

## ***Earicandona*, new genus and the first record of *Typhlocypris pratensis* (Crustacea, Ostracoda) from South Korea**

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Candoninae is the most diverse group of freshwater ostracods with over 300 living species described from all around the world. However, only 11 species have been reported from South Korea. Considering abundant freshwater ecosystems here this number is very low. It is no wonder that newly collected samples of freshwater meiofauna often contain Candoninae ostracods which are new records for South Korea, or new taxa. *Earicandona mounchyon* gen. nov. sp. nov. and *Typhlocypris (Pseudocandona) pratensis* (Hartwig, 1901) were collected from two open freshwater bodies in Gangwon-do, and Gyeongsangbuk-do in South Korea. The new genus is most closely related to the *breuili*-group of *Fabaeformiscandona* Krstic, 1972. The most important apomorphic character of the new genus is a hemipenis with a poorly sclerified lobe “g”, and prehensile palps with more rounded dorsal margins. Beside the new species, *Earicandona* contains only *E. oku-boi* (Smith & Janz, 2008) comb. nov. from Lake Biwa. This species was originally described in *Fabaeformiscandona*, *fabaeformis*-group. They differ mostly in the morphology of the shell, but also some details of soft body, including the more pronounced genital process in the Korean species. *Typhlocypris pratensis* was so far known from Europe and this finding significantly broadens its area of distribution. Both *Typhlocypris* and *Earicandona* belong to the tribe Candonini and the key to the genera of this tribe is also presented here.

Keywords: biodiversity, Candoninae, East Asia, Podocopida, taxonomy

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DOI: 10.12651/JSR.2013.2.2.145

### **INTRODUCTION**

The subfamily Candoninae is well known for its high diversity and ecological plasticity (Karanovic, 2007). More than 300 living species have been named so far from a wide variety of freshwater habitats and from all continents (excluding Antarctica). In some, such as open surface water bodies, Candoninae often share habitat with several other ostracod groups, but in subterranean waters these are almost only ostracods found (Danielopol, 1978; Karanovic, 2007). Candoninae is divided into eight tribes (Karanovic, 2007) and 41 genera. Many of these genera are monospecific, or containing only a couple of species (see Danielopol *et al.*, 2011) with a small area of distribution, and usually confined to subterranean waters. For example, recently described *Undulacandona* Smith, 2011 is a monospecific genus from subterranean waters of Japan (Smith, 2011), while *Pierrecandona* Karanovic, 2007 and *Pioneercandonopsis* Karanovic, 2005 are known from subterranean waters of Australia (Karanovic, 2004; 2007). In fact, the number of genera with two or less

species represents 44% of all Candoninae. On the other hand genera such as *Typhlocypris* Vejdovský, 1882 and *Fabaeformiscandona* Krstic, 1972 are much more specious, having 85 and 62 species respectively (see Martens & Savatentalinton, 2011).

*Typhlocypris*, established on monotypy, has been a disputed genus for a long time (for discussion see Karanovic, 2005). Traditionally, it is divided into six species groups: *eremita*-, *zschokkei*-, *rostrata*-, *compressa*-, *prespica*-, and *caribbeana*- (see Meisch, 2000) based on the number of setae in the setal group on the second segment of the mandibular palp, as well as carapace shape. However, the name *Pseudocandona* Kaufmann, 1900 is more commonly used for the *Typhlocypris* species. Karanovic (2005), on the other hand, recognizes the name *Pseudocandona* as a subgenus of *Typhlocypris*. Meisch (2000) also postulates a possibility that the genus *Typhlocypris* may define the *eremita*-group, but refrains from further changes. More recently, Danielopol *et al.* (2012) established the genus *Marmocandona* Danielopol, Namiotko and Meisch, 2012 to incorporate five species of the *zschokkei*-group. Without much discussion, the authors recognize

the genus *Typhlocypris* for the *eremita*-group, leaving *rostrata*- and *compressa*- groups in *Pseudocandona* and arguing that the remaining two groups, *prespica*- and *caribbeana*-, need further revision.

The generic boundaries of *Fabaeformiscandona* have also been point of argument for a long time. The genus was described primarily to include a (sub)fossil group of species with a characteristic shape of carapace which has a postero-dorsal keel on the left valve (Krstic, 1972), but over time many species, originally described in the genus *Candona* Baird, 1845, have been transferred to *Fabaeformiscandona*, and the carapace shape lost its taxonomic importance. For most taxonomists the only relevant feature was the appearance of the gamma seta (one of the distal setae on the penultimate segment of the mandibular palp), which is smooth in *Fabaeformiscandona* and papose in *Candona* (see Meisch, 2000). Based on this, Petkovski and Karanovic (2000) argued that *Fabaeformiscandona* is a junior synonym of *Eucandona* Daday, 1900, because the type species, *E. balatonica* (Daday, 1894), was included in the genus *Fabaeformiscandona* based on the morphology of the gamma seta. Karanovic (2006) revised the diagnosis of *Fabaeformiscandona*, pointing out the chaetotaxy of the antennula, appearance of male prehensile palps, and female genital field as very important taxonomic characters. Nevertheless, most modern authors continue to use the “broad” definition of *Fabaeformiscandona*, and divide it into following species groups: *acuminata*, *balatonica*-, *breuili*-, and *fabaeformis*-group based on the number of setae in the setal group on the inner side of the second segment of the mandibular palp (Meisch, 2000; Smith & Janz, 2008). According to Karanovic (2006), the genus should include only about eight species of the *fabaeformis*-group. This also excludes some species assigned to *fabaeformis*-group because of the same number of setae in the setal group of the mandibular palp, but with clear differences in the carapace and soft body morphology (i.e. *Fabaeformiscandona angusta* (Ostermeyer, 1937), *F. tyrolensis* (Löffler, 1963), *F. brisiaca* (Klie, 1938). Recently Smith & Kamiya (2007) and Smith & Janz (2008) described another nine species belonging to *fabaeformis*-group from the Lake Biwa, and point out that there are potentially two phylogenetic lineages provisionally naming them “A” and “B” lineage, “A” being a more typical *Fabaeformiscandona* (as originally defined by Krstic, 1972 and later on by Karanovic, 2006). Beside *fabaeformis*-group, Smith & Janz (2008) described two species in the *acuminata*-group, however in the genus *Fabaeformiscandona*.

