

## Atyid shrimps of the genus *Paracaridina* (Crustacea, Decapoda, Atyidae) from Hunan Province, China

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Received 24 March 2003; accepted 4 August 2003

**Key words:** Decapoda, Atyidae, *Paracaridina*, new species, China

### Abstract

Three species of the genus *Paracaridina* (family Atyidae) are reported from Hunan Province, China, including *P. chenxiensis* sp. nov. A partial re-description of the type species of *Paracaridina*, *P. longispina* (Guo & He, 1992) is provided, as is a revised diagnosis of the genus. *Caridina guizhouensis* (Liang & Yan, 1986) is removed to *Paracaridina* and recorded for the first time from Hunan.

### Introduction

The family Atyidae presently contains 38 genera in 4 subfamilies (Holthuis, 1993; Liang & Cai, 1999; Liang et al., 1999), one of the most recently erected genera of which is *Paracaridina* Liang & Guo (Liang et al., 1999) from Hunan, China. The original description of the genus is as follows: 'Rostrum short. Carapace with antennal spine, no supraorbital spine. Eye normal. Anterior of carpus of the first two pereopods excavated. With eight pairs of gills' (translated from Liang et al., 1999).

A brief discussion of its generic affinities was added, as follows (translated from Liang et al., 1999): 'Apart from the gill formula, the new genus is similar to *Caridina* Milne-Edwards. The differences in the former [sc. *Paracaridina*] lacking an arthrobranch on the first pereopod. The eyes of the new genus developed, cornea of eyes pigmented, with pleurobranches on all pereopods, epipods on first four pereopods; all of the above mentioned characters same as *Caridinopsis* Bouvier, 1912. But the third maxilliped of the latter genus with two pairs of arthrobranches, no pleurobranch, and the anterior of the carpus of the first pereopod not excavated. All of these are different from the latter (sic)' [Should read former, as it pre-

sumably refers to *Paracaridina*]. For a discussion of the branchial formula in *Paracaridina* and its generic affinities, see below.

Two species have up to now been included in the genus: *Paracaridina longispina* (Guo & He) (described in Guo et al., 1992 as *Caridina longispina*), and selected as the type species by Liang et al. (1999) and *Paracaridina zijinica* Liang, 2002. The previously non-illustrated mouthparts of the type species are herein illustrated and described, whilst an additional species is described, and freshly collected material of one species of *Caridina* allows for a generic re-assignment.

The following abbreviations are used throughout the text: total length (tl, measured from the rostral tip to the posterior margin of the telson), carapace length (cl, measured from the postorbital margin to the posterior margin of the carapace), rostral length (rl, measured from the rostral tip to the postorbital margin). The majority of the type specimens have been deposited in the collection of Hunan Agricultural University, China (HAU), some paratypes and additional material has been deposited in the Shanghai Fisheries University collection, China (SFU), the Queensland Museum, Australia (QM) and the Oxford University Museum of Natural History, U.K. (OUMNH).

## Systematics

### Family Atyidae De Haan

#### Genus *Paracaridina* Liang & Guo, in Liang et al., 1999

*Revised diagnosis:* Eye developed; antennular peduncle slender; antennal spine sharp, situated at inferior orbital angle; pterygostomial margin rounded; telson rounded distally, with 4–9 pairs of dorsal spines along lateral margin. Mandible with 6–7 teeth at extremity of incisor process; maxillula with simple palp, lower lacinia broadly rounded, upper lacinia short, inner edge straight; maxilla with slender palp, upper endite subdivided; scaphocerite tapering with numerous long partially plumose setae terminally; palp of first maxilliped broadly triangular terminally; endopod of second maxilliped with dactylus and propodus indistinctly divided; third maxilliped ending in single terminal claw, surrounded by simple setae. Branchial formula, as follows:

	Maxillipeds			Pereiopods				
	1	2	3	1	2	3	4	5
Pleurobranchs	–	–	–	1	1	1	1	1
Arthrobranchs	–	–	2	–	–	–	–	–
Podobranchs	–	1	–	–	–	–	–	–
Epipods	–	1	1	1	1	1	1	–
Exopods	1	1	1	–	–	–	–	–

First and second pereiopods with carpus anteriorly excavated, fingers with brushes of setae; third and fourth pereiopods similar to each other, propodus armed with numerous small spines; dactylus short, with numerous spines along flexor margin. Endopod of first male pleopod sub-rectangular, with appendix interna; appendix masculina of male second pleopod sub-cylindrical, spinose on distal margin; uropodal di-aresis with 15–20 spines. Eggs large, size 0.62–0.72 × 1.00–1.25 mm (in *P. longispina*).

