



This paper is dedicated to Prof. Dr. Eugen Kempf on the occasion of his 80th birthday (16 April 2012)

ON SOME RECENT NON-MARINE OSTRACODS FROM NORTHERN CHINA, WITH DESCRIPTION OF ONE NEW SPECIES

BY

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ABSTRACT

Preliminary investigations of urban waters in Beijing City and small water-bodies in Inner Mongolia yielded a total of 12 living ostracod species. Five species are new records for China: *Candona quasiakaina* Karanovic & Lee, 2012, *Fabaeformiscandona myllaina* Smith & Kamiya, 2007, *Heterocypris auricularis* sp. nov. (previously known as *Heterocypris sanukiensis* Okubo, 2004 nomen nudum), *Ilyocypris mongolica* Martens, 1991 and *Plesiocypridopsis newtoni* (Brady & Robertson, 1870). *Bradleycypris vittata* (Sars, 1903), *Ilyocypris angulata* Sars, 1903, *Limnocythere stationis* Vávra, 1891 and *Physocypris kraepelini* G. W. Müller, 1903 are the first records for Palaearctic China. *Cypridopsis vidua* (O. F. Müller, 1776), *Heterocypris incongruens* (Ramdohr, 1808) and *Limnocythere inopinata* (Baird, 1843) are also reported in this paper, although they had already been found in China before. Of the above species, *B. vittata*, *I. angulata* and *I. mongolica* are re-described. The present study expands our knowledge on the taxonomy and geographical distribution of ostracod species.

Key words. — Freshwater ostracods, taxonomy, redescription, zoogeography, China

ZUSAMMENFASSUNG

In ersten Untersuchungen von städtischen Gewässer von Peking und Kleingewässern in der Inneren Mongolei konnten insgesamt 12 lebende Ostrakodenarten nachgewiesen werden. Davon konnten fünf Arten für China erstmalig nachgewiesen werden, namentlich *Candona quasiakaina* Karanovic & Lee, 2012, *Fabaeformiscandona myllaina* Smith & Kamiya, 2007 *Heterocypris*

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auricularis sp. nov. (bisher beschrieben als *Heterocypris sanukiensis* Okubo, 2004 nomen nudum), *Ilyocypris mongolica* Martens, 1991 und *Plesiocypridopsis newtoni* (Brady & Robertson, 1870). Ferner sind folgende Arten Erstnachweise für die Paläarktis in China, *Bradleycypris vittata* (Sars, 1903), *Ilyocypris angulata* Sars, 1903, *Limnocythere stationis* Vávra, 1891 und *Physocypris kraepelini* G.W. Müller, 1903. Weitere Arten, die bereits für China bekannt sind, werden in der vorliegenden Arbeit aufgeführt *Cypridopsis vidua* (O.F. Müller, 1776), *Heterocypris incongruens* (Ramdohr, 1808) und *Limnocythere inopinata* (Baird, 1843). Von den oben genannten Arten werden *B. vittata*, *I. angulata* und *I. mongolica* neuerlich beschrieben. Die vorliegende Studie erweitert die Erkenntnis über die Taxonomie und geographische Verteilung der genannten Ostrakoden-Arten.

Schlüsselworte. — Süßwasserostracoden, Taxonomie, Neubeschreibung, Zoogeographie, China

INTRODUCTION

There are few taxonomic data on the Recent non-marine ostracods of China. More than 90 years after the pioneering work of Sars (1903), only 47 living species were recorded from China (Yin & Martens, 1997). A total of 154 species were included in the checklist of Yu et al. (2009), of which only 94 were considered to be “living” (Martens & Savatnallinton, 2011). Recent works, such as Wroczynska et al. (2009), Mischke et al. (2010), and Yu et al. (2010), recorded more species (mostly as subfossil material) that are new for China. In general, however, the living ostracod fauna of China still remains poorly known (Horne et al., 2011). Due to the lack of knowledge on the Recent species, many ostracodologists in this country have to rely on taxonomic guides to fossil species (Hou & Gou, 2002; Hou et al., 2007) for identification. Meanwhile, most Chinese ostracodologists describe species based on shell morphology, and little attention has been paid to the soft parts (Chen, 1990; Neale & Zhao, 1991; Yin & Martens, 1997; Yu et al., 2009, 2010). Species identification based on carapace alone can potentially be problematic (especially for Candonidae, *Ilyocypris* and *Heterocypris*), and can lead to wrong biodiversity estimations, because many closely related species may not be detected using this method alone.

Because of a potentially high biodiversity in China, there is a need for a systematic study of ostracods based on careful examinations of both carapace and soft parts. In the present study, several living ostracod species from Beijing and Inner Mongolia in northern China are recorded, with their diagnostic morphology and geographical distribution described. It is only a small account of the ostracods of China, but may be a useful reference for future studies in this country.

MATERIAL AND METHODS

The investigated water-bodies can be divided into two parts: those in the City of Beijing and those in the eastern Inner Mongolia Province (fig. 1). The sites in

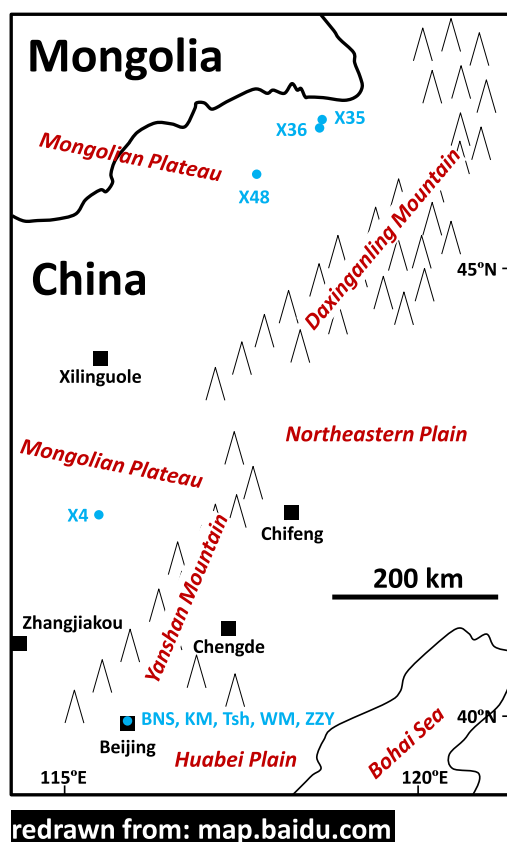


Fig. 1. Map of the study area (redrawn from: map.baidu.com), showing the main geomorphological settings, locations of the sampling sites (solid blue circles) and the major cities (solid black squares). Also see table I. This figure is published in colour in the online edition of this journal, which can be accessed via <http://booksandjournals.brillonline.com/content/journals/15685403>.

Beijing City are artificial lakes, and are coded with abbreviations of the locality names. The sites in Inner Mongolian grassland consist of small ponds and small lakes near the paved road, and are coded by the character 'X' followed by a number, e.g., X35. Table I gives a summary of the coordinates and brief descriptions of the sites.

Some samples were collected by sucking the surface sediment and the bottom water with a pipette. A few were collected with a bottle or a spoon moving above the substrate. At the sites X35, X36 and X48 the ostracods were very abundant and were captured directly with a pipette.

For the samples from Beijing, animals were picked alive under an XTD-3 stereomicroscope, killed with 15% ethanol and stored in 70% ethanol. Some recently dead specimens were also picked. The samples from Inner Mongolia were

TABLE I

Information on the habitat types, geographical coordinates, sampling time and species records of the study sites

Site	Habitat description	Time of sampling	Ostracods (adult records)
BNS	Pond, 39.988°N 116.389°E	10/2012	Bvi, Cvi, Phk
KM	Lake, 39.992°N 116.262°E	07/2011	Cvi, Phk
KM	Lake, 39.988°N 116.266°E	09/2011	Lst, Phk
Tsh	Artificial lake, 40.001°N 116.313°E	09/2011	Cqu, Fmy, Ian, Phk
Tsh	Artificial lake, 40.000°N 116.314°E	03/2012	Fmy, Ian, Phk
Tsh	Artificial lake, 40.000°N 116.314°E	11/2012	Cqu, Fmy, Ian, Lin
Tsh	Artificial lake, 40.000°N 116.314°E	12/2012	Bvi, Cqu, Fmy, Ian, Phk
WM	Artificial lake, 39.993°N 116.302°E	07/2011	Phk
WM	Artificial lake, 39.992°N 116.304°E	09/2011	Phk
ZZY	Artificial lake, 39.940°N 116.310°E	05/2011	Phk
X4	Dead arm of a river, 42.236°N 115.625°E	07/2012	Hau, Imo, Lin, Pln
X35	Small puddle, 45.516°N 118.626°E	07/2012	Hin
X36	Small puddle, 46.514°N 118.608°E	07/2012	Imo
X48	Small pond, 46.008°N 117.756°E	07/2012	Hin

Abbreviations: Bvi, *Bradleycypris vittata* (Sars); Cqu, *Candona quasiakaina* Karanovic & Lee; Cvi, *Cypridopsis vidua* (O. F. Müller); Fmy, *Fabaeformiscandona myllaina* Smith & Kamiya; Hau, *Heterocypris auricularis* sp. nov.; Hin, *Heterocypris incongruens* (Ramdohr); Ian, *Ilyocypris angulata* Sars; Imo, *Ilyocypris mongolica* Martens; Lin, *Limnocythere inopinata* (Baird); Lst, *Limnocythere stationis* Vávra; Phk, *Physocypris kraepelini* G. W. Müller; Pln, *Plesiocypridopsis newtoni* (Brady & Robertson).

transferred to 70% ethanol within 5 days after sampling and the animals were picked dead.

Some animals were dissected in Hydro-Matrix (Micro-Tech-Lab, Graz, Austria). Others were dehydrated in ethanol before being dissected in a solution containing 60% fresh pine resin and 40% ethanol. Soft parts were sealed and examined with a BK3300 light microscope. Valves were stored dry in micropalaeontology slides and examined with an XTD-3 stereomicroscope or an LEO 1450VP scanning electron microscope. Line drawings were produced with the aid of microscopic photos. All specimens are housed in the Institute of Geology and Geophysics, Chinese Academy of Sciences.

Abbreviations.— LV, left valve; RV, right valve; lat., lateral view; int., internal view; ext., external view; dor., dorsal view; ven., ventral view; fron., frontal view; A1, antennule; A2, antenna; Md, mandible; Mx, maxillula; L5, fifth limb; L6, sixth limb; L7, seventh limb; Ur, uropod; Hp, hemipenis; ZO, Zenker organ. Terminology of the appendage chaetotaxy follows Martens (1987), Meisch (2000) and Karanovic (2012).

RESULTS

During this survey, a total of 12 species were found, which are listed below, with a description of each species' morphological features and known geographical distribution. All the referred specimens were adults unless otherwise noted.

Superfamily CYPRIDOIDEA Baird, 1845

Family CANDONIDAE Kaufmann, 1900

Subfamily CANDONINAE Kaufmann, 1900

Genus *Candona* Baird, 1845

***Candona quasiakaina* Karanovic & Lee, 2012**

2012 *Candona quasiakaina* n. sp. Karanovic & Lee: 3368; figs. 1-4

Material examined.— Two dissected males (dyzoc368, dyzoc393) and one dissected female (dyzoc394) from a small lake (Tsh, fig. 1, table I) in Tsinghua University. Two dissected females (dyzoc195, dyzoc236) from the same site with the soft parts deteriorated to different extents.

Dimensions.— Male (LV, $n = 2$) length 1440-1520 μm , H/L ratio 0.53-0.54. Female (LV, $n = 3$) length 1420-1480 μm , H/L ratio 0.49-0.51.

Brief description.— Carapace large for the genus. Sub-triangular in lat. Dorsal margin strongly arched with the highest point situated behind mid-length. Male dorsum more strongly arched than female, hump-like (fig. 2). Lobe a (i.e., outer lobe) of Hp with a spine-like extremity. Male L5 palps not equal, with right palp larger and slightly inflated at the middle. Both male L5 palps with a small lobe-like expansion at the ventro-subapical part of the finger (fig. 3). Female genital lobe with large, inflated basal part and narrow, rounded posterior end. Sp seta of Ur extending significantly beyond base of claws.

Comparisons with *C. quasiakaina* from South Korea (Karanovic & Lee, 2012).— Some morphological differences are found between the Chinese specimens and the South Korean specimens. For example, the male t2 of A2 of the Chinese specimens has a sharp and pointed end, while that of the South Korean specimens has a rounded end. The shortest seta on 1st A2 protopodal segment and the α seta of Md palp are longer and thinner in the Chinese specimens than those in the South Korean specimens. Despite the observed differences, the two populations resemble each other in the morphology of male and female reproductive organs and male prehensile palps, and most of the details of chaetotaxy. They are here considered to be conspecific.

Comparisons with other Candoninae species.— Within the subfamily, some other species also have a spine-like extremity on the outer lobe a of Hp. Nonetheless, they can be distinguished from *C. quasiakaina*. (1) Shell of *Fabaeformiscandona akaina* Smith & Janz, 2008 has a very narrow, nearly pointed posterior end in lat. (Smith & Janz, 2008). Sp of Ur extends only slightly beyond base of claws.



Fig. 2. *Candona quasiakaina* Karanovic & Lee, 2012, male and female. A, male LV, ext. (dyzoc368); B, male RV, int. (dyzoc368); C, female LV, ext. (dyzoc195); D, female LV, ext. (dyzoc236). Scale bar = 500 μm .

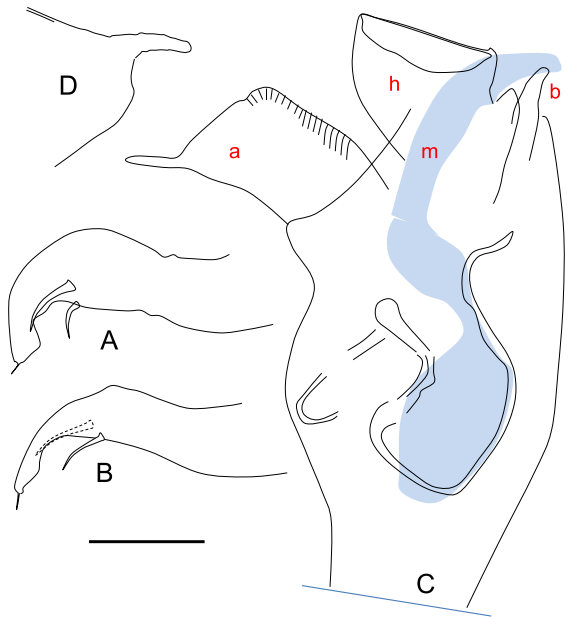


Fig. 3. *Candona quasiakaina* Karanovic & Lee, 2012, male and female. A, male right L5 palp (dyzoc368); B, male left palp (dyzoc368); C, male Hp (dyzoc368); D, posterior part of female genital lobe (dyzoc394). Scale bar = 100 μm . This figure is published in colour in the online edition of this journal, which can be accessed via <http://booksandjournals.brillonline.com/content/journals/15685403>.