The first Candoninae species described from Korea, *Candona morimotoi* McKenzie, 1972 was discovered in one of the Korean caves (McKenzie, 1972). In the revision of *Typhlocypris*, Karanovic (2005) reexamined the type material of this species and assigned it to the *rostrata*-

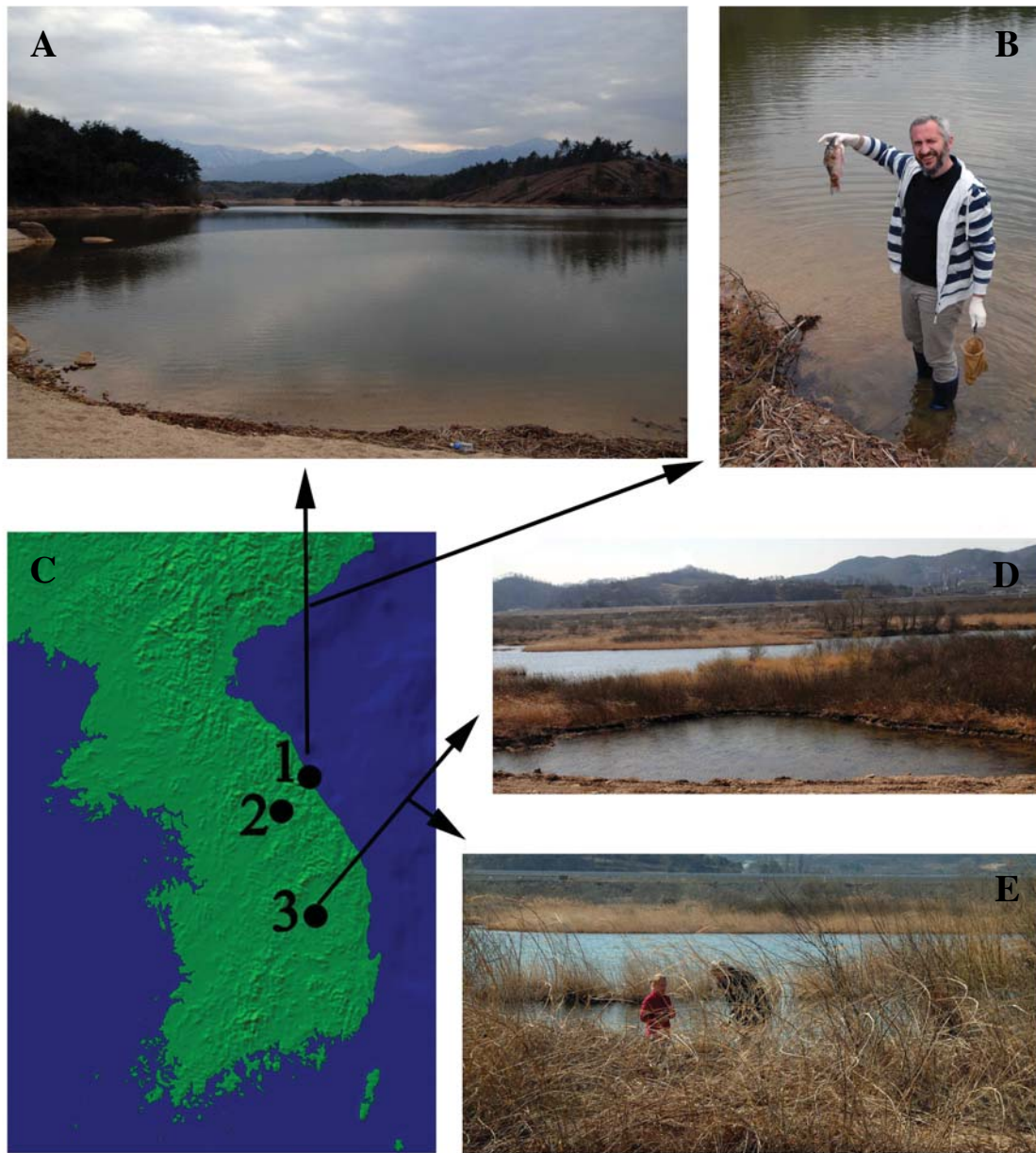
group of the genus *Typhlocypris*. Since 1972 until 2012, there were no new records of Candoninae in Korea. Finally, Karanovic and Lee (2012a; 2012b) and Chang *et al.* (2012) report the following species from this county: *Candona quisiakaina* Karanovic & Lee, 2012; *Candona sil-lae* Karanovic and Lee, 2012; *Candonopsis transgrediens* Brehm, 1923, *Cryptocandona brehmi* (Klie, 1934); *C. tsukagoshii* Smith, 2011; *C. smithi* Karanovic & Lee, 2012; *Fabaeformiscandona subacuta* (Yang, 1982); *F. koreana* Karanovic & Lee, 2012; *Typhlocypris choi* Karanovic & Lee, 2012; and *Schellencandona tea* Karanovic & Lee, 2012. Arguing against the broad definition of the genus *Fabaeformiscandona*, Karanovic & Lee (2012) decided to keep *Candona quisiakaina* in *Candona*, acknowledging its belonging to *acumianta*-group, while *F. koreana* is undoubtedly a representative of the *fabaeformis*-group of species.