*Remarks:* when erecting the genus *Paracaridina*, Liang et al. (1999) provided little discussion of its generic affinities, but noting it as being morphologically close to *Caridina* H. Milne Edwards. Two branchial characters were highlighted as being different between both genera, a branchial formulae consisting of eight branchiae in *Paracaridina* (versus nine in *Caridina*) and the absence of an arthrobranch on the first pereiopod in *Paracaridina*. However, it is the actual loss of the arthrobranch on the first pereiopod in *Paracaridina*, which results in a branchial formula of eight

branchiae. Indeed, Bouvier (1925) characterised his série caridienne, which includes the genus *Caridina*, by the presence of an arthrobranch on the first pereiopod. Therefore only one morphological character (viz. absence vs presence of arthrobranch on first pereiopod) distinguishes *Paracaridina* from *Caridina*.

Even though in general habitus, as well as several other characteristics (telson and uropod shape and armature, endopod of male first pleopod, appendix masculina, etc.) *Paracaridina* is similar to *Caridina*, both genera belong to a different subfamily following the classification of Holthuis (1993), with *Paracaridina* being placed in the Caridellinae (vs *Caridina* in Atyinae), a subfamily characterised by having no exopodites nor any arthrobranches on the pereiopods (except *Caridinides* Calman which harbours a exopod on the first pereiopod). A full discussion of this subfamily is given by Bouvier (1925, as 'série caridellienne') and Holthuis (1986, as Caridellinae). The subfamily presently contains the following genera: *Atyella* Calman, *Caridella* Calman, *Caridinides*, *Caridinopsis* Bouvier, *Edoneus* Holthuis, *Halocaridina* Holthuis, *Halocaridinides* Fujino & Shokita, *Jolivetya* Cals, *Limnocaridella* Calman, *Limnocaridina* Calman, *Mancicaris* Liang et al., *Micratya* Bouvier, *Paracaridina*, *Parisias* Holthuis, *Puteonator* Gurney, *Pycneus* Holthuis, and *Pyncisia* Bruce. Although Holthuis (1993) included *Typhlocaridina* Liang & Yan in this subfamily, the branchial formulae consists of nine branchiae (Guo, pers. obs.) and thus the genus is here transferred to the Atyinae.

*Paracaridina* differs from *Edoneus*, *Halocaridina*, *Halocaridinides*, *Jolivetya*, *Mancicaris*, *Puteonator*, *Pycneus* and *Pyncisia* in having the eyes not degenerated and with a pigmented cornea, versus degenerated and non-pigmented in these stygiobiotic genera. *Paracaridina* differs from the African genera *Atyella*, *Caridella*, *Limnocaridella* and *Limnocaridina* in having a pleurobranch on the fifth pereiopod, and in this respect is similar to *Caridinides*, *Caridinopsis*, *Jolivetya* and *Parisias*. It however differs from *Caridinides* in the presence of epipodites on the first four pereiopods (vs. absent on the last three pereiopods in *Caridinides*), and differs from *Caridinopsis* in having the carpus of the first pereiopod excavated (vs non excavated). Further, *Paracaridina* differs from *Parisias* in harbouring two arthrobranches on the third maxilliped and no epipod on the first maxilliped (vs one arthrobranch and one epipod on the first maxilliped in *Parisias*). The Caribbean genus *Micratya* differs from *Paracaridina* in harbouring no pleurobranch on the fifth pereiopod and in