Female genital lobe becomes gradually narrower posteriorly, rather than contracting suddenly at the middle part as in *C. quasiakaina*. (2) Male right L5 palp of *F. danielopoli* Yin & Martens, 1997 has a sinuated dorsal margin, and the Hp has a smaller lobe a with a stronger spine-like projection (Yin & Martens, 1997). (3) Hp of *F. hyalina* (Brady & Robertson, 1870) has a much narrower lobe a, and the basal part of Ur ramus is less swollen (Martens & Dumont, 1984). (4) Lobe a of Hp of *F. nishinoae* Smith & Janz, 2008 has a progressively narrower distal half (Smith & Janz, 2008), compared with the quadrate one in *C. quasiakaina*. Apical setae on the trunk of the prehensile palp are much shorter in *F. nishinoae*.

Distribution.— This species was originally described from a freshwater stream in South Korea (Karanovic & Lee, 2012) and this is the first record outside of the type locality.

Remarks.— (1) *Candona quasiakaina* has a smooth γ seta on Md palp, and should be placed in the genus *Fabaeformiscandona* according to the criterion of Meisch (2000). However, Karanovic & Lee (2012) assigned their specimens to genus *Candona* by arguing that the genus *Fabaeformiscandona* should be much narrower (Karanovic, 2006) and that some of the species included in this genus at the present should be given new generic positions. The allocation of this species to *Candona* is adopted here. (2) In fig. 3A of Karanovic & Lee (2012) a walking leg with 5-segmented endopod was drawn for *C. quasiakaina*. According to the description in the text and personal communication to one of those authors (Ivana Karanovic), this leg of the holotype specimen is an anomaly, and that the normal L6 endopod is 4-segment. (3) The lobe h (both sides of the Hp) of specimen dyzoc368 seems to be folded and shows a different shape. They are expected to be rounded in normal condition. This folding may indicate a gap of the internal structure in lobe h, and thus was retained in fig. 3.

Genus *Fabaeformiscandona* Krstić, 1972

***Fabaeformiscandona myllaina* Smith & Kamiya, 2007**

2004 *Fabaeformiscandona* cf. *subvomerina* — Okubo: 19; fig. 5

2007 *Fabaeformiscandona myllaina* n. sp. Smith & Kamiya: 228; figs. 1, 2, 4, 6-8

Material examined.— Two dissected males (dyzoc203, dyzoc375) and two dissected females (dyzoc205, dyzoc223) from the site Tsh (fig. 1, table I).

Dimensions.— Male (LV, $n = 2$) length 1310-1420 μm , H/L ratio 0.51. Female (LV, $n = 2$) length 1260 μm , H/L ratio 0.48-0.49.

Brief description.— Carapace sub-reniform and elongated in lat., greatest height situated well behind mid-length. LV slightly overlapping RV posteriorly. Female carapace with truncated posterior end. Male with inflated, rounded posterior end and a more concave ventral margin (fig. 4). Male L5 palps unequal, with right palp

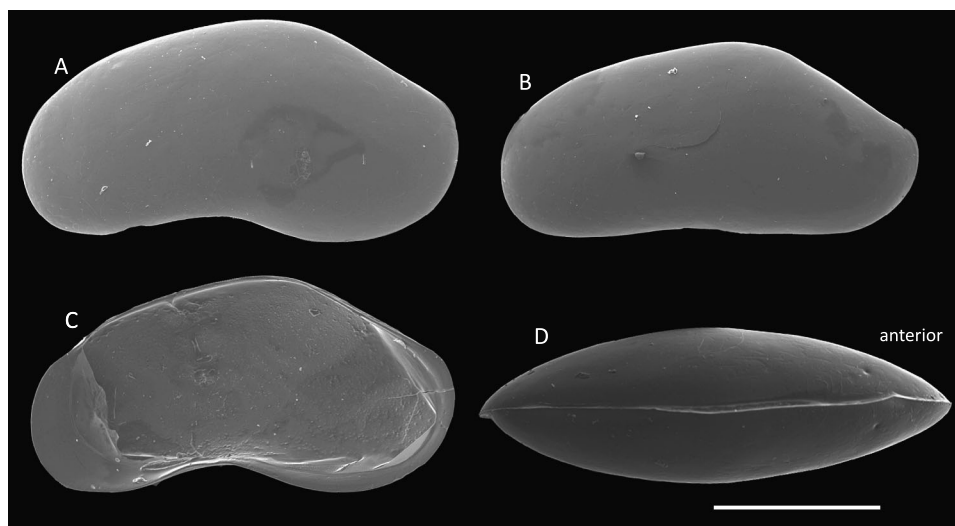


Fig. 4. *Fabaeformiscandona myllaina* Smith & Kamiya, 2007, male and female. A, male LV, ext. (dyzoc203); B, female LV, ext. (dyzoc205); C, male RV, int. (dyzoc203); D, male carapace, dor. (dyzoc375). Scale bar = 500 μ m.

significantly inflated. Hp with S-shaped lobe a (i.e., outer lobe) directed nearly vertically away, m process (an elongated, sclerotized structure surrounding the bursa copulatrix) slightly inflated at sub-distal part. Female with large genital lobes (fig. 5).

Comparisons with the Japanese specimens.— In chaetotaxy, the Chinese specimens are identical to those described by Smith & Kamiya (2007), except that the dorso-apical seta on the 3rd segment of A1 is not smooth but setulose. This minor difference is here considered as within-species variation.

Distribution.— This species has been reported from irrigation ponds and lotus fields of Japan (as *Fabaeformiscandona* cf. *subvomerina* Liu & Lu, 1999) (Okubo, 2004). It was formally named by Smith & Kamiya (2007) who collected the specimens from an artificial pond in Japan. The species was also found in Lake Biwa (Smith & Janz, 2008). This is its first report from China.

Subfamily CYCLOCYPRIDINAE Kaufmann, 1900

Genus *Physocypria* Vávra, 1897

***Physocypria kraepelini* G. W. Müller, 1903**

1903 *Physocypria kraepelini* n. sp. G. W. Müller: 165; figs. 1-7

1927 *Cypria* (*Physocypria*) *fadeewi* — Dubowsky: 84; figs. 10-18

1934 *Physocypria kliei* — Schäfer: 559; figs. 1-6

1941 *Cypria inversa* — Klie: 236; figs. 1-9

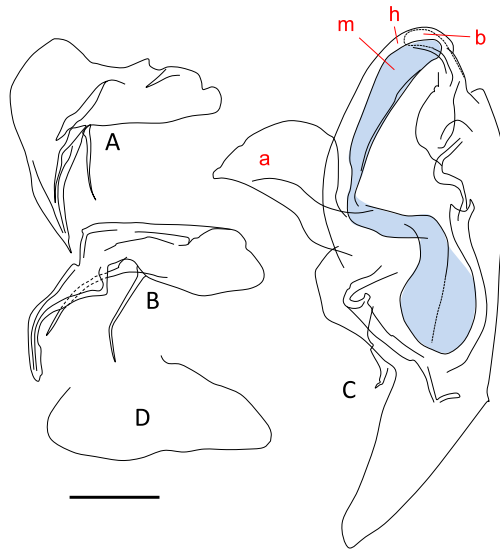


Fig. 5. *Fabaeformiscandona myllaina* Smith & Kamiya, 2007, male and female. A, male right L5 palp (dyczoc203); B, male left L5 palp (dyczoc203); C, male Hp (dyczoc203); D, female genital lobe (dyczoc205). Scale bar = 100 μ m. This figure is published in colour in the online edition of this journal, which can be accessed via <http://booksandjournals.brillonline.com/content/journals/15685403>.

1943 *Physocypria perlata* — Rome: 1; fig. 1

Material examined.— Six dissected males (dyczoc2, dyczoc229, dyczoc237, dyczoc242, dyczoc243, dyczoc248) and nine dissected females (dyczoc1, dyczoc96, dyczoc97, dyczoc99, dyczoc204, dyczoc211-213, dyczoc359) from several sites in Beijing (table I).

Dimensions.— Male (LV, $n = 5$) length 540-560 μ m, H/L ratio 0.67-0.75. Female (LV) length 585-660 μ m ($n = 7$), H/L ratio 0.67-0.72 ($n = 4$).

Brief description.— Carapace very stout in lat. with a more or less arched dorsal margin (fig. 6). RV overlaps LV with a dorsal hump in fron. RV with small pustules on both the antero- and postero-ventral margins. These pustules are sometimes hard to observe. Colour brownish when alive, becoming whitish several days after death. A1 with very long swimming setae, some of which feathery. A2 with long swimming setae extending beyond the terminal claws with ca. 2/3 of their length. L6 without d1 and d2 setae, and with very long e seta reaching beyond the terminal segment. L7 with long h3 seta and short, sub-equally long h1 and h2. Ur with Gp shorter than Ga. Male L5 palps asymmetric with right palp stronger (fig. 7). Hp with slender, distally pointed lobes a (i.e., outer lobe) and b (i.e., inner lobe); b shorter than a, more or less curved.

Distribution.— This species is common in Europe (Meisch, 2000). *Physocypria nipponica* Okubo, 1990 reported from Japan may be conspecific with *P. kraepelini* (Smith & Janz, 2008). In China, *P. kraepelini* has been reported from Taihu Lake

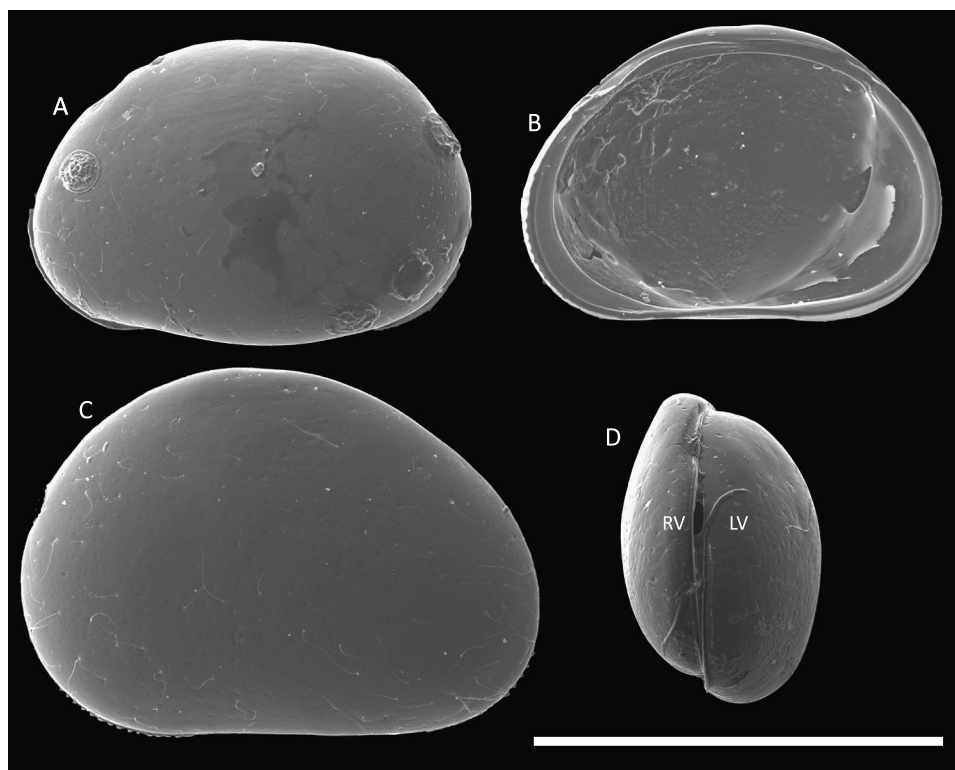


Fig. 6. *Physocypris kraepelini* G. W. Müller, 1903, male and female. A, male LV, ext. (dyczoc243); B, male RV, int. (dyczoc243); C, female RV, ext. (dyczoc359); D, male carapace, fron. (dyczoc248). Scale bar = 500 μ m.

in Jiangsu Province (Yu et al., 2005), Dianchi Lake in Yunnan Province (Yu et al., 2010) and from Taiwan Island (Hsiao & Young, 2001). In Beijing City, *P. kraepelini* was found in all of the 5 sites investigated, and seemed to be present at least throughout the ice-free months (March to December; table I), being the most common ostracod in these habitats.

Family ILYOCYPRIDIDAE Kaufmann, 1900
Subfamily ILYOCYPRIDINAE Kaufmann, 1900
Genus *Ilyocypris* Brady & Norman, 1889
***Ilyocypris angulata* Sars, 1903**

1903 *Ilyocypris angulata* n. sp. Sars: 22; pl. IV, fig. 8

1981a *Ilyocypris dentifera* form *angulata* — Victor & Fernando: 1106; figs. 23-38

Material examined.— Five dissected males (dyczoc383, dyczoc389, dyczoc401-403) and six dissected females (dyczoc214, dyczoc241, dyczoc373, dyczoc385, dyczoc390, dyczoc392) from a small lake in Tsinghua University of Beijing (Tsh, fig. 1, table I). Soft parts of dyczoc241, dyczoc373, dyczoc392

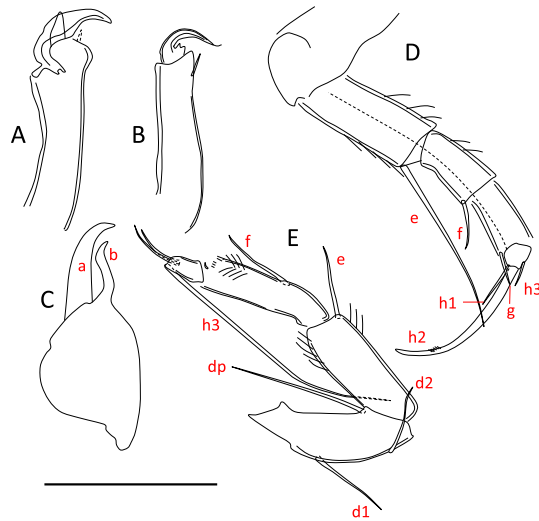


Fig. 7. *Physocypria kraepelini* G. W. Müller, 1903, male. A, right L5 palp (dyczoc243); B, left L5 palp (dyczoc243); C, Hp (dyczoc2); D, L6 (dyczoc243); E, L7 (dyczoc242). Scale bar = 100 μ m. This figure is published in colour in the online edition of this journal, which can be accessed via <http://booksandjournals.brillonline.com/content/journals/15685403>.

and dyczoc401-403 are deteriorated to different extents, yet readily identifiable. Carapaces of dyczoc392, dyczoc401 and dyczoc402 are deteriorated to some extent.