Candoninae ostracods of Korea are still understudied, and almost every new sampling effort reveals new taxa. In this paper I report another two species recently collected from open freshwater bodies in Korea (Fig. 1). One is a new species with some characteristics of the *fabaeformis*-group (the same number of setae in the setal group on the mandibular palp), but a new genus is erected in the present paper to accommodate this and another closely related species from Lake Biwa. In this way, a revision of the genus *Fabaeformiscandona* s. sl. is continued and here I point out the existence of several clear phylogenetic lineages. The key to the tribe Candonini, which is also provided here, should facilitate identification of the new genus and also point out distinguishing characters between it and closely related genera. The second species is *Typhlocypris (Pseudocandona) pratensis* (Hartwig, 1901), which is the first record for Korea. Since it was so far known only from Europe (see Meisch, 2000), this finding considerably extends its area of distribution to the Far East.

## MATERIALS AND METHODS

The samples were taken with hand plankton net with 0.05 mm mesh size, and fixed in 99% ethyl alcohol. Specimens were dissected and mounted on microscope slides in CMC-10 mounting media (Masters Company, Inc.), and dissected appendages were then covered with a coverslip. All drawings were prepared using a drawing tube attached to a Leica DMLS bright-field compound microscope with N-PLAN achromatic objectives. Specimens that were not drawn were examined in propylene glycol, and left in the pure alcohol. Scanning Electron Micrographs (SEM) were taken with Hitachi S-4700 scanning electron microscope at Eulji University (Seoul).

Martens (1987) revised the terminology for A2 given originally by Broodbakker & Danielopol (1982). This



**Fig. 1.** Sampling localities. A. Yongjiho Lake, type locality of *Earicandona mounchyon* gen. nov., sp. nov.. B. a dead fish found in the Jongjiho at the sampling area. C. Map of Korea with sampling localities shown. D, E. Banbyeoncheon (River), Andong, sampling locality of *Typhlocypris (P.) pratensis* (Hartwig, 1901).

present paper follows Martens (1987), except that the short claw on the male terminal segment is considered to be homologous with female GM claw, while the long one is homologous with female Gm claw, which is based on the position of these claws on A2, GM claw being the more external one. The terminology for the A1, Md, Mx1, L5 and L6 follows Broodbakker and Danielopol (1982), and for the L7 Meisch (1996). Lobes on the hemipenis are labeled according to Danielopol (1969). Here, the view of Meisch (2007) regarding the terminology and homology of the most posterior appendage on the ostracod

body (“furca”) is accepted. Setal classification system follows Garm (2004). Holotype, allotype and most of the paratypes are deposited at the National Institute for Biological Research (NIBR), Seoul, some material is kept for future DNA studies.

Abbreviations used in text and figure captions: A1 - antennula; A2 - antenna; UR - uropodal ramus; H - height; L - length; LV - left valve; Md - mandible; Mx1 - maxillula; RV - right valve; L5, L6, L7 - first, second and third thoracopods; W - width.

## SYSTEMATICS

Class Ostracoda Latreille, 1802  
 Order Podocopida Sars, 1866  
 Family Candonidae Kaufmann, 1900  
 Subfamily Candoninae Kaufmann, 1900  
 Tribe Candonini Kaufmann, 1900  
 Genus *Earicandona* gen. nov.

**Type species.** *Earicandona mounchyon* sp. nov.

**Other species.** *Earicandona okuboi* (Smith & Janz, 2008) comb. nov.

**Diagnosis.** Shell without prominent ornament, covered with sparse hair-like setae. LV overlaps RV around all free margins. No prominent flange, selvage narrow and peripheral. Inner calcified lamella relatively narrow. LV without postero-dorsal keel. Sexual dimorphism of the carapace sometimes well-pronounced (males having more inflated posterior end than females). Marginal pore canals short and straight. A1 7-segmented, penultimate segment without posterior most seta. A2 sexually dimorphic, males with setae t2 and t3 transformed into sensory organs, and subdividing penultimate segment. Males also with both z1 and z2 setae transformed in claws, or only z1 transformed, while z2 seta like. Claws G1 and G3 reduced. A2 in females with all three z-setae remaining seta-like, all claws on the penultimate and terminal segments normally developed and remaining claw-like. Mx1 palp with slightly dilated terminal segment which carrying two claws and four setae. Penultimate segment with four setae. Md palp with 3+2 setae on the inner side of the second segment. L5 in males transformed into asymmetrical prehensile palp: both palps with robust bodies, right one more than left. Bodies of the palps with even margins. Fingers short and curved. Both palps with two subterminal structures situated at the base of the fingers. Only one seta present in the exopod (branchial plate) of L5, one a, b, and d seta present on protopod of the same appendage. L6 with basal seta, d1. Endopod 4-segmented terminating with long claw. All setae, e, f, and g, present. L7 with d1 and dp seta on the basal segment. Endopod 4-segmented, or possibly third and fourth segments partially to completely fused. Only g-seta present. Terminal segment with short h1 and long h2 and h3 setae. UR with both claws and both setae present. Posterior seta relatively short. Genital field in females rounded or with some small projections. Hemipenis with a distinct a-lobe, lobes b and h situated very close together and relatively hard to distinguish. Inner sclerified part, g, inconspicuous, mostly with basal part clear while proximal part not.