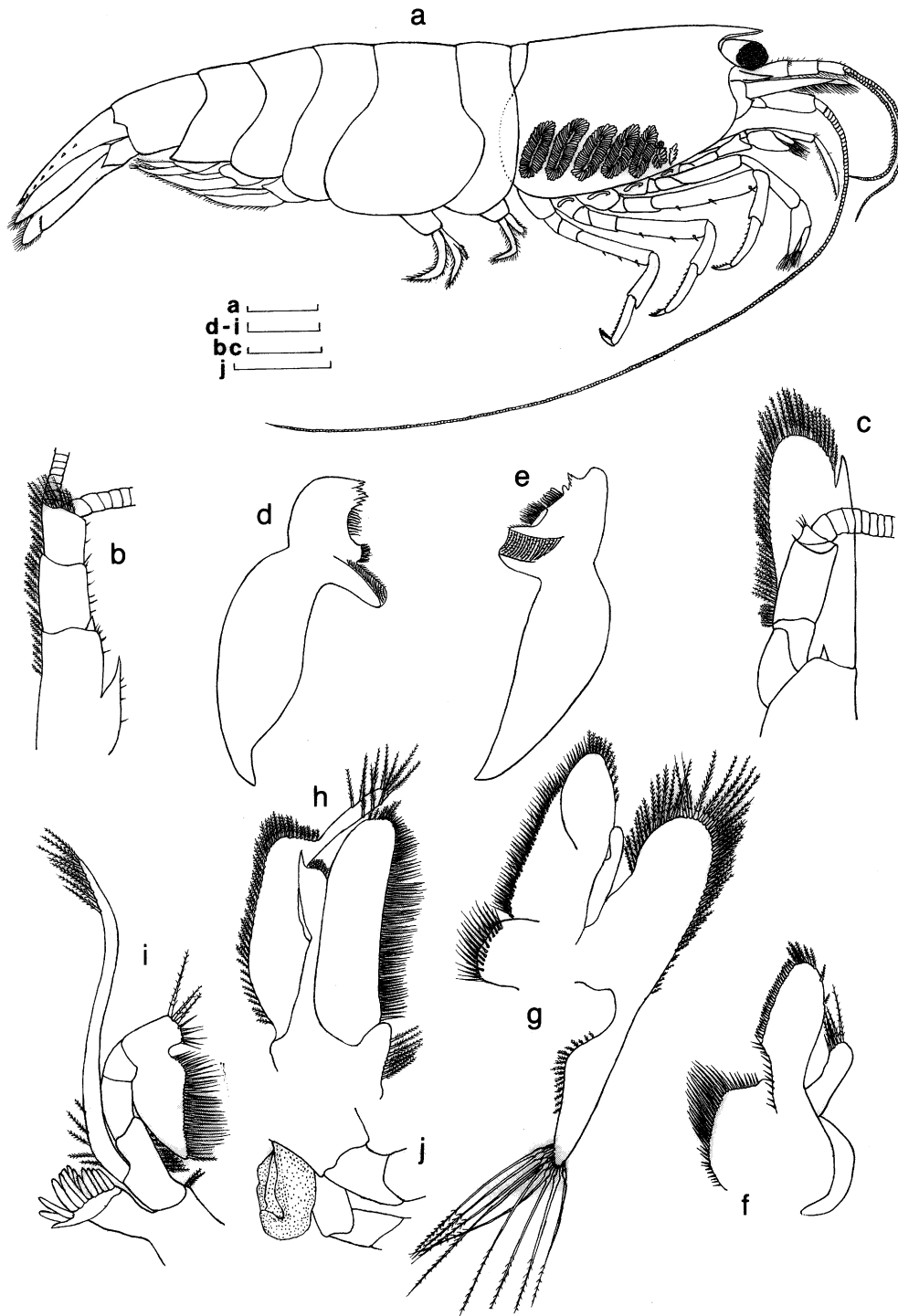


Figure 1. *Paracaridina longispina* (Guo & He), male holotype (HAU 1992-04-04). a: entire animal, lateral view, b: antennular peduncle, c: antennal peduncle, d: left mandible, e: right mandible, f: maxillula, g: maxilla, h: first maxilliped, i: second maxilliped, j: spermatophore. Scale bars indicate 1 mm (a), 0.3 mm (d–i), or 0.5 mm (b, c, j).