Dimensions.— Male (LV, $n = 5$) length 850-900 μ m, H/L ratio 0.51-0.54. Female (LV, $n = 5$) length 860-1020 μ m, H/L ratio 0.51-0.54.

Re-description.— Carapace (fig. 8) sub-reniform in lat. Dorsal margin straight, greatest height situated at ca. first 1/5. Anterior and posterior margins broadly rounded. Ventral margin concave. Shell surface strongly pitted, with four prominent nodes, the one near the postero-dorsum usually being the largest and usually pointing posteriorly. Anterior margin of the valve with ca. 12 short spines. Posterior margin of valve with ca. 8 longer spines. Spines also developed on surface of valve. Number, position and size of the spines relatively constant. Anterior part of carapace moderately compressed in dor. Nodes and spines protruding beyond valve outline. In int., under the SEM, medial part of postero-ventral margin of LV with 2-4 conspicuous ripples and numerous small striations. Color of carapace pearly white when alive, dirty white some time after death.

A1 (fig. 9) with 8 segments. First two segments with short spinules on the internal side. Second segment with 1 dorsal seta and 2 long ventral setae. Third segment quadrate or slightly elongated, with 1 short dorso-apical seta. Fourth segment with 1 short dorso-apical seta and 1 short ventro-apical seta. Fifth segment with 2 long dorso-apical setae and 2 unequal ventro-apical setae. Sixth segment with 2 long dorso-apical setae and 2 intermediately long ventro-apical setae, one

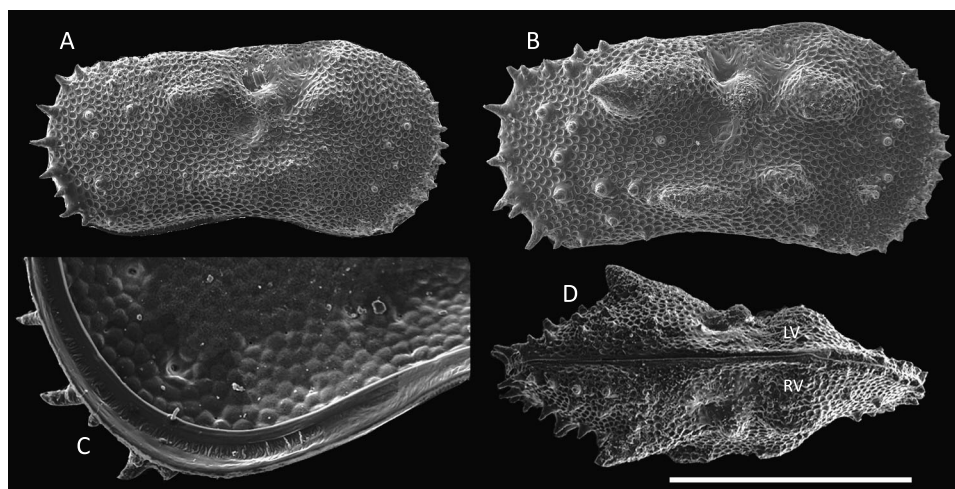


Fig. 8. *Ilyocypris angulata* Sars, 1903, male and female. A, male RV, ext. (dyczoc383); B, female RV, ext. (dyczoc385); C, male LV, showing ripples on the postero-ventral margin (dyczoc383); D, female carapace, oblique-dor. (dyczoc214). Scale bar = 100 μ m for A, B and D, 200 μ m for C.

of which claw-like. Seventh segment with 4 long apical setae besides the α seta. α seta extending somewhat beyond the terminal segment. Eighth segment with 4 apical setae. Ventral-most seta claw-like, conspicuously longer than y_a .

A2 (fig. 9) with 5 segments, penultimate segment undivided in both sexes. One of the ventral setae of first segment strongly plumose. Second, third and penultimate segments with well developed pseudochaetae and spinules most of which situated on the internal side of the limb. Arrangements of spinules on iv-b segment very characteristic. Swimming setae sub-equal, extending beyond the longest claw with ca. 25% of their length. Sixth seta only extending to middle of claws. t1 strong, reaching beyond the terminal segment. t2-t4 progressively shorter. Female with strong G1, G2, G3 and GM claws and untransformed z setae. Male with strong G1, G2 and GM claws, and claw-like z1. y_3 ca. 1/3 the length of Gm. All claws smooth.

Md palp (fig. 9) with few specific features. Unnamed seta of first segment of palp clearly branchial at the distal part. S1 and S2 plumose. α seta short and thin. Grouped setae on second segment sparsely plumose, extending beyond the terminal claws. The fourth seta much shorter, smooth. β seta short, slender, strongly plumose. Third segment with a total of 4 sub-apical and 4 apical setae one of which plumose. Fourth segment with 1 medio-lateral seta and 4 terminal claws/setae.

Mx (not shown) typical of the genus, with few specific features.

Male L5 palps (fig. 10) sub-equal in shape, but slightly different in chaetotaxy. Trunks of both sides with unequal apical setae. Finger of right side with one

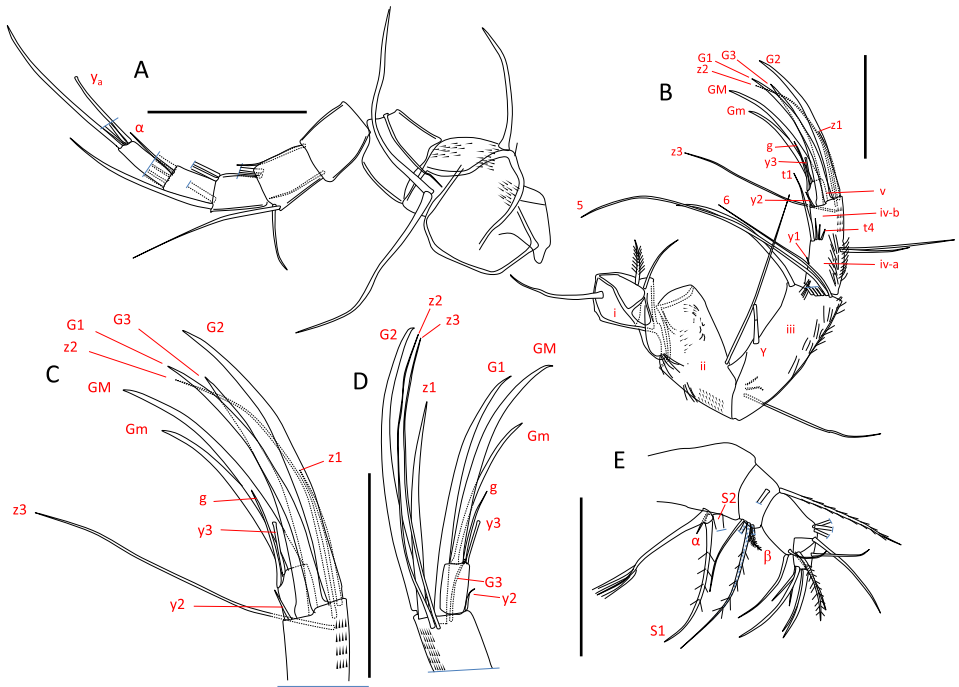


Fig. 9. *Ilyocypris angulata* Sars, 1903, male and female. A, male A1 (dyzoc383); B, female A2 (dyzoc385); C, distal part of female A2 (dyzoc385); D, distal part of male A2 (dyzoc383); E, palp of male Md (dyzoc389). Scale bars = 100 μm . This figure is published in colour in the online edition of this journal, which can be accessed via <http://booksandjournals.brillonline.com/content/journals/15685403>.

prominent apical seta and two very thin setae. Finger of left side with one very long apical seta and one short sub-apical seta. Female L5 palp 2-segmented (not shown).

L6 (fig. 10) penultimate segment undivided. h1 conspicuously longer than h3. h2 extraordinarily long, sub-equal to total length of the endopodal segments, slightly serrated at the middle part. First endopodal segment with well-developed, long pseudochaetae.

L7 (fig. 10) penultimate segment with two long setae (f and g). Distal end of penultimate segment without any spinules or pseudochaetae. h2 slightly longer than h3. h1 much shorter but stronger. All setae smooth. Posterior margin of first endopodal segment with several groups of stiff pseudochaetae.

Ur (fig. 10) with arched ramus. Ga and Gp sub-equal, bare. Sp reaching about base of claws in male, extending slightly beyond ramus in female. Sa short. Distal half of ramus with long pseudochaetae.

Hp (fig. 10) with short lobe a. Lobe b reaching slightly beyond mid-way of lobe h, with curved and pointed distal end. Lobe h with strong neck and inflated distal

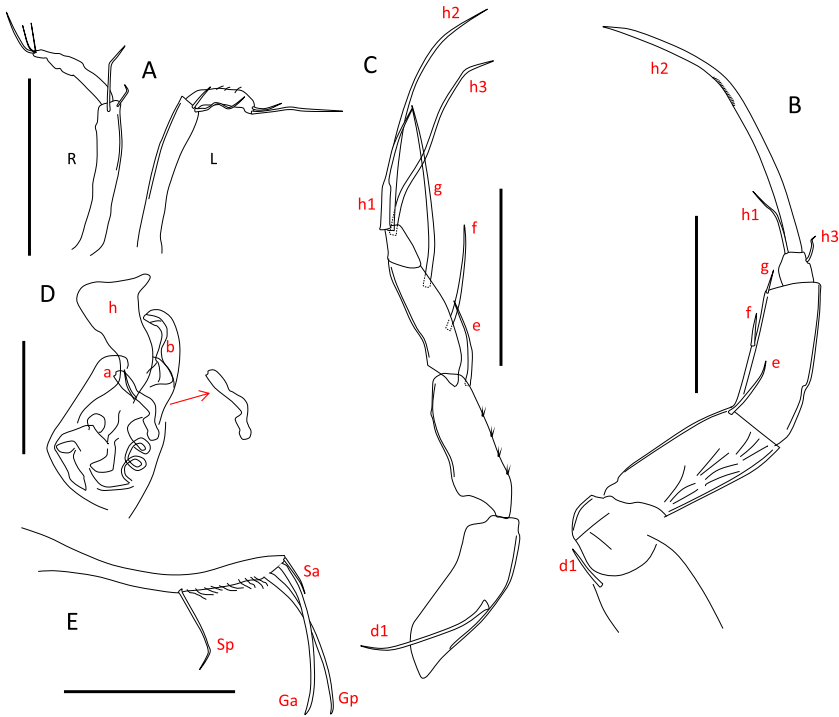


Fig. 10. *Ilyocypris angulata* Sars, 1903, male. A, L5 palps (dyzoc389); B, L6 (dyzoc389); C, L7 (dyzoc389); D, Hp (dyzoc389); E, Ur (dyzoc383). Scale bars = 100 μ m. This figure is published in colour in the online edition of this journal, which can be accessed via <http://booksandjournals.brillonline.com/content/journals/15685403>.

end. Internal end of lobe h pointed. A fourth bar-like structure positioned across the Hp with a small mouth-like opening at the distal extremity.

ZO (fig. 11) with ca. 22-23 rows of spines. Distal end slightly inflated.

Comparisons with the type specimens.— Victor & Fernando (1981a) figured female *I. angulata* (as *I. identifera* form *angulata*) from the type series. Karanovic & Lee (2013) found males from the type material and presented SEM images of

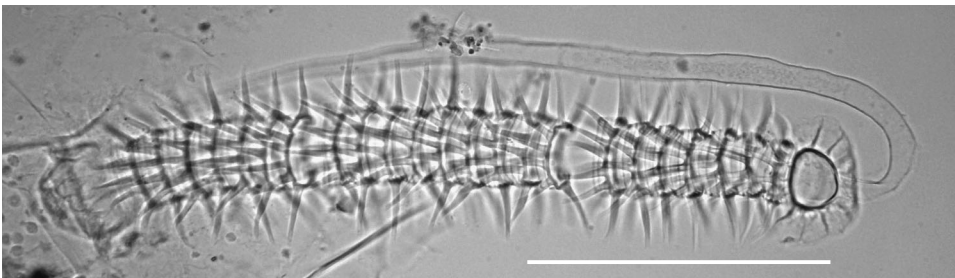


Fig. 11. *Ilyocypris angulata* Sars, 1903, male ZO (dyzoc383). Scale bar = 100 μ m.

valves of both sexes, as well as line drawings of some of the limbs of female and Hp of male. It is unfortunate that much of the chaetotaxy of the A1, A2, and male L5 palps, and the morphology of male ZO of the type specimens have not been described, which prevents a complete comparison here. Nonetheless, some differences can be found between the Beijing specimens and the types. Females measured by Victor & Fernando (1981a) have a mean H/L ratio of 0.58 ($n = 20$; probably measured on whole carapaces). The LV of female paralectotype examined by Karanovic & Lee (2013) has a H/L ratio of 0.56 (measured from fig. 11A of that paper). The females of *I. angulata* from Beijing (this paper) have a mean H/L ratio of 0.53 ($n = 5$), being more elongated than the type specimens. The males from Beijing have a mean H/L ratio of 0.52 ($n = 5$), which is slightly more elongated than the females. The only male carapace illustrated by Karanovic & Lee (2013) (fig. 11I therein) was probably decalcified and deformed (Ivana Karanovic, personal communication) and thus the H/L ratio of the male type specimens is not available at the present. Female L6 terminal claw of the type specimen (fig. 35 of Victor & Fernando (1981a)) is significantly shorter than those of both sexes of the Beijing specimens (fig. 10). Besides, both sexes of the Beijing specimens lack the small apical spinule on the L7 penultimate segment, which was illustrated for the female in fig. 36 of Victor & Fernando (1981a).

Distribution.— *Ilyocypris angulata* was originally described from Fujian Province of southern China (Sars, 1903), and was also found in the nearby Hunan (Chen, 1990) and Jiangsu (Yu et al., 2005) Provinces. This is the first report in the Palaearctic part of the country (i.e., north of Qinling Mountain). Okubo (1974) reported both sexes of *I. angulata* from Japan. However, Karanovic & Lee (2013) pointed out that the Hp of the so-called *I. angulata* by Okubo (1974) is different from that of the males in the type series, and suggested that the Japanese specimens belong to a different species.