**Etymology.** The genus is named after the Greek noun *ear*, meaning spring (as the season of the year).

### *Earicandona mounchyon* sp. nov. (Figs. 2, 3, 4, 5, 6A, B)

**Material examined.** Holotype - male (NIBRIV0000279526), dissected on one slide, shell not kept (broken during dissection).

Allotype - female (NIBRIV0000279527), dissected on one slide, shell not kept (broken during dissection).

Paratypes - two males and one female on the SEM slide (NIBRIV0000279528), 6 females, 3 males, and 1 juvenile kept in 99% ethyl-alcohol.

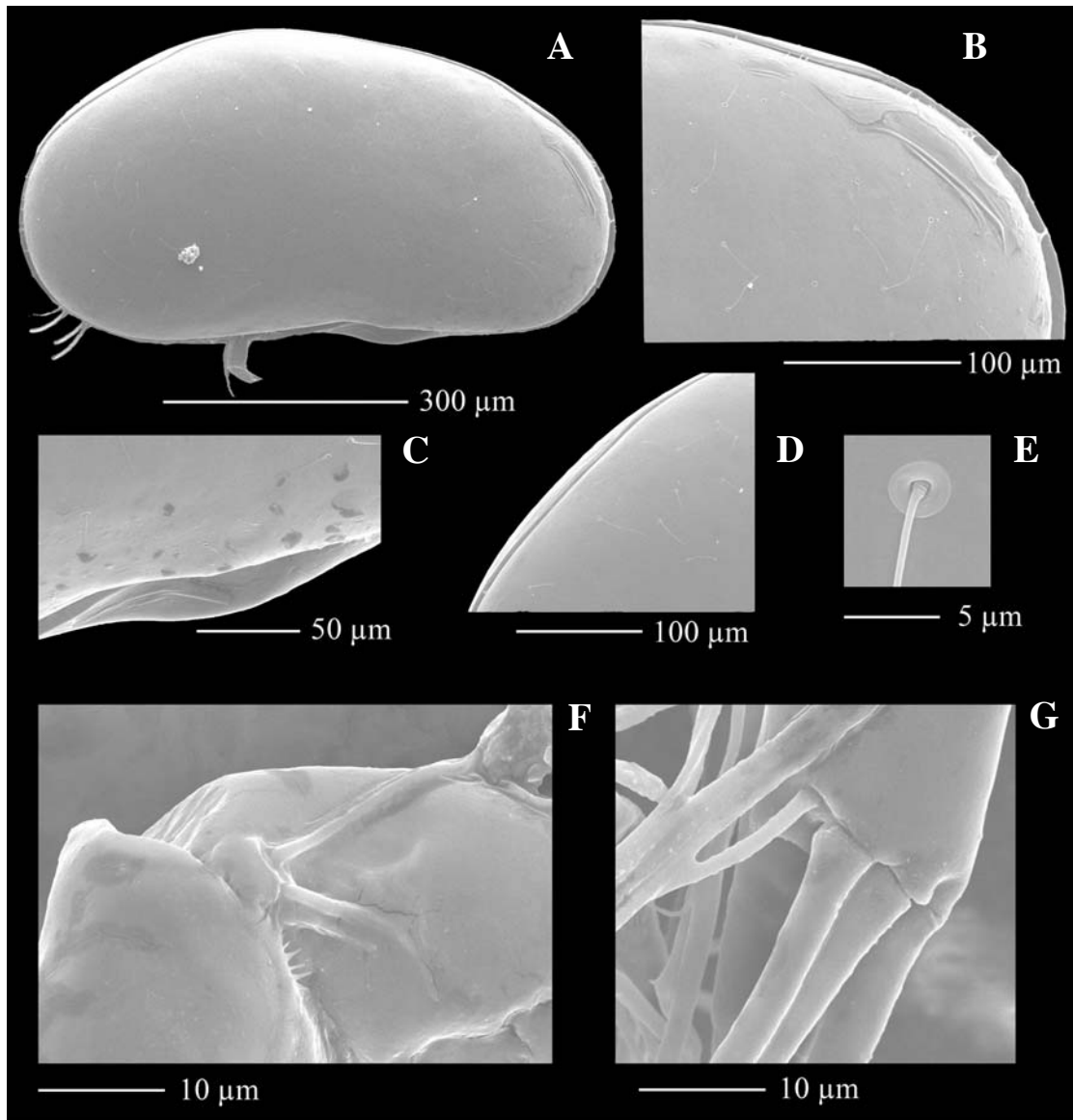
**Type locality.** Sample taken in the area around a dead fish (Fig. 1B), Yongjiho Lake, Gangwon-do, South Korea, 38° 13.697'N 128° 33.868'E, 2012/04/16, collector I. Karanovic.

**Etymology.** The species is named after the Greek noun *Mounchyon*, meaning April, referring to the month when the species was collected.

