondson) (Crustacea, Decapoda, Atyidae) in the Solomon Islands. *Hydrobiologia*, **85**: 49–58.

Suzuki, H., 1980. An atyid shrimp living in anchialine pool on Kuro-Shima, the Yaeyama group, Okinawa Prefecture. *Proceedings of the Japanese Society of Systematic Zoology*, **18**: 47–53, Figs. 1–5.

Thallwitz, J., 1891. Ueber einige neue indo-pacifische Crustaceen (vorläufige mittheilung). *Zoologischer Anzeiger*, **14**: 96–103.

Thallwitz, J., 1892. Decapoden-Studien, insbesondere basiert auf A. B. Meyers Sammlungen im Ostindischen Archipel, nebst einer Aufzählung der Decapoden und Stomatopoden des Dresdener Museums. *Abhandlungen und Berichte des Königlichen Zoologischen und Anthropologisch-Ethnographischen Museums zu Dresden*, **1890-91**(3): 1–55, Pl. 1.

Tiwari, K. T. & R. S. Pillai, 1971. Atyid shrimps of the genus *Caridina* H. Milne Edwards, 1837, from the Andaman Islands (Decapoda, Caridea). *Crustaceana*, **21**: 79–91.

Von Martens, E., 1868. Ueber einige ostasiatische Süsswasserthiere. *Archiv für Naturgeschichte*, **34**(1): 1–67, Pl. 1.

Weber, F., 1795. Nomenclator entomologicus secundum Entomologiam systematicum ill. Fabricii adjectis speciebus recens detectis et varietatibus. Chilonii et Hamburgi: viii+171 pp.

Wowor, D., & S. Choy, 2001. The freshwater prawns of the genus *Macrobrachium* Bate, 1868 (Crustacea: Decapoda: Palaemonidae) from Brunei Darussalam. *Raffles Bulletin of Zoology*, **49** (2): 269–289.

Wowor, D., Y. Cai & P. K. L. Ng, 2004. Crustacean: Decapoda: Caridea. In: C. Yule & H. S. Yong (editors). *The freshwater invertebrates of Malaysia and Singapore*. Malaysian Academy of Sciences, Kuala Lumpur: 337–357.

Yeo, D. C. J., Cai, Y., & P. K. L. Ng, 1999. The freshwater and terrestrial decapod Crustacea of Pulau Tioman, Peninsular Malaysia. *Raffles Bulletin of Zoology*, Supplement No. **6**: 190–244, Figs. 1–20.

Yu, S. C., 1936. Report on the Macrurous Crustacea collected during the "Hainan Biological Expedition" in 1934. *Chinese Journal of Zoology*, **2:** 85–99, Figs. 1–7.