***Ilyocypris mongolica* Martens, 1991**

1991 *Ilyocypris mongolica* n. sp. Martens: 55; fig. 1

Material examined.— Three dissected males (dyczoc319-321) and two dissected females (dyczoc322, dyczoc323) from a puddle (X36, fig. 1, table I) in Inner Mongolia. Two dissected females (dyczoc341, dyczoc342) from a small lake formed by a dead arm of a river (X4, fig. 1, table I) in Inner Mongolia.

Dimensions.— Male length (LV, $n = 3$) 800-815 μm , H/L ratio 0.52-0.53. Female length (LV, $n = 4$) 760-890 μm , H/L ratio 0.52-0.54.

Diagnosis (modified after Martens (1991)).— A medium-sized *Ilyocypris* (fig. 12). Lacking nodes (at least for specimens in this study and those found in Martens (1991)). Shell surface covered with well-developed, rounded pits. Very small, short spines present along the posterior margin (sometimes absent). In int., under the SEM, LV with no obvious marginal ripplelets (fig. 12). A2 natatory se-

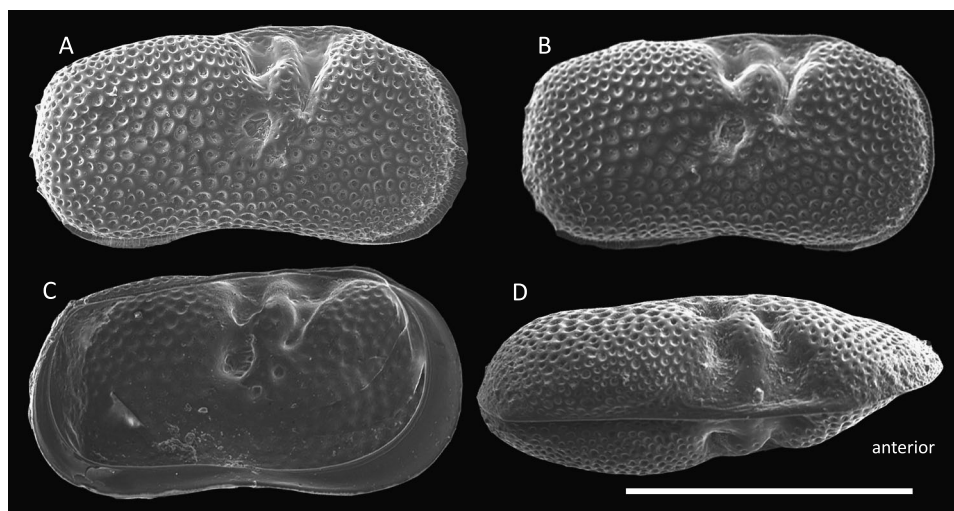


Fig. 12. *Ilyocypris mongolica* Martens, 1991, male and female. A, male RV, ext. (dyczoc320); B, female RV, ext. (dyczoc322); C, female LV, int. (dyczoc322); D, male carapace, oblique-dor. (dyczoc319). Scale bar = 500 μ m.

tae extending beyond terminal claws with ca. 50% of their lengths (fig. 13). Male L5 palps sub-equal, slender, with sub-apical part of the fingers slightly inflated (fig. 14). L6 penultimate segment divided. L7 penultimate segment with two setae (f and g). This segment apically bearing 3-6 hook-like structures. Hp with short, broad lobe a, slender lobe b, triangular lobe h (i.e., medial lobe) and one slender, pointed stylus.

Re-description.— Carapace sub-reniform in lat. (fig. 12). Dorsal margin straight, sloping posteriorly. Highest point situated at first 1/6 of valve. Anterior margin broadly rounded. Posterior margin nearly straight. Ventral margin concave. Anterior and postero-ventral margins surrounded by narrow compressed zones. Two transverse sulci starting from the anterior part of dorsal margin, directed slightly posteriorly, terminated at middle of the shell. A sub-ovate depression situated below the posterior sulcus. Carapace sub-elliptical in dor., both ends bluntly pointed. Shell surface densely covered with well-developed, rounded pits. In int., under the SEM, LV with no obvious ripplelets, sometimes with dense, fine striations in the medial area of the valve margin.

A1 (fig. 13) with eight segments, first two of which fused forming a large base, supporting one dorsal seta and two long ventral setae. Third segment quadrate with one dorso-apical seta extending beyond the next segment. Fourth segment elongated with one dorso-apical seta and one shorter ventro-apical seta. Fifth segment quadrate with two long dorso-apical setae and two unequally long ventro-apical setae. Sixth segment quadrate with two dorso-apical setae and two ventro-apical setae, one of which intermediately long, the other one shorter and claw-like.

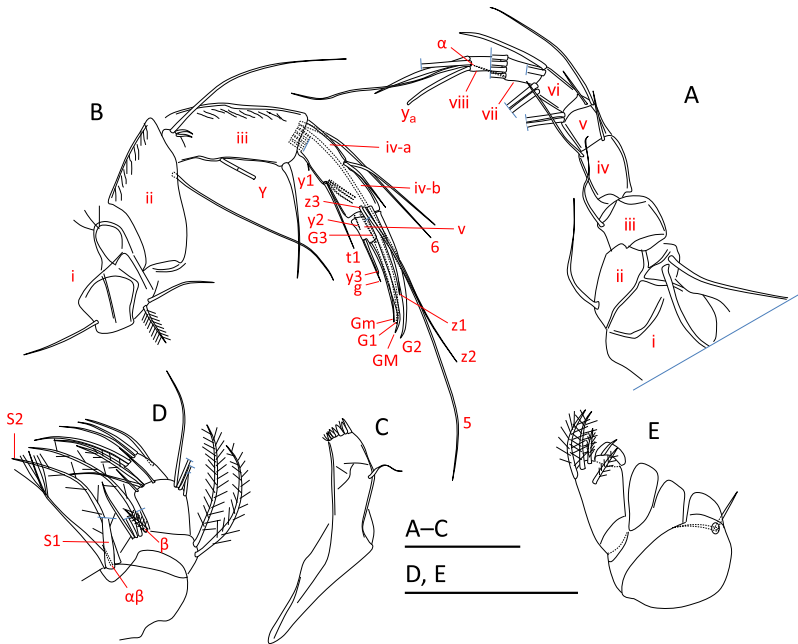


Fig. 13. *Ilyocypris mongolica* Martens, 1991, male (dyzoc320). A, A1; B, A2; C, coxa of Md; D, palp of Md; E, Mx endites and palp. Scale bars = 100 μ m. This figure is published in colour in the online edition of this journal, which can be accessed via <http://booksandjournals.brillonline.com/content/journals/15685403>.

Seventh segment elongated with five apical setae, the shortest one (α seta) situated at the external side of the segment. Eighth segment elongated with four apical setae, the aesthetasc y_a situated at the dorsal corner, a claw-like seta at the ventral corner, and two unequally long ones situated between the above two.

A2 (fig. 13) penultimate segment undivided in both sexes, producing a total of five segments. Swimming setae reaching beyond the terminal claws with ca. 50% of their length, while the sixth seta only to the middle part of the claws. Seta t1 extending somewhat beyond the terminal segment. Setae t2 to t4 sub-equal, ca. 3/5 the length of the iv-b segment. Seta z1 of male claw-like, slightly shorter than the G-claws. Setae z2 and z3 not transformed, extending beyond the claws. Female z-setae untransformed. Male G3 very small, seta-like. Female G3 claw untransformed. Terminal segment with the GM claw slightly shorter than Gm. The aesthetasc y_3 ca. half the length of Gm, slightly shorter than g seta.

Md (fig. 13) coxa with short teeth, typical of the genus. Palp 4-segmented. Unnamed seta on the first segment with a swollen, rounded base and strongly setulose (or branchial) distal part. S1 and S2 sub-equally long, both sparsely plumose, basally not swollen. α seta smooth, ca. 1/5 the length of accompanying setae. Second segment with 3 + 1 + β setae. The grouped setae reaching beyond

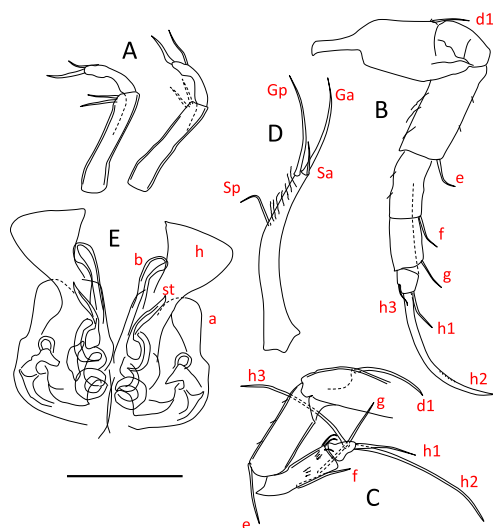


Fig. 14. *Ilyocypris mongolica* Martens, 1991, male (dyczoc320). A, L5 palps; B, L6; C, L7; D, Ur; E, penis. Scale bar = 100 μ m. This figure is published in colour in the online edition of this journal, which can be accessed via <http://booksandjournals.brillonline.com/content/journals/15685403>.

mid-way of terminal claws, sparsely setulose. The fourth seta much shorter. Seta β short, slender, plumose. One of the apical setae on the external side of third segment plumose. Terminal segment with one medio-dorsal claw and four unequal terminal claws.

Mx (fig. 13) palp 2-segmented, the second segment stout, relatively short. Endite lobes progressively shorter.

Male L5 palps (fig. 14) sub-equal. Basal segment (i.e., trunk) elongated and slender with two apical setae. Terminal segment (i.e., finger) narrower at the middle, carrying one strong apical seta and one thin sub-apical seta.

L6 (fig. 14) penultimate segment divided. d1 short, d2 absent, e, f and g sub-equally long. h1 longer than h3. h2 claw smooth.

L7 (fig. 14) penultimate segment undivided, carrying two long setae (f and g). d1 somewhat claw-like, d2 and dp absent, e and f sub-equally long and shorter than g. h1 shorter than h2 and h3. h2 longer and slightly stronger than h3. Penultimate segment apically with a group of hook-like structures. Number of hook-like structures: 3 in male, 4 to 8 in female. Penultimate segment sometimes with ca. 2 rows of fine pseudochaetae at the sub-apical part.

Note: For a more detailed illustration of the “hook-like structures” see Martens (1991). Martens (1991) observed 2 stout, 1 intermediate and 1 slender structures in the holotype male, and 3 + 1 + 2 structures in the allotype female. In the Chinese specimens, the males usually have 2 stout and 1 slender structures. Some females have 7-8 progressively shorter structures (similar to the pattern observed in female

allotype), but some carry 3 stout and 1 slender structures (similar to male holotype). It seems that these hook-like structures are variable among individuals of both sexes.

Ur (fig. 14) with slender ramus evenly bent posteriorly. Claws Ga and Gp subequally long. Seta Sp longer than Sa and extending to the base of the claws. Distal half of the ramus bearing fine pseudochaetae.

Hp (fig. 14) consisting of 4 distal lobes, namely outer lobe a, inner lobe b, medial lobe h and the stylus. Lobe a wide, distally broadly rounded. Lobe b slender, longer than a, distally swollen. Lobe h being the longest, distally enlarged forming a nearly perfect symmetrical triangle. Stylus slender, reaching terminal of lobe a, distally pointed.

ZO (fig. 15) with ca. 13-14 rows of spines, both ends spherically enlarged but distal end much larger.

Distribution.— This species was originally reported from a saline ditch in the flood area of the Herlen River in eastern Mongolia. Aside from the type locality, it was also reported from a lake in western Mongolia (Van der Meeren et al., 2010). In the present study, a dense bisexual population was found in site X36 of Inner Mongolia, and several females were also found at site X4 (table I).

Remarks.— Wrožyna et al. (2009) reported subfossil valves and a mummified male of *I. cf. mongolica* from Nam Co Lake in southern Tibet, with the identification done mainly based on shell morphology. Carapaces of those specimens are more elongated and the posterior margin of the valve is more arched compared with *I. mongolica*. The compressed zones surrounding the anterior and the postero-ventral margins in *I. mongolica* (fig. 12) are missing in *I. cf. mongolica*. And marginal ripples are clearly seen along the distal part of the postero-ventral margin of LV in *I. cf. mongolica*. Moreover the pits on the shell surface are small

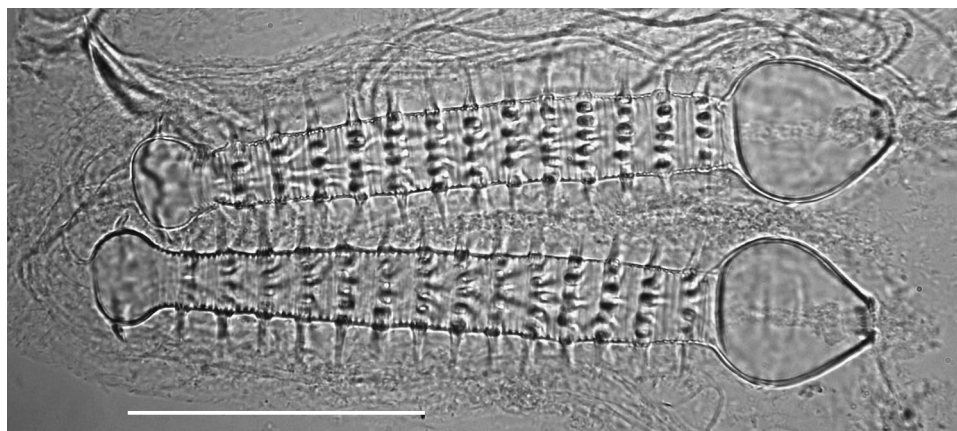


Fig. 15. *Ilyocypris mongolica* Martens, 1991, male ZOs (dyzoc320). Scale bar = 100 μ m.

and shallow in *I. cf. mongolica*. Based on the above observations, it is here suggested that the *I. cf. mongolica* reported by Wrozyńska et al. (2009) was probably not “true” *I. mongolica*, and that detailed examinations on the soft parts of those specimens are needed to confirm their taxonomic status.