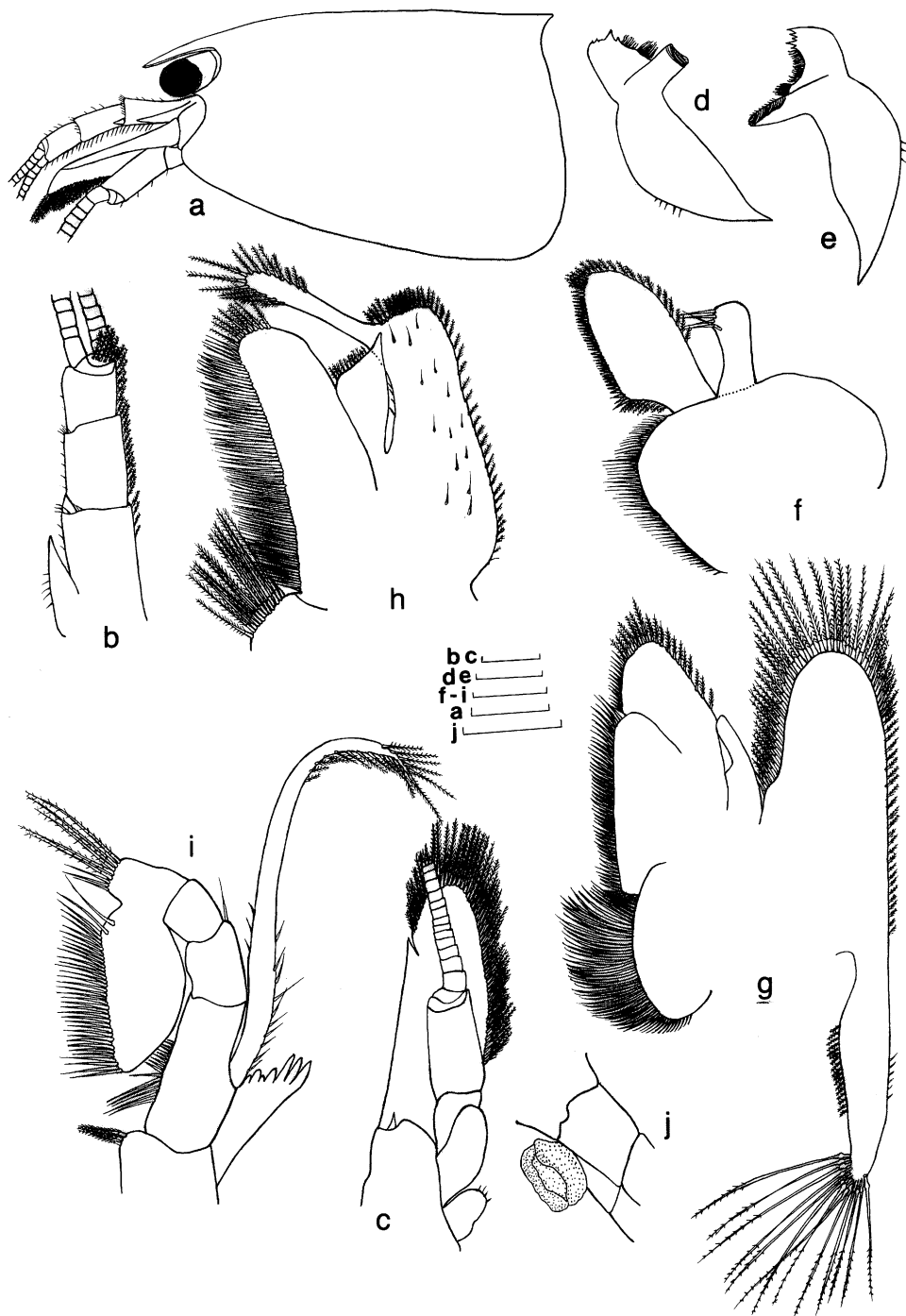


Figure 2. *Paracaridina chenxiensis* sp. nov., male holotype (HAU 1992-08-12-01). a: cephalothorax, b: antennular peduncle, c: antenna, d: left mandible, e: right mandible, f: maxillula, g: maxilla, h: first maxilliped, i: second maxilliped, j: spermatophore. Scale bars indicate 0.5 mm (b–e, j), 0.3 mm (f–i) or 1 mm (a).