**Description.** Male: Carapace reniform (Figs. 2A, 3A). L=0.75 mm. Greatest H situated behind middle, equaling 50% of L. Dorsal margin arched behind middle, than rounded towards posterior and gently sloping towards anterior end. Posterior and anterior margins rounded and equally wide. Ventral margin gently concave, and with prominent enlargement around mouth region (Fig. 2C). Postero dorsal margin of LV without prominent keel (Fig. 2D). Inner calcified lamella narrow anteriorly and posteriorly. Marginal pore canals short and relatively dense. Surface of shell smooth, antero-dorsally with two short ridges (Fig. 2B). Surface sparsely covered with hair-like setae (sensory setae) (Fig. 2E).

A1 (Fig. 3B) 7-segmented. First segment anteriorly with one proximal and one distal seta, both serrulate; posteriorly same segment with two long setae situated distally. Second and third segments with one serrulate antero-distal seta each. Fourth segment with one postero-distal and two antero-distal setae; postero-distal seta slightly exceeding distal margin of following segment, anterior setae much longer. Fifth segment with the same chaetotaxy as fourth one. Sixth segment with short  $\alpha$ -seta, two long and one short seta. Terminal segment with aesthetasc (ya) which approximately 1.5 times longer than seventh segment, one short posterior seta, and two long setae. L ratio between last five segments equal: 1 : 1.1 : 1.1 : 1.4 : 1.6. Segments one and two, and two and three articulated.

A2 (Fig. 3C) with 4-segmented endopod. Basal segment with two setae. Protopod with one long seta. Exopod reduced to plate with one long and two short setae (Fig. 2F). First endopodal segment with two postero-distal setae (unequally) long, and aesthetasc Y which barely reaching distal end of first endopodal segment. Following segment subdivided with two male sexual setae. Aesthetasc y1 situated slightly above these. Seta t4 as long as male sexual setae, while seta t1 much shorter; one



**Fig. 2.** SEM of *Earicandona mounchyon* n. gen. n. sp. Paratype male. A. shell, lateral view from the right outside. B. Antero-dorsal margin of the RV, outside view. C. ventral margin, around mouth region. D. Postero-dorsal margin, outside view. E. seta on the shell surface. F. exopod of A2. G. detail of the penultimate segment of A2.

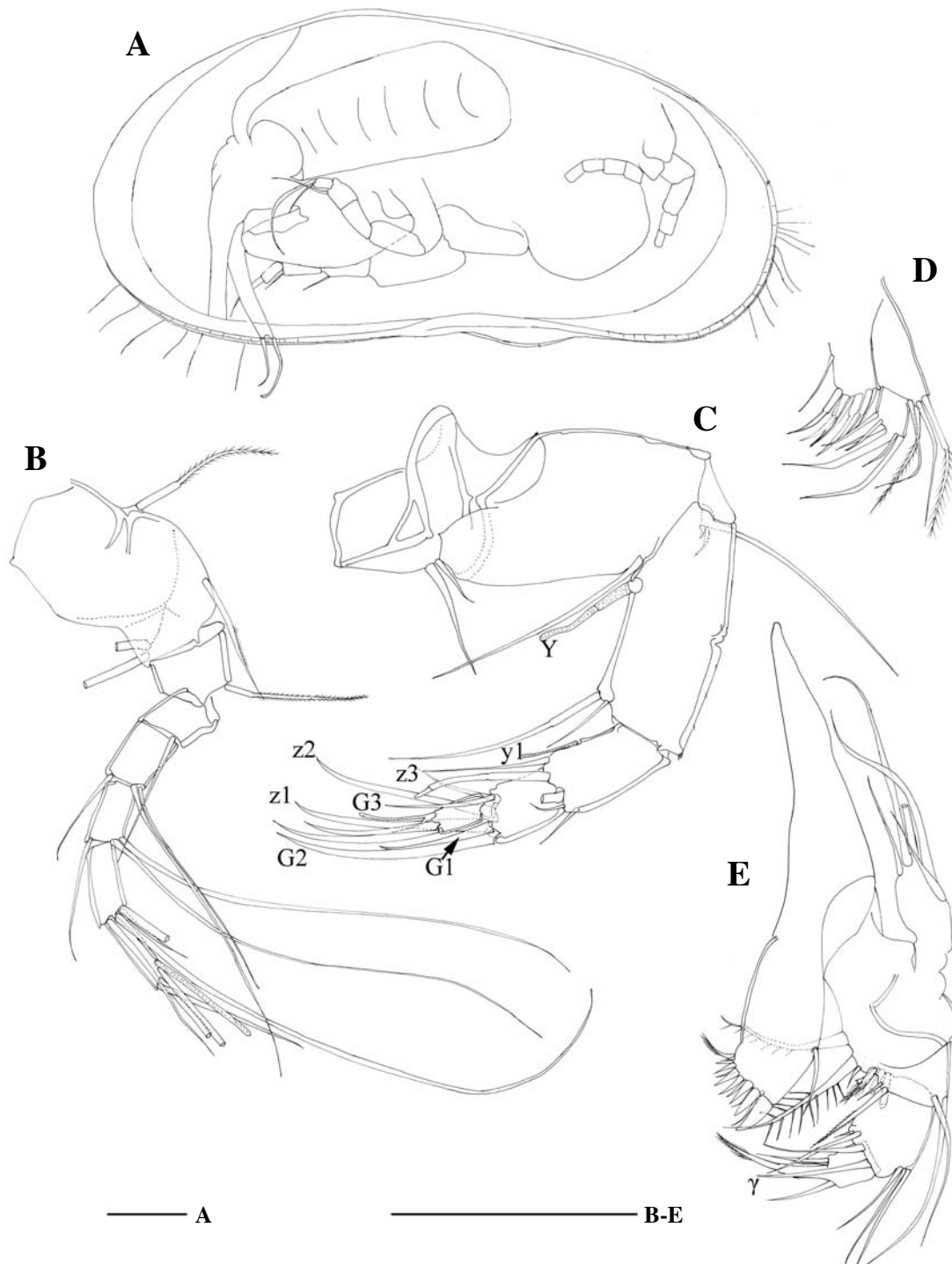
more short seta present next to t1. Claws G1 and G2 reduced, G1 still claw-like but only two times longer than terminal segment, G3 as long as G1 but transformed into seta; claw G2 long and strong. Setae z1 and z2 transformed into strong claws, subequally long and as long as G2, z3 seta like (Fig. 2G). Terminal segment carrying two claws (GM and Gm), aesthetasc y3, and one additional seta. GM shorter than Gm. Aesthetasc y2 not observed. L ratio between endopodal segments: 4.2 : 2.2 : 1.7 : 1.