Family CYPRIDIDAE Baird, 1845

Subfamily CYPRINOTINAE Bronshtein, 1947

Genus *Heterocypris* Claus, 1892

***Heterocypris incongruens* (Ramdohr, 1808)**

1808 *Cypris incongruens* n. sp. Ramdohr: 86; pl. 3

1892 *Heterocypris incongruens* nov. comb. — Claus: 161

1900 *Heterocypris incongruens* var. *elongata* — Kaufmann: 269; pls. 15, 13

1920 *Cyprinotus hertwigi* — Lindner: 37

1938 *Cyprinotus incongruens* s.sp. *attenuata* — Gauthier: 55; figs. 6, 7

Material examined.— Thirty-five dissected parthenogenetic females (dyczoc252, dyczoc256-262, dyczoc264-266, dyczoc268, dyczoc271-275, dyczoc279-282, dyczoc285-290, dyczoc294-300) from a puddle (X35, fig. 1, table I) in Inner Mongolia. Twenty-four dissected parthenogenetic females (dyczoc278, dyczoc303-318, dyczoc324-330) from a small pond (X48, fig. 1, table I) in Inner Mongolia.

Dimensions.— Length (LV) 1200-1500 μm ($n = 56$), H/L ratio 0.56-0.62 ($n = 11$).

Brief description.— Carapace shape variable, but generally slightly stout in lat. (fig. 16). Anterior and posterior margin sub-equally rounded. RV with tiny pustules on both anterior and posterior margins; presence of pustules variable among individuals (fig. 16), sometimes missing. In dor. anterior end pointed, or (rarely) slightly beak-shaped with LV overlapping RV. A1 swimming setae long. A2 swimming setae extending well beyond terminal claws (fig. 17). G1, G3 and GM sub-equally long, G2 shorter. All these claws serrated. Md palp with slender α and β setae and strong, setulose γ seta. Third endite of Mx with two serrated tooth bristles. L6 without d2 seta. Gp of Ur slightly shorter than Ga. Sp only slightly shorter than Gp.

Comparisons with *H. incongruens* specimens reported elsewhere.— The present specimens are slightly smaller than the average level of the European specimens (usually 1.4-1.6 mm) examined by Meisch (2000), and are also smaller than those from Dianchi Lake in SW China (1.49-1.61 mm) (Yu et al., 2010). Additionally, the tiny spinules on the anterior part of the shell (Meisch, 2000; Yu et al., 2010) are only present in some of the specimens examined by the present authors.

Comparisons with other species.— (1) The posterior margin of *H. rotundata* (Bronshtein, 1928) is distinctly more broadly rounded than the anterior margin (Meisch, 2000). In *H. incongruens*, both margins are sub-equally broad. In fron., carapace of *H. rotundata* is oblique, with the greatest width of LV situated below

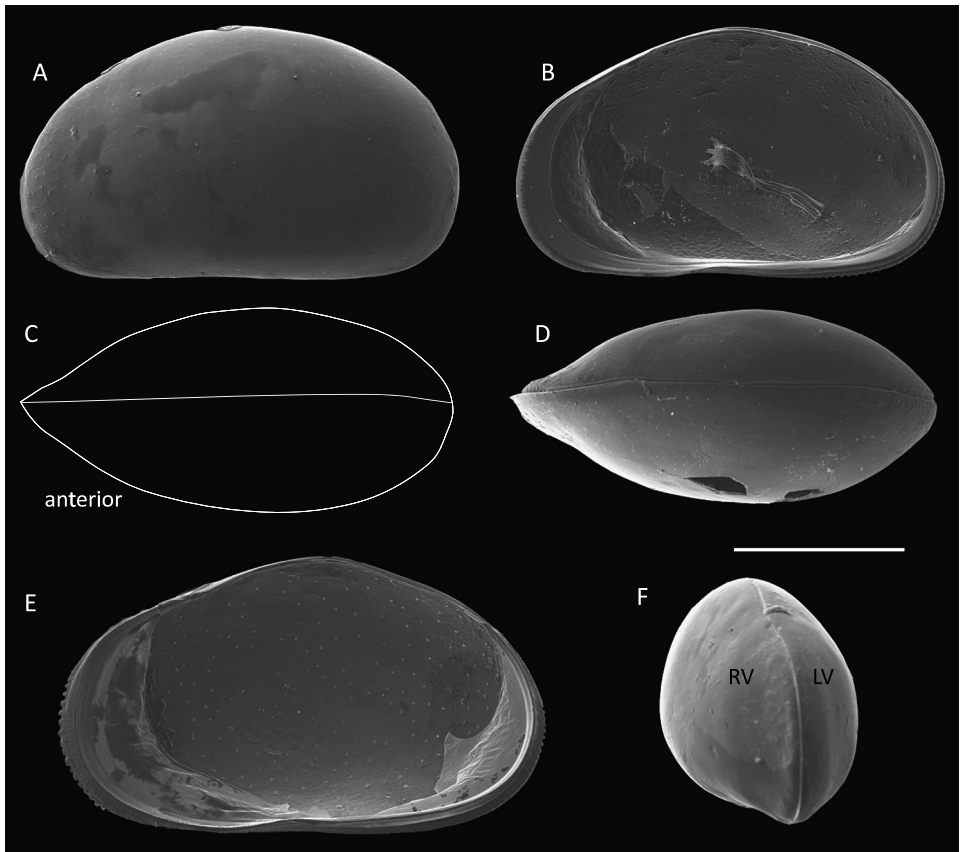


Fig. 16. *Heterocypris incongruens* (Ramdohr, 1808), female. A, LV, ext. (dyczoc252); B, RV, int. (dyczoc252); C, carapace, dor. (dyczoc252); D, carapace, dor. (dyczoc260); E, RV, int. (dyczoc311); F, carapace, oblique-fron. (dyczoc259). Scale bar = 500 μ m.

mid-height. *H. incongruens* lacks this feature (fig. 16F). Meisch (2000) suggested that the beak-shaped anterior end in dor. of *H. rotundata* can also help discriminate between the two. However, while most of the present specimens have pointed anterior in dor. (fig. 16C), a few of them have slightly beak-shaped anterior ends (fig. 16D). It is suggested that the shape of the anterior end of carapace in dor. is variable within the species. (2) Males are usually present in *H. barbara* (Gauthier & Brehm, 1928) and the anterior end of this species is always distinctly beak-shaped (Meisch, 2000). (3) *H. salina* (Brady, 1868) has a distinctly arched (angled) dorsal margin, with a dorsal hump on the LV. Moreover the carapace of *H. salina* usually has a dark-brown colour pattern.

Distribution.— This is a cosmopolitan species occurring in various geographical areas, including Europe, North Africa, North America and Japan (Meisch, 2000; Smith et al., 2011). In China, subfossil and living populations were reported from

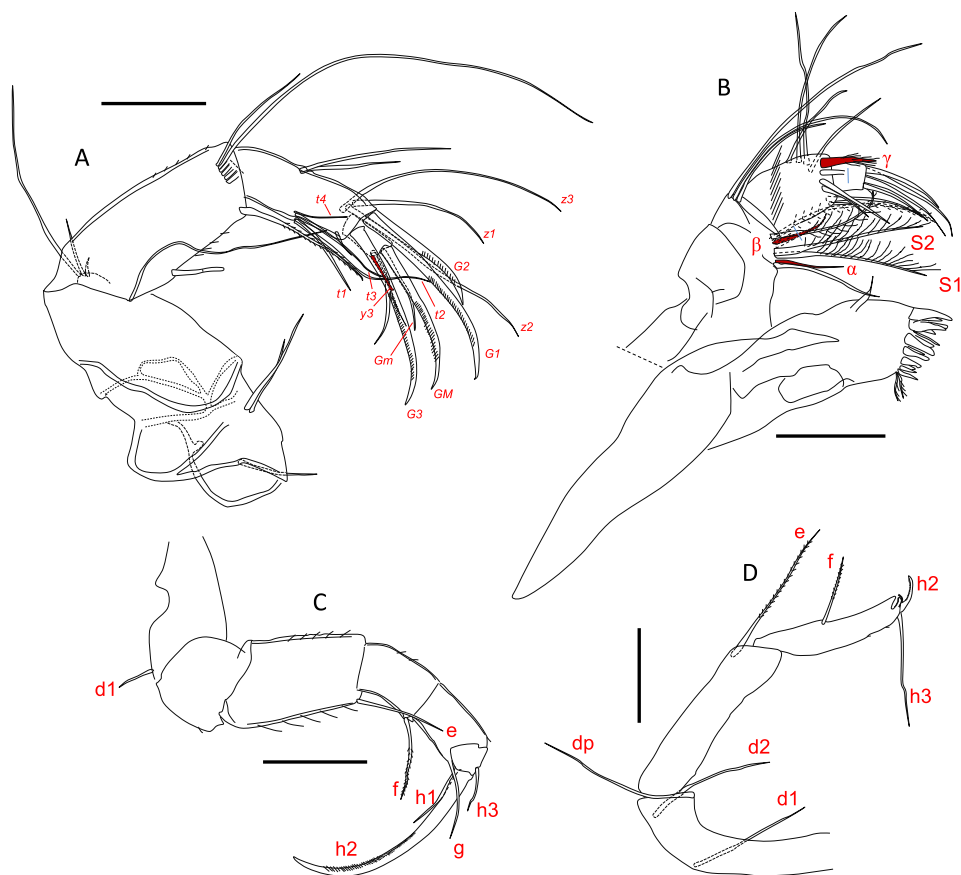


Fig. 17. *Heterocypris incongruens* (Ramdohr, 1808), female (dyczoc252). A, A2; B, Md palp and coxa; C, L6; D, L7. Scale bars = 100 μm . This figure is published in colour in the online edition of this journal, which can be accessed via <http://booksandjournals.brillonline.com/content/journals/15685403>.

Qilian Mountain areas (Mischke et al., 2003), Qinghai Province (Li et al., 2010), Shanghai City and Yunnan Province (Yu et al., 2010).

Remarks.— In the present study, at least two forms of *H. incongruens* were found. The specimens in site X35 are smaller than those from site X48, and the ratios between lengths of setae and carapace are also smaller than those of X48 population (unpublished data).

***Heterocypris auricularis* sp. nov.**

2004 *Heterocypris sanukiensis* nomen nudum — Okubo: 25; fig. 10

Type locality.— A small lake formed by the dead arm of a river in Inner Mongolia (X4, fig. 1, table I).

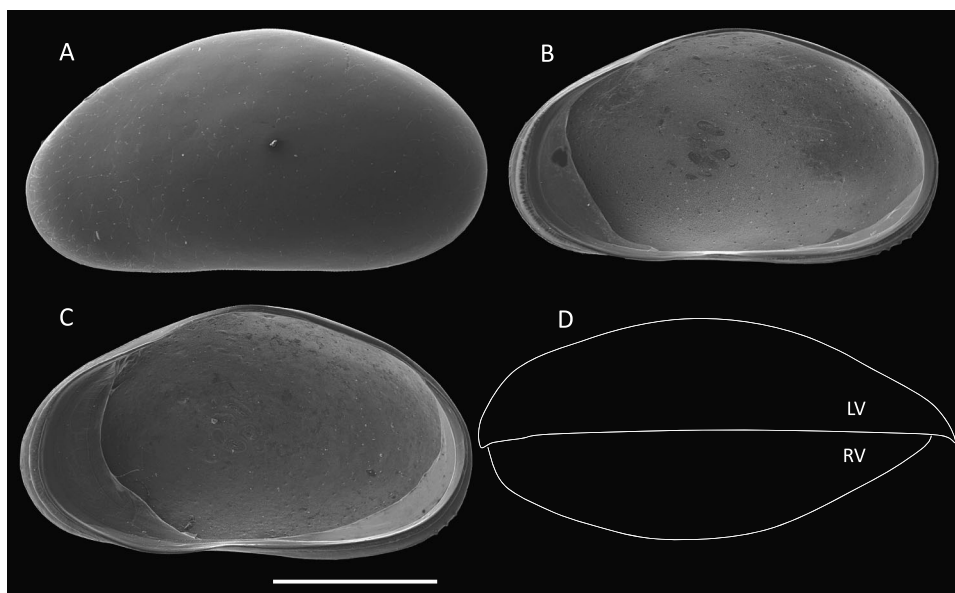


Fig. 18. *Heterocypris auricularis* sp. nov., male. A, LV, ext. (dyczoc331); B, RV, int. (dyczoc331); C, RV, int. (dyczoc350); D, carapace, dor. (dyczoc331). Scale bar = 500 μ m.

Type material.— Holotype: one dissected male (dyczoc350) from the type locality. Paratype: one dissected male (dyczoc331) from the type locality.

Dimensions.— Male (LV, $n = 2$) length 1420–1450 μ m, H/L ratio 0.54–0.57.

Derivation of name.— From the Latin *auricula*, referring to the small auricular-like expansion on the lobe a of Hp.

Diagnosis (based on male).— Carapace sub-ovate in lat., dorsal margin arched with greatest height situated at about mid-length (fig. 18). Sub-elliptical in dor., anterior end slightly compressed, beak-shaped with LV overlapping RV. In LV, selvage, fused zone and calcified inner lamella inclined toward the outer lamella. In RV, selvage and fused zone protruding to fit LV in closure. Postero-ventral margin of RV with 3–4 (may be more variable) small pustules. Anterior margin of RV without pustules. A2 swimming setae extending slightly beyond terminal claws (fig. 19). L5 palps unequal (fig. 20). Left trunk becoming narrower distally. Right trunk conical. Left finger slender, hook-like. Right finger inflated, triangle-shaped. Lobe a of Hp hammer-like, with a small auricular-like expansion at the outer-distal corner. Lobe b very small. Lobe h large, narrowly rounded.