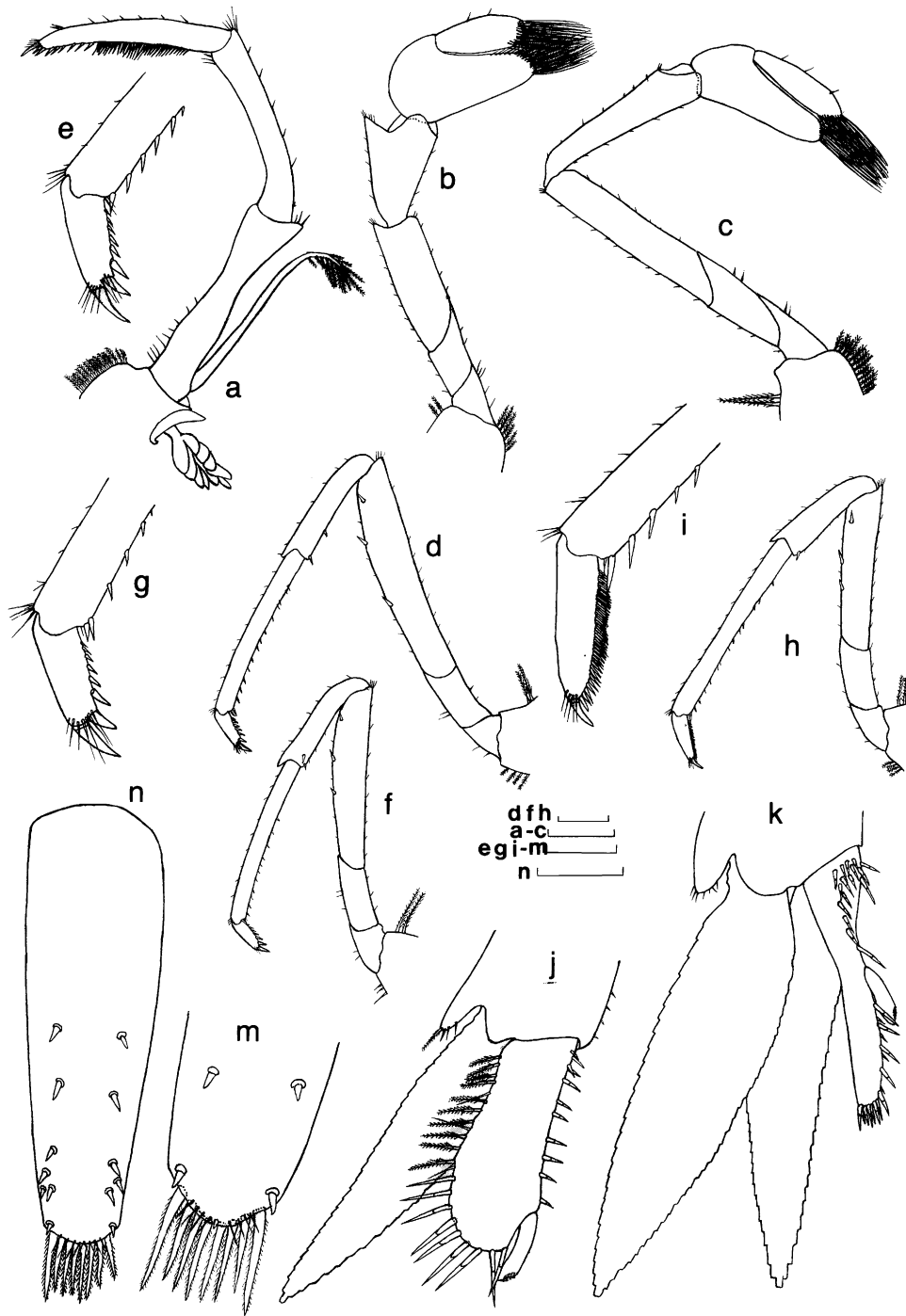


Figure 3. *Paracaridina chenxiensis* sp. nov., male holotype (HAU 1992-08-12-01) a: third maxilliped, b: first pereiopod, c: second pereiopod, d: third pereiopod, e: dactylus of third pereiopod, f: fourth pereiopod, g: dactylus of fourth pereiopod, h: fifth pereiopod, i: dactylus of fifth pereiopod, j: male first pleopod, k: male second pleopod, m: posterior portion of telson, n: telson. Scale bars indicate 0.5 mm (a–c, d, f, h) or 0.3 mm (e, g, i–n).

having a much stronger developed appendix masculina on the male second pleopod.

*Caridina longispina* Guo & He in Guo, He, Xu and Gui, 1992: 717; Figures 1–9.

*Paracaridina longispina*, Liang, Guo & Tang, 1999: 69.