Md (Fig. 3E) with 4-segmented palp, stout coxa and exopod carrying vibratory setae. First segment internally with two plumose setae, more distal one representing S1 seta, seta S2 short and plumose, while  $\alpha$ -seta smooth and

tiny. Following segment with two long setae externally and a group of 3+2 setae internally on segment. Third segment with three long outer extero-distal setae, two medio-distal setae ( $\gamma$ -seta smooth) and two intero-distal setae (one long, other short). Terminal segment with central claw distally pappose, one strong seta on its external side and two setae on its internal side (one short other as long as external seta).

Mx1 (Fig. 3D). Palp 2-segmented, distally slightly dilated. First segment with four setae distally, two plumose, two smooth. Terminal segment with two claws and four setae. Third endite with five claws and several setae.

L5 (Fig. 4A, B). Palps asymmetrical: right one (Fig. 4B)



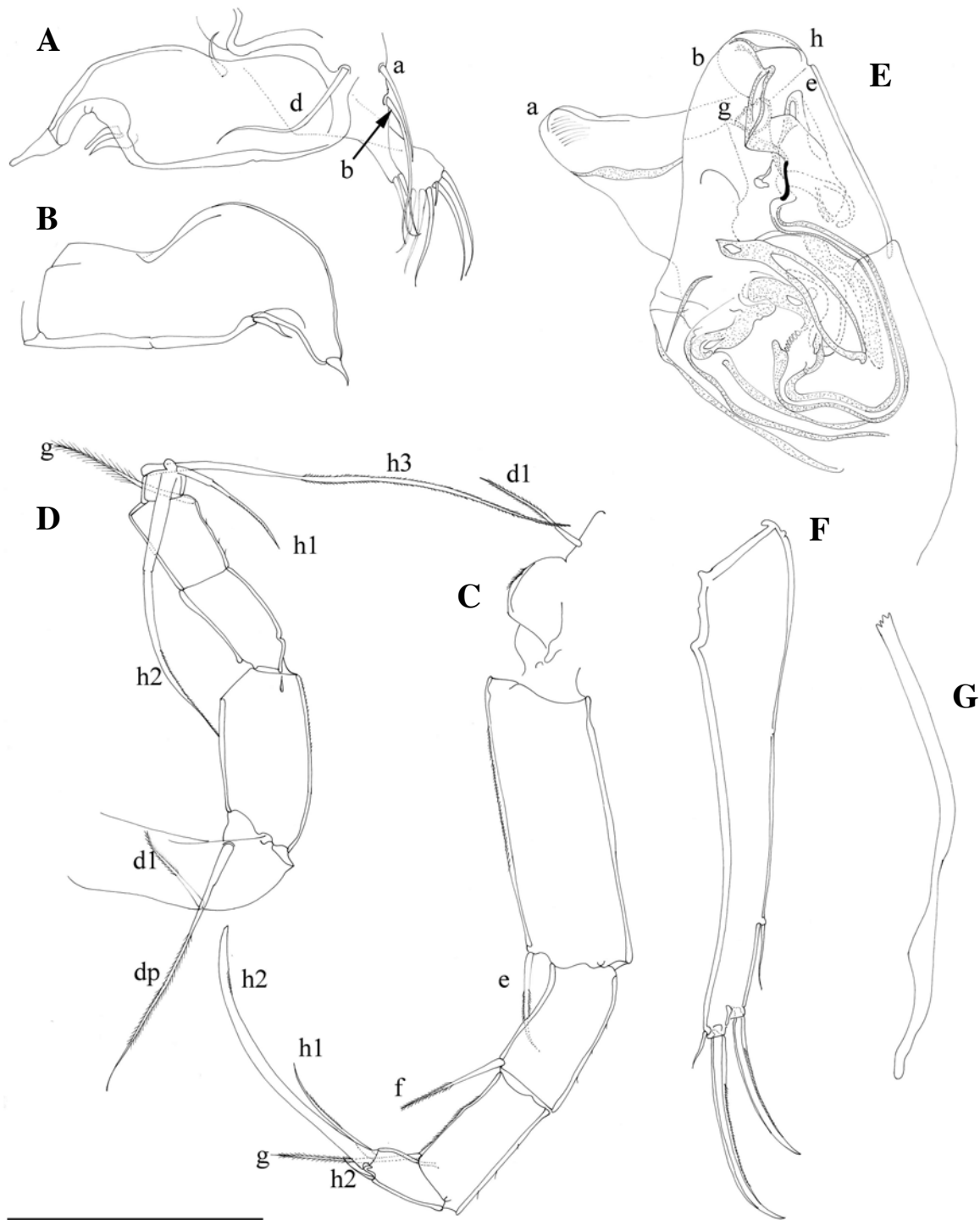
**Fig. 3.** *Earicandona mouchyon* n. gen. n. sp. Holotype, male. A. lateral view from the right side. B. A1. C. A2. D. Mx1. E. Md. Scales= 0.1 mm.

stockier than left one (Fig. 4A). Right palp also with sinusoid dorsal margin. Both fingers very short, left one terminating with stronger tips. Protopod of L5 with one a, one b, and one d-seta. One seta present on exopod.