Description of male.— Shell sub-ovate in lat., slightly elongated (fig. 18). Dorsal margin arched, highest point situated at mid-length or slightly behind. Both ends broadly rounded but anterior margin slightly narrower. Ventral margin slightly concave. In int., selvage significantly displaced inwardly and valve margin defined by the flange at the anterior, ventral and posterior. Fused zone narrow with

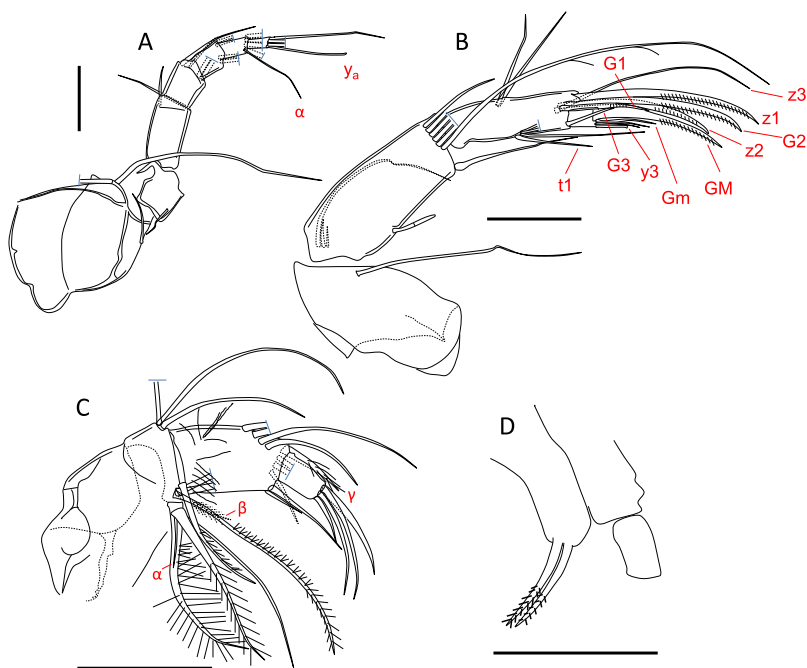


Fig. 19. *Heterocypris auricularis* sp. nov., male (dyczoc350). A, A1; B, A2; C, palp of Md; D, Mx endites and palp. Scale bars = 100 μ m. This figure is published in colour in the online edition of this journal, which can be accessed via <http://booksandjournals.brillonline.com/content/journals/15685403>.

inconspicuous radial pore canals. In LV, selvage, fused zone and calcified inner lamella inclined toward the outer lamella. In RV, selvage and fused zone protruding to fit LV upon closure. Postero-ventral margin of RV with 3-4 small pustules. Anterior margin of RV without such pustules. In dor. carapace sub-elliptical, anterior end slightly compressed, beak-shaped with LV conspicuously longer. Posterior end blunt. Greatest width situated at about mid-length. LV overlapping RV at the anterior, ventral and posterior margins. Shell surface smooth, sparsely covered with fine, soft, short setae.

A1 (fig. 19) 8-segmented. First two segments fused forming a large, quadrate base supporting 1 dorsal seta and 2 unequal, long ventral setae. Third segment quadrate, with 1 short dorsal seta. Fourth segment elongated, with 1 dorso-apical seta and 1 shorter ventro-apical seta. Fifth segment quadrate, with 2 long, strong dorso-apical setae and 2 short, unequal ventro-apical setae. Sixth segment quadrate, with 2 long, strong dorso-apical setae and 2 short, unequal ventro-apical setae. Seventh segment elongated, with 4 strong, long apical setae and a short α seta ca. 3 times the length of terminal segment. Terminal segment slender, ventro-apical seta not claw-like.

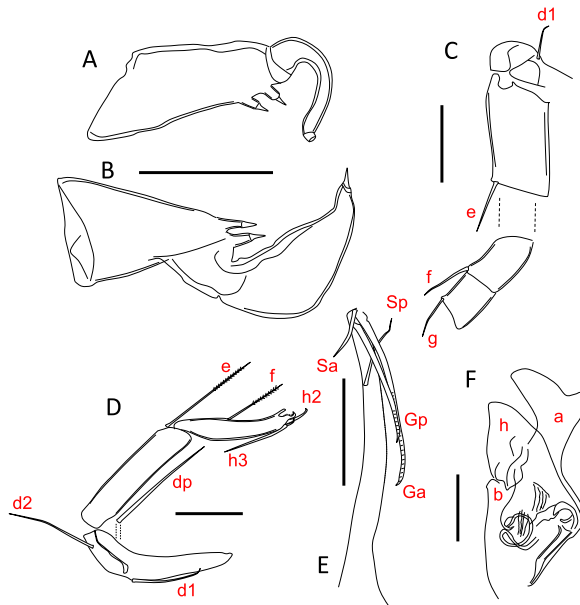


Fig. 20. *Heterocypris auricularis* sp. nov., male (dyczoc350). A, left L5 palp; B, right L5 palp; C, L6; D, L7; E, Ur; F, Hp. Scale bars = 100 μ m. This figure is published in colour in the online edition of this journal, which can be accessed via <http://booksandjournals.brillonline.com/content/journals/15685403>.

A2 (fig. 19) longest exopodal seta extending beyond first endopodal segment. Swimming setae extending slightly beyond the claws. Sixth seta extending to middle of penultimate segment. t1 and t4 extending to end of terminal segment, t2 and t3 to mid-way of claws. G1 short, ca. 1/2 the length of the longest claws, slightly S-shaped. G3 short, ca. 3/5 of G1. G2 slightly longer than GM. z1 transformed, being the longest claw. z2 transformed, claw-like, slender, slightly shorter than GM. z3 untransformed, extending slightly beyond the claws. Gm situated to the internal of GM. z1, G2, GM strongly serrated, comb-like. z2 and G1 slightly serrated.

Md (fig. 19) coxa with narrow proximal end. Vibratory plate with ca. 6 setae. Unnamed seta on first palp segment slender, nearly smooth. S1 and S2 thick, strongly plumose. α seta slim, smooth. Setal group with 3 plumose setae. Fourth seta shorter, plumose. β short, plumose. Second segment with 3 unequal, smooth antero-apical setae. Third segment with long lateral pseudochaetae resembling those of *H. incongruens*. Third segment with 4 sub-apical setae, strong, serrated γ seta and another 3 latero-apical setae and 2 unequal postero-apical setae. Terminal segment with 3 claws and 1 short postero-apical seta.

Mx (fig. 19) palp and endite lobes elongated. Tooth bristles on third endite serrated, with the proximal one more strongly serrated.

L5 palps (fig. 20) asymmetric, with finger of right organ slender and that of left organ inflated. Left trunk elongated, with two short apical bristles tips of which poorly sclerotized. Finger slender, curved, distal end poorly chitinized. Right trunk conical, becoming narrower toward the distal part, with 2 short apical bristles tips of which poorly chitinized. Finger inflated, sub-triangular, ventral margin straight, dorsal margin curved, distal end poorly sclerotized.

L6 as in fig. 20. Setae e, f and g sub-equal. h2 (not shown) serrated along the distal half.

L7 (fig. 20) chaetotaxy typical of the genus. dp and e long. e and f setulose along the distal half.

Ur (fig. 20) with arched ramus. Ga longer than Gp, both serrated. Sa short. Sp extending to about base of claws. Posterior margin of ramus with very short, inconspicuous pseudochaetae (not shown).

ZO (not shown) considerably long, with ca. 39 rows of spines. Neither end enlarged.

Hp (fig. 20) lobe a hammer-like, outer corner of the distal part with an auricular-like expansion. Lobe b short. Lobe h narrowly rounded, shorter than a. b and h partly fused.

Remarks.— Judging by the valve outline, the number of pustules along the postero-ventral margin of RV, as well as the morphology of Hp and Ur, the present specimens are most likely conspecific with the Japanese species *Heterocypris sanukiensis* Okubo, 2004 nomen nudum. Okubo (2004) presented the photos of valves (both sexes), penis and Ur, but did not designate any type specimen for *H. sanukiensis*. Moreover, repository of those specimens (coded as 1131, 1134 and 1139 in that publication) is unknown. Therefore the species name *Heterocypris sanukiensis* Okubo, 2004 would be invalid according to the International Code on Zoological Nomenclature (article 16; International Commission on Zoological Nomenclature, 2000). In the present paper, *Heterocypris auricularis* is described as a new species, with *Heterocypris sanukiensis* Okubo, 2004 nomen nudum listed as a synonym.

Differential diagnosis.— The new species has some unique characters, e.g., the number of marginal pustules on RV, the shape of trunks of male L5 palps, and the small auricular-shaped expansion on lobe a of Hp. These features allow easy distinction with most of the other species in this genus. Hp of *H. bosniaca* Petkovski et al., 2000 also has a similar expansion, which is less prominent. Distal part of the lobe h of *H. bosniaca* is quite broad and bears characteristic striations (Petkovski et al., 2000). Moreover, finger of male right L5 palp of *H. bosniaca* has a rounded ventral margin and is not triangle-shaped as that of *H. auricularis*. Although *H. auricularis* resembles *Heterocypris barbara* (Gauthier & Brehm, 1928) in the shapes of the carapace and the male L5 palps, it can be easily

distinguished from the latter by the auricular-shaped expansion on lobe a of Hp, as well as the much narrower lobe h of Hp. Besides, the number of pustles on RV is 3-4 in the new species, while that of *H. barbara* is much larger (var. *barbara*) or absent (var. *inermis*) (Meisch, 2000).

Distribution.— At the present, the species is only known from Japan and China.

Subfamily CYPRICERCINAE McKenzie, 1971

Genus *Bradleycypris* McKenzie, 1982

***Bradleycypris vittata* (Sars, 1903)**

1903 *Cypris vittata* n. sp. Sars: 22; pl. II, fig. 3

1916 *Cypris* (*Strandesia*) *vittata* — Gurney: 339

1937 *Strandesia vittata* nov. comb. — Tressler: 197

2009 *Bradleycypris vittata* nov. comb. — Savatnalinton & Martens: 3

Material examined.— One dissected female (dyczoc360) captured alive from an artificial pond in the Olympic Park of Beijing (BNS, fig. 1, table I). One dissected female (dyczoc381) from the same locality, dead, shell whitish, blackish bands faded, LV broken, soft parts partly deteriorated. One dissected female (dyczoc404) from a small lake in Tsinghua University (Tsh, fig. 1, table I), dead, LV broken, soft parts partly deteriorated.

Dimensions.— Female (LV) length 810-840 μm ($n = 3$), H/L ratio 0.60-0.62 ($n = 2$).

Re-description of female.— Carapace (fig. 21) sub-ovate in lat. Dorsal margin arched, slightly angled at the middle. Highest point situated at or slightly in front of mid-length. Postero-dorsal margin long and straight. Anterior end broadly rounded. Posterior end narrow. Ventral margin nearly straight. In dor. sub-elliptical with greatest width at or slightly behind mid-length. In int., anterior duplicature wide, posterior duplicature narrow. Carapace asymmetric both in fron. and in caudal view, with LV lower than RV (i.e., the greatest width of LV situated near the ventral margin, while the greatest width of RV situated near the mid-height). Shell surface densely covered with small rounded pits, bearing fine, short and soft setae. Carapace greyish when alive, with 4 transverse blackish bands in lat.

A1 (fig. 22) with 8 segments. First two segments fused forming a large base. Fourth through eighth segments slender. Setae considerably thin. A1 base with one short dorsal seta and two long ventral setae. Third segment quadrate with one dorso-apical seta extending to middle of fourth segment. Fourth segment long, elongated, with one dorso-apical seta and one ventro-apical seta. Fifth segment with two long dorso-apical setae and two short ventro-apical setae. Segmentation lines between the fifth through the eighth segments oblique, directed dorso-proximally. Sixth segment with three dorso-apical setae and one short ventro-apical seta. Seventh segment with four long apical setae. α seta not seen. Eighth segment with relatively long y_a , two long medio-apical setae and one ventral seta slightly shorter than y_a , not claw-like.

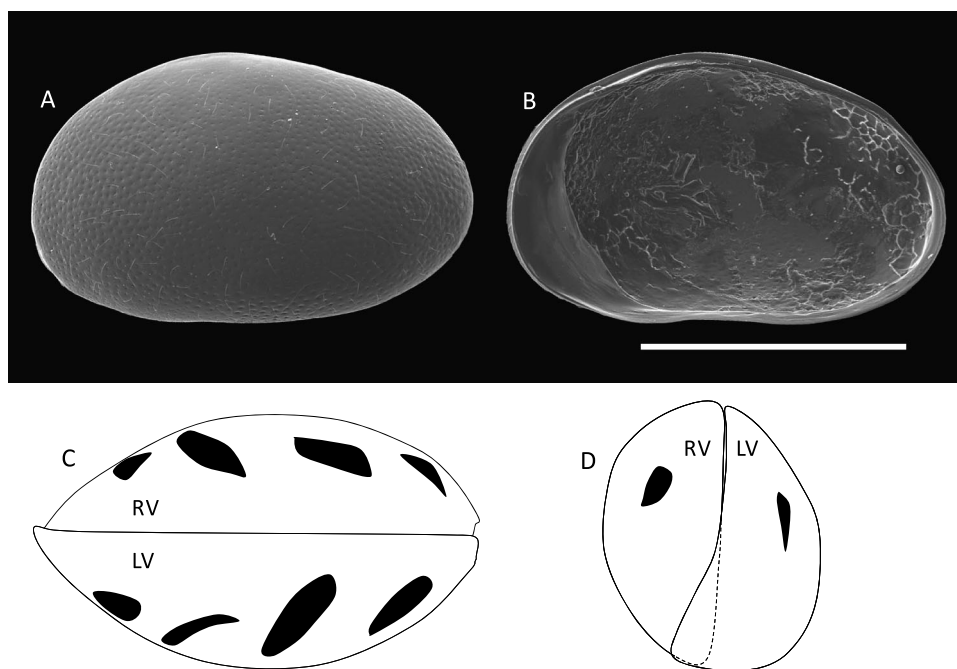


Fig. 21. *Bradleyecypris vittata* (Sars, 1903), female (dyczoc360). A, LV, ext.; B, RV, int.; C, carapace, dor.; D, carapace, fron. Scale bar = 500 μ m.

A2 (fig. 22) with 5 segments, penultimate segment undivided. Segments and claws slender. First segment with two sub-equal ventro-apical setae. Second segment with one ventro-subapical seta extending to middle of penultimate segment. Longest exopodal seta reaching beyond the first endopodal segment with ca. 30% of its length. The rest two exopodal setae very short. Aesthetasc Y situated slightly proximal to the middle of the third segment, relatively long. First five swimming setae sub-equally long, extending to about tips of the claws. In right A2 each of these setae bearing one pseudochaeta at the mid-length. Sixth seta not extending beyond mid-way of penultimate segment. Ventro-apical seta of third segment extending to middle of terminal segment, with a somewhat swollen base. The iv-a segment with 2 unequally long dorso-apical setae. t-setae unequally long, the longest ones (t2 and t3) extending to the tip of the claws, the shortest one (t1) slightly beyond the terminal segment. z-setae extending to about tip of the claws. G1, G3 and GM claws sub-equally long. G2 slightly shorter. Gm shorter than G2.