*Material examined*: male holotype (HAU 1992-04-04, cl 3.6 mm); paratypes: 283 specimens (HAU, cl 3.2–5.0 mm); 4 specimens (SFU, cl 3.9–5.0 mm); 8 specimens (QM, cl 3.7–4.7 mm); 2 specimens (OUMNH 21850, cl 4.0–4.7 mm); all from Yuelu Hills, Changsha City (ca. 28°10' N 112°56' E), leg. Z.-L. Guo, coll. 30-04-1992 and 24-07-1992.

*Supplementary description*: Body (Fig. 1a): slender, sub-cylindrical: rostrum short, typically unarmed (71.9%) or with 1–5 dorsal teeth (28.1%,  $N = 178$ ); carapace without pterygostomial spine but with well developed antennal spine; cornea pigmented.

Antennula (Fig. 1b): Peduncle slender; stylocerite approx. 0.75 times length of proximal segment; penultimate segment approx. 0.58 length of proximal segment, approx. 1.5 length of ultimate segment.

Antenna (Fig. 1c): Scaphocerite slightly longer than antennular peduncle, outer margin straight, non-setose, ending in strong sub-apical spine; length approx. 2.8 times width, medial and anterior margins with long plumose setae.

Mandibles (Fig. 1d–e): Without palp; right mandible with 7 strong sharp incisor teeth laterally; medially 2 groups of setae; molar process ridged; left mandible with 7 irregularly shaped teeth.

Maxillula (Fig. 1f): Lower lacinia broadly rounded; upper lacinia broadly elongate, medial edge straight, with several rows of strong spinules; palp simple, slightly expanded distally, with 8 long simple setae; upper, middle and lower endite with simple marginal and sub-marginal setae.

Maxilla (Fig. 1g): Scaphognathite tapers posteriorly, distally with regular row of long plumose setae and short marginal plumose setae continuing down proximal triangular process, furnished with numerous long plumose setae, the latter with prominent basal dilation; upper and middle endite with marginal simple, denticulate and sub-marginal simple setae, distally with plumose setae; lower endite with long simple marginal setae; palp shorter than cleft of upper endite, wider proximally than distally.

First maxilliped (Fig. 1h): Palp broadly triangular ending in fringe-like tip and with terminal plumose setae; caridean lobe broad; exopodal flagellum well developed; ultimate and penultimate segments of en-

dopod indistinctly divided; medial and distal margins of ultimate segment with marginal and sub-marginal rows of simple, denticulate and plumose setae; penultimate segment with marginal long plumose setae.

Second maxilliped (Fig. 1i): Ultimate and penultimate segments of endopod indistinctly divided; inner margin of ultimate, penultimate and basal segments with long plumose setae; exopod long.

Spermatophore (Fig. 1j): Single, disc shaped.

*Development*: The male to female ratio in the samples was 1.5:1 in April 1992 and 2.81:1 in July 1992. In April, 80% of the adult male specimens possessed a single spermatophore, but in July this proportion decreased to 7%. Eggs slightly yellowish, large; measuring 0.62–0.72 × 1.00–1.25 mm. Number of eggs ranged from 17 to 34. Development partially abbreviated with only 3 larval stages before the metamorphosis to post-larva when reared in the laboratory (pers. obs. Z.-L. Guo).

*Habitat*: The Yuelu Hills are located near the Xiangjiang River, to the west of the city of Changsha, the capital of Hunan Province. The hills are approximately 295 m above sea level and cover an area of approx. 8 km<sup>2</sup>. Although quite a few streams are present, *P. longispina* was only found in an unnamed stream near the Aiwan Pavilion. This particular stream is approx. 2 km long, with a width of 0.5–1.5 m and a depth of 0.2–0.6 m. The bottom of the stream consists of rocks interspersed with gravel and sandy patches. Shrimps were very commonly encountered in the crevices of small waterfalls and rock surfaces. At present this species has only been recorded from the type locality.

*Paracaridina guizhouensis* (Liang & Yan, 1986) *comb. nov.*

*Caridina guizhouensis* Liang & Yan, 1986: 199; Figure 2.

*Material examined*. 5 females (HAU cl 4.0–4.4 mm), 4 males (HAU, cl 3.3–4.2 mm); Yanmeng Village, Maoyang County (ca. 27° 52' N, 109° 44' E), leg. Z.-L. Guo, 25 August 1992.

*Remarks*: Liang & Yan (1986) described this species from Yuping County, Guizhou Province. An full examination of the branchiae of this newly collected material from Hunan, confirms that the branchial formulae consists of only eight branchiae, hence the species is transferred to the genus *Paracaridina*. The present material constitutes the first record of this species for Hunan Province.