L6 (Fig. 4C) 5-segmented. Basal segment with d1 seta.

All setae (e, f, and g) present on endopod, and all serrulate. Terminal segment with one strong claw, only lightly serrate. Terminal claw 0.8 times as long as three terminal segments combined.

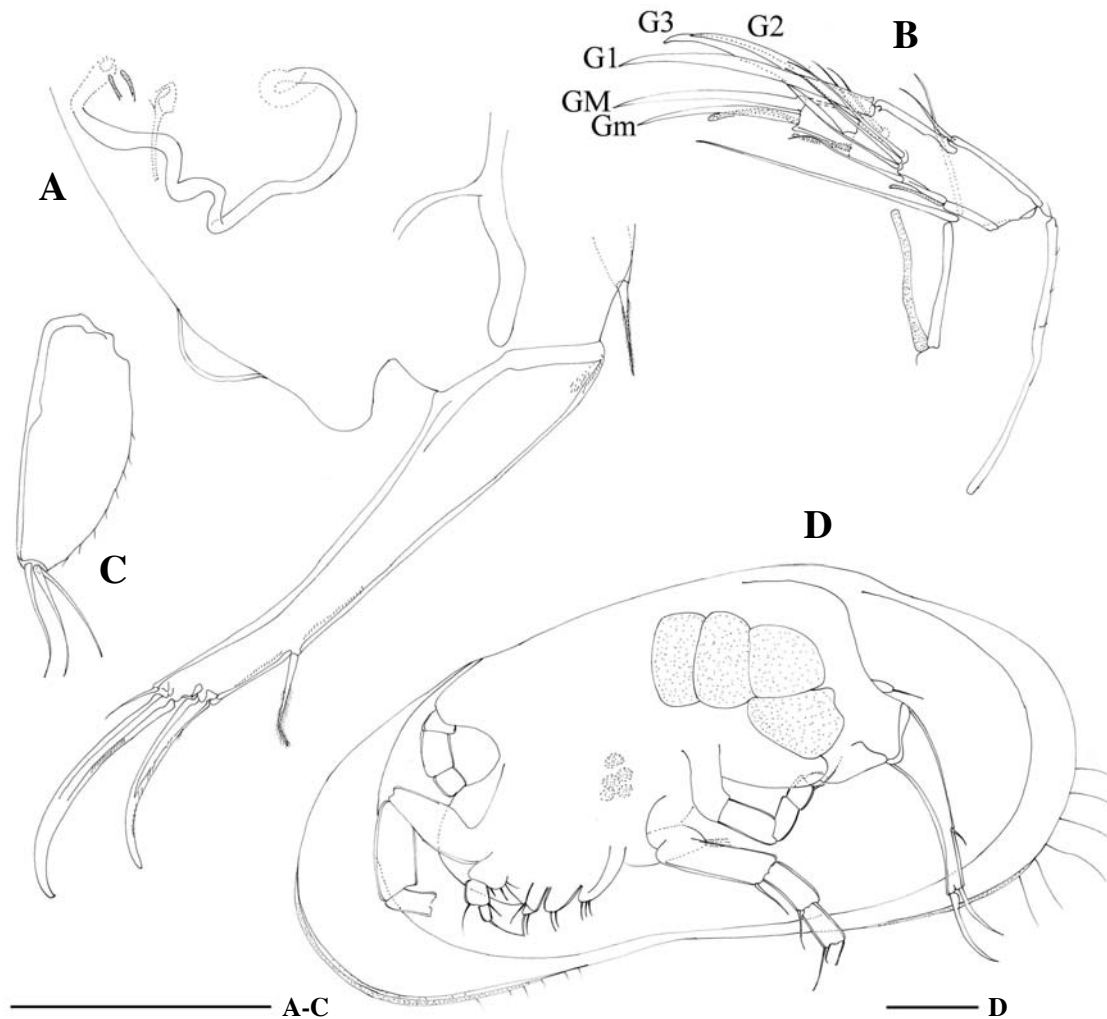
L7 (Fig. 4D) 5-segmented, penultimate segment clear-



**Fig. 4.** *Earicandona mounchyon* n. gen. n. sp. Holotype, male. A. left palp. B. Right palp. C. L6. D. L7. E. hemipenis. F. UR. G. attachment of the UR. Scales=0.1 mm.

ly subdivided. Basal segment with short d1 and longer dp seta; both setae serrulate. Setae e and f missing, while seta g long and serrulate. Terminal segment with one short and two long setae. Length ration between h1, h2, and h3 setae: 1 : 1.4 : 2.1.

UR (Fig. 4F) with long ramus and both claws and setae present. Posterior seta not reaching distal margin of ramus. Anterior claw slightly longer than posterior one. L ratio between anterior margin, anterior and posterior claws equaling: 2.6 : 1.3 : 1. Both claws lightly serrated. Atta-



**Fig. 5.** *Earicandona mounchyon* n. gen. n. sp., Allotype, female. A. UR, with genital field. B. endopod of A2. C. protopod of L5. D. lateral view from the left side. Scales=0.1 mm.

chment of UR (Fig. 4G) without any branching.