Md coxa with a swollen middle part (not shown). Teeth branched. Vibratory plate with 5 setae. Palp (fig. 23) with 4 segments. The unnamed seta on first segment smooth, slender. S1 and S2 sub-equally long, strong, plumose. α seta ca. 1/3 the length of S1, smooth. Setal group with three sub-equal setae extending to tips of terminal claws. The fourth seta much shorter. β seta short, strong, pointed,

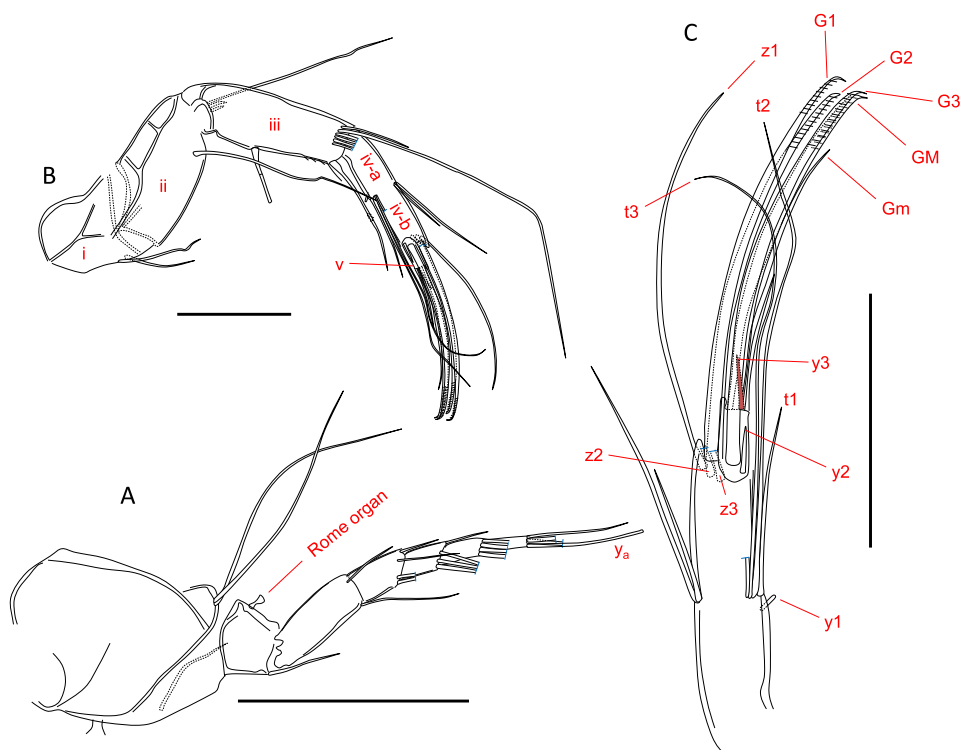


Fig. 22. *Bradleyocypris vittata* (Sars, 1903), female (dyczoc360). A, A1; B, A2; C, details of distal part of A2. Scale bars = 100 μ m. This figure is published in colour in the online edition of this journal, which can be accessed via <http://booksandjournals.brillonline.com/content/journals/15685403>.

strongly plumose. Second segment anteriorly with three unequally long smooth setae. Third segment with 4 sub-equally long sub-apical setae, as well as 5 sub-equally long apical setae, including a strong, smooth (or nearly smooth) γ seta.

Mx (fig. 23) palp 2-segmented. The two large teeth on third endite smooth (specimen dyczoc360) or slightly serrated (specimen dyczoc381). Vibratory plate with ca. 16 setae.

L5 (not shown) vibratory plate with 6 setae. Palp bearing three long terminal setae, with h2 being the longest.

L6 (fig. 23) with 6 segments. Segmentation line between second and third endopodal segments oblique. d1 significantly longer than d2. f longer than e. e longer than g. g sub-equal to h1. h1 longer than h3. All setae smooth. h2 serrated distally.

L7 (fig. 23) d1 and d2 sub-equally long. dp longer than d1 and d2, situated at sub-apical part of protopod, extending slightly beyond first endopodal segment. e extending to base of f seta. Penultimate segment not divided. f relatively short,

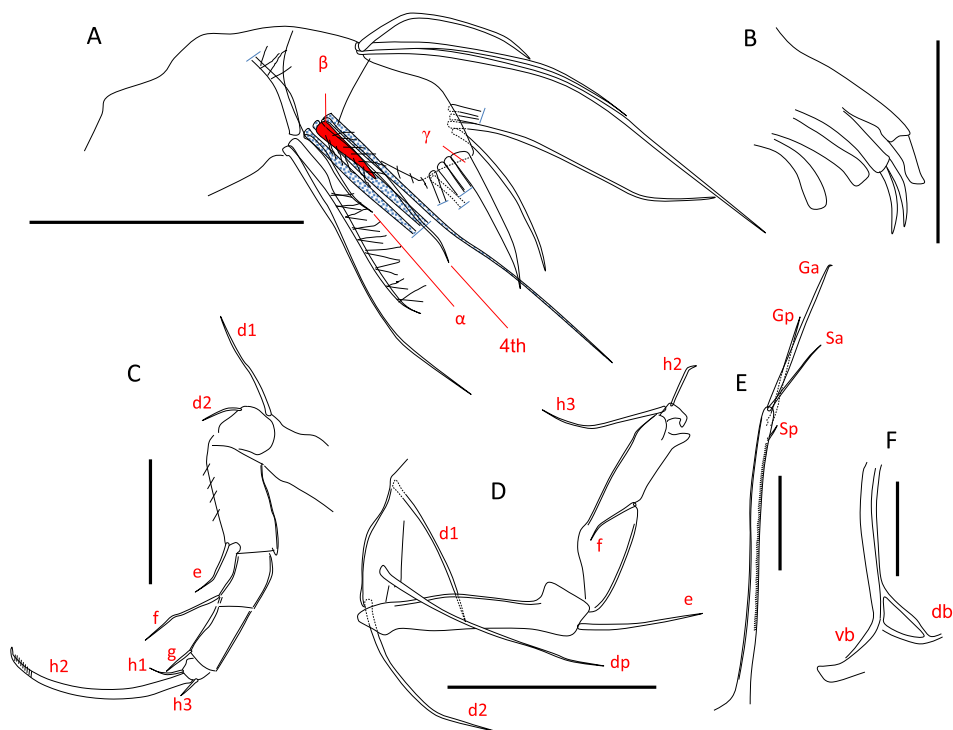


Fig. 23. *Bradleycypris vittata* (Sars, 1903), female (dyczoc360). A, palp of Md (terminal segment not shown); B, Mx endites and palp; C, L6; D, L7; E, Ur; F, Ur attachment. Scale bars = 100 μ m. This figure is published in colour in the online edition of this journal, which can be accessed via <http://booksandjournals.brillonline.com/content/journals/15685403>.

usually inversely directed. h3 intermediately long. h2 short and straight. Pincer organ typical of the family.

Ur ramus very slender, nearly straight (fig. 23, where an approximately anterior view is given). Sp very short, never extending beyond tip of ramus. Ga strong, length ca. 1/2 of the ramus. Gp nearly as thin as Sa, slightly longer than 1/2 of Ga. Sa long, only slightly shorter than Gp. Posterior margin of ramus finely serrated. Triebel loop of attachment large, sub-triangular, situated in front of the branch, typical of the genus. Median shaft strong.

Comparisons with *B. vittata* specimens reported elsewhere.— (1) Type specimens re-described by Victor & Fernando (1981b). The present specimens match the type material in many details including the shape of carapace in lat. and in dor., the position and length of the aesthetasc Y, the morphology of A2 claws, the tooth bristles on Mx, as well as the chaetotaxy of L7 and Ur. Nonetheless, the type specimens are larger (averaging 0.93 mm in length, $n = 20$), and the boundary lines between the A1 segments are generally vertical to the dorsal and the ventral margins (Victor & Fernando, 1981b). (2) *B. vittata* from Thailand (Savatena-

ton & Martens, 2010), which belong to bisexual populations, differ from the type specimens and the present ones in many aspects, although most of those illustrated limbs are based on females. For the most impressing feature, the longest A2 exopodal seta of the Thailand *B. vittata* only reaches mid-way of the first endopodal segment and has a sinuated distal part (Savatenalinton & Martens, 2010). It is not known whether this is also the case in the type material, but in the present specimens, the longest A2 exopodal seta reaches well beyond the first endopodal segment (fig. 22). It is also noted that the L6 segments of the Thailand specimens are stouter, and the setae f and h3 of this limb are longer, while the h2 claw is shorter than both the type specimen illustrated by Victor & Fernando (1981b, fig. 228) and the Beijing specimens. Ur Sp of Thailand *B. vittata* extend beyond the ramus, while those of the type and the present specimens never extend beyond the ramus. Additionally, the Thailand females also differ from the Beijing females at least in the length of the ventro-apical seta of A1 terminal segments, the ventro-apical seta of the second A2 segments, the A2 claws, d1, e, f and h1 setae of L6, f seta of L7, the Ur claws, as well as the shape and length ratios of segments on A1, A2 and L6.

Distribution.— This species is currently known from both the Palearctic and the Oriental Regions (Martens & Savatenalinton, 2011). Previous records in China were restricted to the southern provinces (Yu et al., 2009), and this is the first record in the Palearctic part of the country.

Subfamily CYPRIDOPSINAE Kaufmann, 1900

Genus *Cypridopsis* Brady, 1867

***Cypridopsis vidua* (O. F. Müller, 1776)**

1776 *Cypris vidua* n. sp. O. F. Müller: 199

1821 *Cypris pincta* — Straus: 59; figs. 17-19

1869 *Cypridopsis obesa* — Brady & Robertson: 364; pl. 18

1900 *Cypridopsella helvetica* — Kaufmann: 310; pls. 19, 22

1900 *Cypridopsella tumida* — Kaufmann: 313; pls. 19, 22

1900 *Cypridopsis parva* — G. W. Müller: 81; pl. 18

1943 *Cypridopsis mariae* — Rome: 6

1977 *Cypridopsis parvoides* — J. M. Martens: 87; figs. 1-8; pls. 1, 2

Material examined.— Two dissected females (dyczoc105-106) from a medium-sized lake (KM, fig. 1, table I) in Beijing. Three dissected females (dyczoc361-363) from an artificial pond (BNS, fig. 1, table I) in Beijing.

Dimensions.— Female (LV, $n = 4$) length 610-690 μm , H/L ratio 0.58-0.66.

Brief description.— When alive, this species can be identified based on the carapace alone (Meisch, 2000). Carapace stout (fig. 24) carrying four transverse blackish bands on each valve that meet at the dorsal margin. Posterior duplicature of both valves with double folded inner list (fig. 24B). Tiny pustules present along the anterior margin of RV (fig. 24D). A2 swimming setae extending somewhat

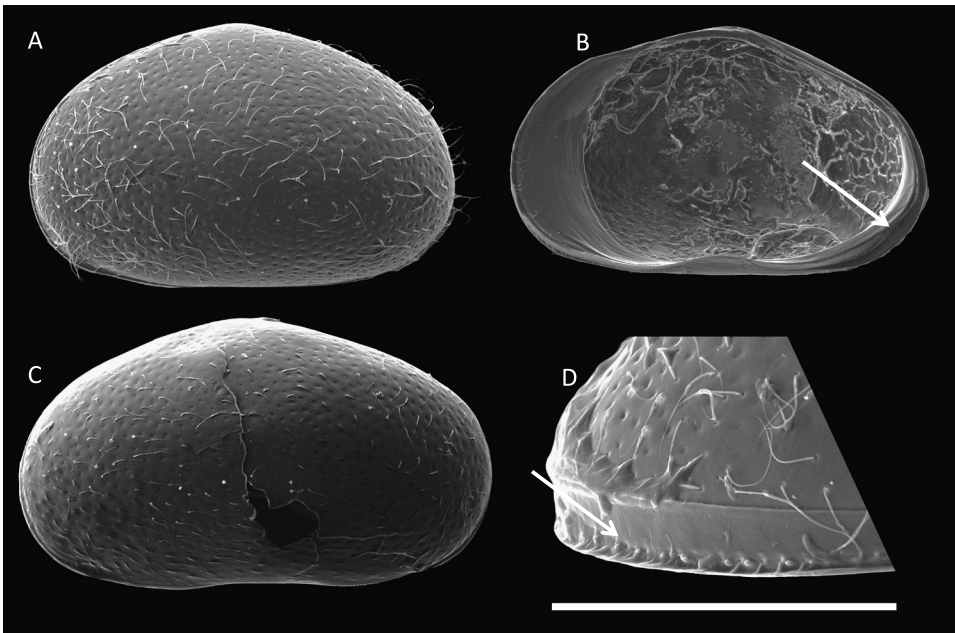


Fig. 24. *Cypridopsis vidua* (O. F. Müller, 1776), female. A, LV, ext. (dyzoc362); B, RV, int. (dyzoc362), note the inner list; C, LV, ext. (dyzoc105); D, RV, dor. (dyzoc363), showing small pustules on the extro-anterior margin; Scale bar = 500 μm for A, B and C, 141 μm for D.

beyond the terminal claws. Md palp with plumose γ seta. L6 d1 absent. h3 absent or very short (fig. 25).

Distribution.— This is a cosmopolitan species (Meisch, 2000). In China, *C. vidua* was reported from the western (e.g., Qilian Mountains, Mischke et al., 2003), north-central (Beijing, Pang, 1996) and southeastern (Fujian, Sars, 1903) areas, but most of the records were sub-recent.

Genus *Plesiocypridopsis* Rome, 1965

Plesiocypridopsis newtoni (Brady & Robertson, 1870)

1870 *Cypridopsis newtoni* n. sp. Brady & Robertson: 14; pl. 7

1898 *Cypridopsis aldabrae* — G. W. Müller: 281; pl. 18

1965 *Cypridopsis* (*Plesiocypridopsis*) *newtoni* nov. comb. — Rome: 51

1971 *Plesiocypridopsis newtoni* nov. comb. — McKenzie: 164

Material examined.— Four dissected females (dyzoc339, dyzoc340, dyzoc345, dyzoc346) from a small lake formed by the dead arm of a river (X4, fig. 1, table I).

Dimensions.— Female (LV) length 920–950 μm ($n = 4$), H/L ratio 0.59–0.61 ($n = 2$).

Brief description.— Carapace sub-triangular in lat. (fig. 26). Dorsal margin strongly arched with the highest point situated anterior to middle of the shell.