*Habitat*: The present specimens were collected from a slow flowing small stream near Yanmeng Village, Maoyang County at an elevation of 550 m. They were found among aquatic grasses together with *Neocaridina palmata palmata* (Shen). The stream is approximately 1.5–2.2 m wide and 0.8–1.1 m deep (water temperature 25 °C, pH 6.5).

*Holotype*. Adult male (HAU 90-08-12-01; tl 16.0 mm, cl 4.0 mm, rl 1.0 mm); small stream at an elevation of 450 m near Huomachong Village, Chenxi County (ca. 27° 47' N, 110° 16' E), leg. Z.-L. Guo, 15 August 1990.

*Paratypes*: Adult female allotype (HAU 90-08-12-02; tl 19.2 mm, cl 4.8 mm, rl 1.1 mm); 3 females (HAU 90-08-12-03 through to 90-08-12-05, tl 13.9–21.7 mm); 3 males (HAU 90-08-12-06 through to 90-08-12-09, tl 12.7–15.5 mm); 1 male (SFU, tl 13.8 mm); 1 female (SFU, tl 16.1 mm); 1 female (OUMNH 21849, tl 14.5 mm); collection data as holotype.

*Derivatio nominis*: The species name is derived from the type locality: Chenxi County (Hunan Province, China).

*Description*: Small, slender and sub-cylindrical; males reach 16.0 mm TL, females reach 21.7 mm TL.

*Rostrum* (Fig. 2a): Short, slender, 0.24–0.29 of CL, curving downwards, reaching end of eye to tip of basal antennular segment, usually unarmed, sometimes with 1–5 dorsal teeth and 1 ventral tooth. Eye small, on short ocular peduncle, cornea globular, well developed.

*Carapace* (Fig. 2a): Smooth, glabrous. Lower orbital angle indistinct, almost fused to sharp antennal spine; pterygostomial margin rounded, slightly produced forward; pterygostomial spine absent.

*Antennule* (Fig. 2b): Peduncle not reaching beyond scaphocerite; stylocerite ca. 0.81 times length of proximal segment; second segment ca. 0.77 times length of proximal segment, ca. 1.4–1.6 times length of distal segment; all segments with submarginal plumose setae.

*Antenna* (Fig. 2c): Peduncle ca. 0.56 times length of scaphocerite; scaphocerite outer margin straight, non-setose, ending in a strong sub-apical spine; length ca. 2.8 times width, medial and anterior margins with long plumose setae; long, finger-like process arising from inner margin of basal segment.

*Mandibles* (Figs 2d–e), *maxillula* (Fig. 2f), *maxilla* (Fig. 2g), *first maxilliped* (Figure 2h), and *second maxilliped* (Fig. 2i) as figured, typical for genus.

*Third maxilliped* (Fig. 3a): Reaches to tip of antennular peduncle; endopod three-segmented, length of basal segment 3.7–4.6 times width, proximally with marginal plumose setae; length of penultimate segment ca. 5.4–5.6 times width, ca. 0.84–0.93 times length of basal segment; distal segment ca. 1.1 times length of penultimate segment, ending in a large claw-like spine surrounded by simple setae, preceded by (usually) 8 spinules on distal third of posterior margin, proximally with a clump of long and short simple, serrate setae; exopod reaching to ca. 0.14 of second segment of endopod, distal margin with long plumose setae.

Branchial formula, as in generic diagnoses.

*First pereiopod* (Fig. 3b): Reaching tip of eyes; length of chela 1.7–2.3 times width; movable finger 2.6–3.5 times as long as wide, 1.1–1.5 times length of palm; carpus excavated disto-dorsally, 1.5–1.8 times as long as wide, 0.78–0.85 times length of chela and 0.78–0.86 times length of merus.

*Second pereiopod* (Fig. 3c): Reaches tip of antennular peduncle, more slender and longer than first pereiopod; chela ca. 2.2–2.4 times as long as wide; movable finger 3.8–4.0 times as long as wide, 1.3–1.7 times length of palm; carpus 4.2–5.1 times as long as wide, excavated distally, length ca. 1.3–1.4 times chela and approximately as long as merus.