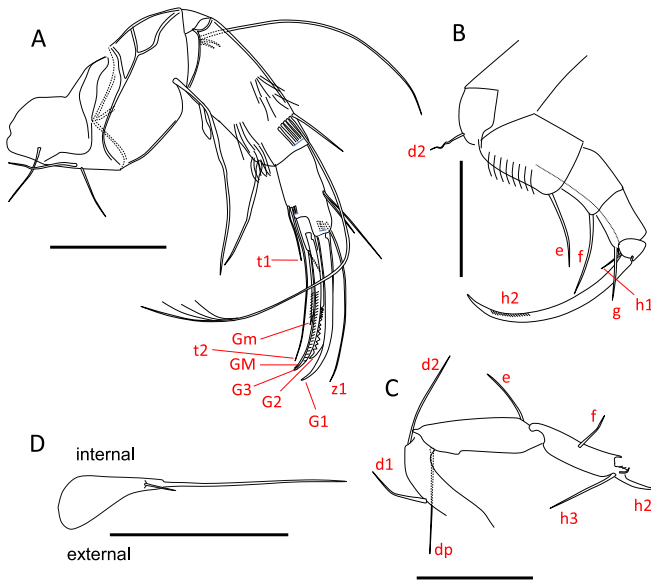


Fig. 25. *Cypridopsis vidua* (O. F. Müller, 1776), female. A, A2 (dyzoc105); B, L6 (dyzoc105); C, L7 (dyzoc105); D, Ur (dyzoc361). Scale bars = 100 μ m. This figure is published in colour in the online edition of this journal, which can be accessed via <http://booksandjournals.brillonline.com/content/journals/15685403>.

Anterior margin broad. Posterior margin narrow, sometimes slightly pointed. Ventral margin concave, with an inward lobe-like expansion at the middle. Shell surface densely pitted, covered with many setae. Extero-anterior margin of RV with small pustules. Anterior duplicature broad. Posterior duplicature narrow. A1 with very large basal segment and long swimming setae. y_a very long. A2 with plumose swimming setae reaching beyond the terminal claws (fig. 27). G1 significantly longer and stronger than the rest claws. G3 usually slightly dorsally directed. Setal group of Md palp with 3 smooth setae. α seta short and smooth. β short, strong and setulose. γ very strong. Third endite of Mx bearing two serrated teeth. L6 d1 absent, d2 short, f setulose, h2 claw serrated, h3 very short. L7 with d1 shorter than d2 and dp. e and f relatively short. Pincer organ typical of the family. Ur consisting of a cylindrical base with a short sub-apical seta and distally a long flagelliform structure. An unnamed strong hook structure situated adjacent to Ur.

Distribution.— *Plesiocypridopsis newtoni* is widespread across Eurasia and northern Africa, but it has not been reported from China before. This is also the first report of the genus *Plesiocypridopsis* in this country.

Remarks.— Zhai (2010) and Zhai et al. (2011) reported *Cypridopsis* sp. from the Holocene sediment of Hulun Lake of Inner Mongolia. The identification was based on shell morphology. Based on careful re-examination of the shells, some of these specimens probably belong to *Plesiocypridopsis newtoni*, or at least belong to

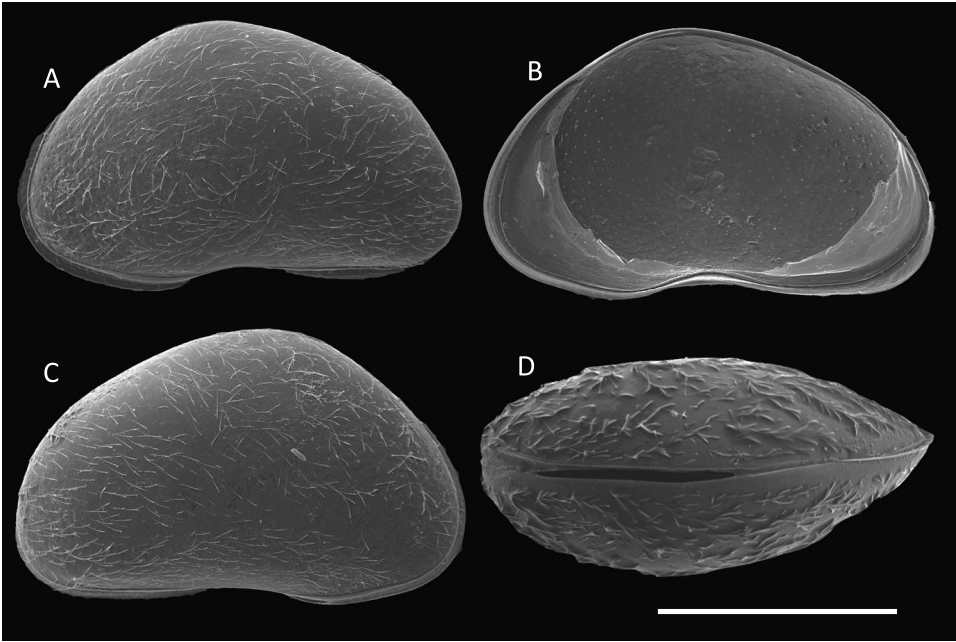


Fig. 26. *Plesiocypridopsis newtoni* (Brady & Robertson, 1870), female. A, LV, ext. (dyczoc339); B, RV, int. (dyczoc339); C, RV, ext. (dyczoc340); D, carapace, oblique-dor. (dyczoc346). Scale bar = 500 μm .

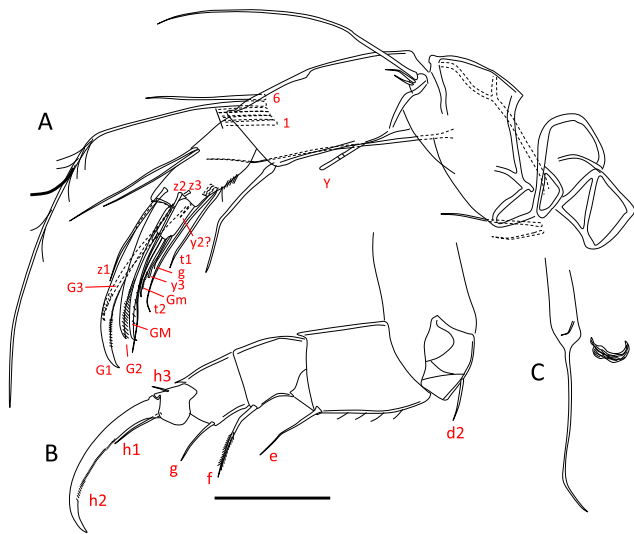


Fig. 27. *Plesiocypridopsis newtoni* (Brady & Robertson, 1870), female (dyczoc339). A, A2; B, L6; C, Ur and a hook structure adjacent to it. Scale bar = 100 μm . This figure is published in colour in the online edition of this journal, which can be accessed via <http://booksandjournals.brillonline.com/content/journals/15685403>.

the genus *Plesiocypridopsis*. Further study of the soft part morphology are needed to confirm the taxonomy of the Cypridopsinae specimens from Hulun Lake.

Superfamily CYTHEROIDEA Baird, 1850

Family LIMNOCYTHERIDAE Klie, 1938

Subfamily LIMNOCYTHERINAE Klie, 1938

Genus *Limnocythere* Brady, 1868

***Limnocythere inopinata* (Baird, 1843)**

1843 *Cythere inopinata* n. sp. Baird: 195

1867 *Limnocythere inopinata* nov. comb. — Brady: 121

1888 *Limnocythere incisa* — Dahl: 617; pl. 17

1963 *Limnocythere sappausensis* — Staplin: 1197; pl. 160

1964 *Limnocythere binoda* — Huang: 252; pl. 5

1972 *Limnocythere inopinata* s.sp. *orientalis* — Ghetti: 140; pl. 11

1987 *Limnocythere inopinata pleistocenica* — Krstić: 216; pls. 1-2

Material examined.— One dissected female (dyczoc380) from a small lake in Tsinghua University (Tsh, fig. 1, table I) in Beijing. One dissected female (dyczoc406) from a small lake formed by a dead river (X4, fig. 1, table I) in Inner Mongolia.

Dimensions.— Female (LV, $n = 2$) length 500-540 μm , H/L ratio 0.54-0.55.

Brief description.— Female carapace sub-rectangular in lat. (fig. 28). Dorsal margin slightly arched or straight. Ventral margin concave. Anterior end more broadly rounded than posterior end. The fused zone highly laterally compressed, bearing long radial-pore canals, distributed along the whole anterior margin, the antero-ventral, postero-ventral and part of posterior margins. Shell surface more or less reticulated. Adductor muscle scars typical of the family, situated in an elongated depression below the transverse sulcus. Male carapace longer and more inflated than female in the posterior half, especially at the postero-dorsal part (see Yin et al., 1999; Zhai et al., 2010). Both male and female with variable nodding

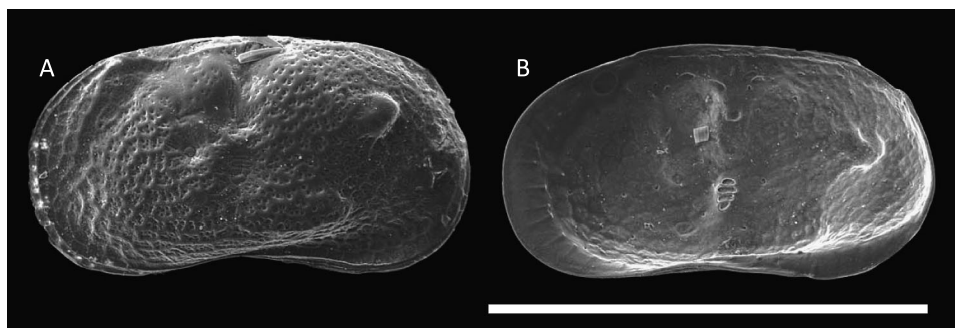


Fig. 28. *Limnocythere inopinata* (Baird, 1843), female (dyczoc380). A, LV, ext.; B, RV, int. Scale bar = 500 μm .

patterns (Yin et al., 1999; Zhai et al., 2010). Female limbs with less diagnostic features, typical of the genus.

Distribution.— This species is widespread across Eurasia (Meisch, 2000) and was found in North America (Forester et al., 2005). It was also found in Africa south of Sahara (Martens, 1994). In China, *L. inopinata* has been reported from various localities, including Qilian Mountains (Mischke et al., 2003) and Lake Qinghai (Yin et al., 1999; Li et al., 2010) in western provinces, Inner Mongolia (Wang & Ji, 1995; Zhai et al., 2010) in northeastern areas, as well as Taihu Lake (Zhao & Wang, 1998) in southern China. In general, however, *L. inopinata* is more abundant in arid and semi-arid regions (western and northern China) than in humid regions (southern and eastern China).

***Limnocythere stationis* Vávra, 1891**

1891 *Limnocythere stationis* n. sp. Vávra: 108; fig. 38

Material examined.— One dissected female (dyczoc189) from a medium-sized lake in Beijing (KM, fig. 1, table I).

Dimensions.— The specimen (dyczoc189) found from Beijing has a length (RV) of 430 μm and a height of 250 μm , which is close to the average size of European specimens (Meisch, 2000). Those from Taihu Lake (Yu et al., 2005) (ranging from 0.33 to 0.35 mm), and the syntype described by Vávra (1891) (0.36 mm) were considerably smaller.

Brief description (slightly modified from Meisch (2000)).— Carapace very small for the genus, stout in lat. Anterior higher than posterior. Dorsal margin straight, sloping posteriorly. Postero-dorsal part of RV usually with 1-3 denticles directed posteriorly or upwards. Each valve usually with two dorsal tubercles, one postero-ventral ala, and one central tubercle near the central muscle scars. Valve surface reticulated. L7 strikingly small, shorter than L5 and L6.

Distribution.— This species was frequently reported from Europe, Russia and Africa (Martens, 1984; Meisch, 2000). In China, it was only reported from Taihu Lake of Jiangsu Province (Yu et al., 2005). This species is very rare in the site KM (fig. 1, table I) investigated in the present study. It is unclear whether it has colonized this lake successfully. Alternatively, it might be an occasional visitor to the lake.

DISCUSSION

The 12 species recorded from northern China in this study provide new information on the zoogeography of living non-marine ostracods. Despite that half of the species (*Cypridopsis vidua* (O. F. Müller, 1776), *Heterocypris incongruens*

(Ramdohr, 1808), *Limnocythere inopinata* (Baird, 1843), *L. stationis* Vávra, 1891, *Physocypria kraepelini* G. W. Müller, 1903 and *Plesiocypridopsis newtoni* (Brady & Robertson, 1870)) have been recorded from various other parts of the world and display wide geographical distribution (Martens & Savatnalinton, 2011), some of them have been rarely, or not at all found in China before. For example, previous data indicated that *P. kraepelini* is widespread across Eurasia and North America (Meisch, 2000; Yu et al., 2005, 2010; Martens & Savatnalinton, 2011), but it was not known from the Chinese territory north of Qinling Mountain (i.e., the Palaearctic part of China) until this study. The present study also presents the first reports of *B. vittata*, *I. angulata*, and *L. stationis* in Palaearctic China. *P. newtoni*, another widespread species in the Palaearctic and Afrotropical Regions, is reported from China for the first time.

Four species known from other East Asian countries are found in China. *Candona quasiakaina* Karanovic & Lee, 2012 is reported for the first time outside South Korea. *Fabaeformiscandona myllaina* Smith & Kamiya, 2007 and *Heterocypris sanukiensis* Okubo, 2004 nomen nudum (as *Heterocypris auricularis* sp. nov. in this paper) are new for areas outside of Japan. *Ilyocypris mongolica* Martens, 1991 is reported for the first time outside of Mongolia. It is possible that these ostracods are endemic to East Asia, but more data are needed to define the geographical occurrence of these relatively less known species.

It should be noted that the occurrence of the ostracods recorded in this study may not faithfully represent their natural distributions. The Beijing specimens were collected from artificial lakes in the city. The water in these lakes comes from man-made dams to the north and northwest of the city, which were in turn fed by brooks and rivers arising from nearby mountain areas. The aquatic plants and animals in these urban lakes may thus have come from the above water-bodies, or even have been introduced from more distant places. The sampling area in Inner Mongolia is very sparsely populated, but the possibility of man-conducted dispersal cannot be ruled out, since the sampling sites were close to the paved road.

China has a vast continental territory and has diverse geographical conditions. Various types of water-bodies, ranging from small puddles to large lakes, from underground flows to great rivers, from fresh to hyper-saline waters are present. The ostracod fauna residing in this land is thus expected to be diverse. Many of these species, however, are poorly known to science and a more intense investigation of China's extant ostracod fauna is urgently required.

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