*Third pereiopod* (Figs 3d–e): Overreaches antennular peduncle tip by approx. distal fourth of propodus; dactylus 3.6–4.2 times as long as wide, ending in a prominent claw-like spine surrounded by simple setae, proximally with 5–7 spinules; propodus length 8.1–10.0 times width, 3.1–4.2 times length of dactylus; carpus 0.59–0.76 times length of propodus; merus 1.6–1.9 times as long as carpus, usually with 3 spinules on postero-lateral margin.

*Fourth pereiopod* (Figs 3f–g): Reaching tip of first segment of antennular peduncle; generally similar to pereiopod 3; length of dactylus 2.7–3.7 times width.

*Fifth pereiopod* (Figs 3h–i): Reaching middle of third segment of antennular peduncle; length of dactylus 3.3–4.5 times width, ending in a claw-like spine surrounded by simple setae, postero-proximally a comb-like row of 36–45 spinules; length of propodus 9.0–12.7 times width, 3.2–3.9 times length of dactylus; carpus 0.49–0.58 times length of propodus; merus 1.2–1.6 times length of carpus, usually with 3 spines on posterior margin.

*Male first pleopod* (Fig. 3j): Endopod approx. 0.60–0.72 times length of exopod, slightly wider distally, length approx. 2.7–2.9 times maximum width,

sub-rectangular in shape; medial border with thin marginal and sub-marginal spinules, distally with long and strong spinules, basal part of lateral margin with long plumose and simple setae; appendix interna well developed, arising from distal part, overreaching tip of endopod by half its length.

Male second pleopod (Fig. 3k): Endopod ca. 0.87 times length of exopod; appendix interna short, reaching ca. 0.45 of appendix masculina; appendix masculina rod-shaped, reaching to ca. 0.58 of endopod length, with a row of long and a row of short spinules on medial and distal margins.

Abdomen: Well developed, rotund, glabrous; sixth somite 0.46–0.52 times carapace length.

Telson (Figs 3m–n): 0.52–0.56 times carapace length, distinctly longer than sixth somite, tapering posteriorly, ending in rounded margin with small median projection, dorsal surface with 5–9 pairs of stout movable spines including pair at postero-lateral angle, occasionally 2–4 pairs arranged more closely on dorso-posterior region; posterior margin with 3–5 pairs of intermedial plumose setae, lateral pair usually stouter and longer, sub-lateral pair shorter than the next intermedial pair.

Uropodal diaeresis: with 18–20 spines.

Spermatophore (Fig. 2j): single, disc-shaped.

*Live colouration*: All specimens light orange colour.

*Remarks*: *Paracaridina chenxiensis* sp. nov. is closely related to *P. guizhouensis* (Liang & Yan, 1986) in the shape of the endopod of the male first pleopod and the appendix masculina of the male second pleopod. It can be distinguished from *P. guizhouensis* by the shape of the rostrum, which is typically unarmed, curved downwards and not reaching the end of the basal antennular segment (versus 6–9 dorsal teeth, not curved downwards and reaching beyond the middle of the second segment in *P. guizhouensis*); the length to width ratio of the carpus of the first pereopod (1.5–1.8 versus 1.3–1.4 in *P. guizhouensis*) and the uropodal diaeresis possessing 18–20 spinules (versus 12–14 spinules in *P. guizhouensis*). *Paracaridina chenxiensis* can be distinguished from *P. zijinica* by the much shorter stylocerite, not reaching the end of the proximal segment (vs. reaching end in *P. zijinica*) and from *P. longispina* by its rostrum (overreaching the cornea in *P. chenxiensis* vs. falling short of cornea

in *P. longispina*), shape of the endopod of the male first pleopod (compare Fig. 8 in Guo et al. (1992) with Fig. 3j) and the more elongated appendix masculina.

*Habitat*: The type series was collected from a small stream at an elevation of 450 m near Huomachong Village, Chenxi County (ca. 27° 47' N, 110° 16' E). The stream has a rocky bed, approximately 0.8–1.2 m wide and 0.3–1.0 m deep (temperature 28 °C, pH 7.0). The shrimps were found under stones and in aquatic grasses.

## Acknowledgements

Professor Liang (Shanghai) and Dr Cai (Singapore) are gratefully acknowledged for substantial advice and encouragement. Professors L.B. Holthuis, K.-I. Hayashi and Dr S. Choy provided essential literature, whilst the comments of two anonymous referees substantially improved an earlier version of the manuscript.

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