Hemipenis (Fig. 4E) with laterally projecting, triangular lobe a. This lobe with rounded tip, lightly striate and with one longitudinal sclerified patch. Both lobe b and h rounded, and hard to distinguish one from another. Lobe g not clear as well, only its basal part. Ejaculatory projection e with sclerified tip. Inside structures of hemipenis consist of several sclerified patches some probably belonging to lobe g. Inside canals not coiled.

Female: Carapace much lower from male (Figs. 5D, 6A), L=0.8 mm. Dorsal margin not arched as in male, slightly sinusoid postero-dorsally. Greatest H 47% of L. Surface of shell as in male (Fig. 6B), but no anterior striae present.

A2 (Fig. 5B) with long G1 and G3 claws, while G2 slightly shorter. All z setae unchanged.

L5 (Fig. 5C) with three apical, subequally long setae on endopod.

UR (Fig. 5A) with posterior seta slightly longer than in males. Caudal seta longer than in males. Genital field with only small protruding projection. Attachment of UR with one lateral branch starching towards genital field.

Other soft parts same as in male.

**Remarks and affinities.** Beside the new species, the genus *Earicandona* gen. nov. contains only *E. okuboi* (Smith & Janz, 2008) comb. nov., described from the Lake Biwa (Smith & Janz, 2008). Two species share a very similar hemipenis and prehensile palp morphology. On the other hand they differ in the shell shape, especially considering the sexual dimorphism, which is more pronounced in *E. mounchyon* sp. nov. Males of the new species have more inflated posterior end of the shell, and have a prominent enlargement on the ventral margin of the shell in the mouth region. The following details in the soft part morphology clearly separate the two species:

1. Seta z2 in *E. okuboi* male is thinner than in *E. moun-*



*chyon*.

2. Claw G2 in *E. okuboi* female is shorter in comparison to the G1 and G3 claws than in *E. mounchyon*.
3. Posterior claw on the UR is shorter in comparison to the anterior claw in the new species.
4. Female genital field is evenly rounded in Japanese species, while there is a small but clear triangular projection in *E. mounchyon*.

Other species that can potentially belong to *Earicandona* is *Fabaeformiscandona condylea* Smith & Janz, 2008, also known from Lake Biwa (Smith & Janz, 2008). Similar to *E. mounchyon* sexual dimorphism in carapace is more pronounced. It also has a relatively small but prominent projection on the genital field, however larger than in the new species. Prehensile palps are also short and stocky, although the left one does not have arched dorsal margin. In addition to all this, *F. condylea* lacks lobe g on the hemipenis, a character which may indicate the close relationship. Two main reasons for yet not including *F. condylea* into the new genus are: a peculiar position of the lobe a on the hemipenis (not laterally projected), and the seta z2 on the male A2 not transformed into a claw. *Fabaeformiscandona bilobata* (Klie, 1938) and *F. bilobatoides* (Löffler, 1961) have a very similar hemipenis like *F. condylea*, what was also noticed by Smith & Janz (2008). These two species are only known from Germany and Austria, and according to Meisch (2000) they may even be synonyms. Nevertheless, the morphology of prehensile palps of *F. bilobata* and *F. bilobatoides* is similar to *Earicandona*, with longer fingers, especially on the left palp in *F. bilobatoides*. These two species belong to the *breuili*-group of the genus *Fabaeformiscandona* Krstic, 1972, characterized by a small genital lobe, and a group of 4+2 setae on the inner side of the second segment of the Md-palp. So far the group contains four species, and beside *F. bilobatoides* and *F. bilobata* males are known only for *F. latens* (Klie, 1940), while only females are known for *F. breuili* (Paris, 1920), except for the rare males known only from the fossil record (Diebel & Pietrzeniuk, 1984). *Fabaeformiscandona latens* is the only species of the group with apparently prominent lobe g on the hemipenis, and a subdivided segment on the L7. In all other species the L7 is 4-segmented. So far, all species of the *breuili*-group live in subterranean waters (Meisch, 2000) and reduction in the number of segments is not rare within Candoninane living in this environment (see Danielopol, 1978; Karanovic, 2007). When establishing this group, Meisch (2000) pointed out also the small size of animals and elongated claws on the A2, another two characters of the stygobiont ostracods. In my opinion, *F. latens* is not closely related to other members of the *breuili*-group, and the other three species will most likely proven to belong to a different genus, if not *Earicandona*, than certain to a very closely related one.

Genus *Typhlocypris* Vejdovský, 1882

Subgenus *Pseudocandona* Kaufmann, 1900

***Typhlocypris (Pseudocandona) pratensis* (Hartwig, 1901) (Figs. 6C-E, 7)**

Synonymy. [non] *Candona compressa* n. sp. - Kaufmann, 1900: p. 371, Pl. 27, Figs. 4-6, Pl. 28, Figs. 6-11, Pl. 31, Fig. 18

*Candona pubescens* n. sp. - Müller, 1900: p. 26, Pl. 4: 3-4, 6, 16, 18-19, 21-22.

*Candona pratensis* nom. nov. - Hartwig, 1901: p. 109

*Pseudocandona pratensis* (Hartwig, 1901) comb. nov. - Danielopol, 1980: p. 747.

*Typhlocypris (Pseudocandona) pratensis* (Hartwig, 1901) comb. nov. - Karanovic, 2005: p. 399.

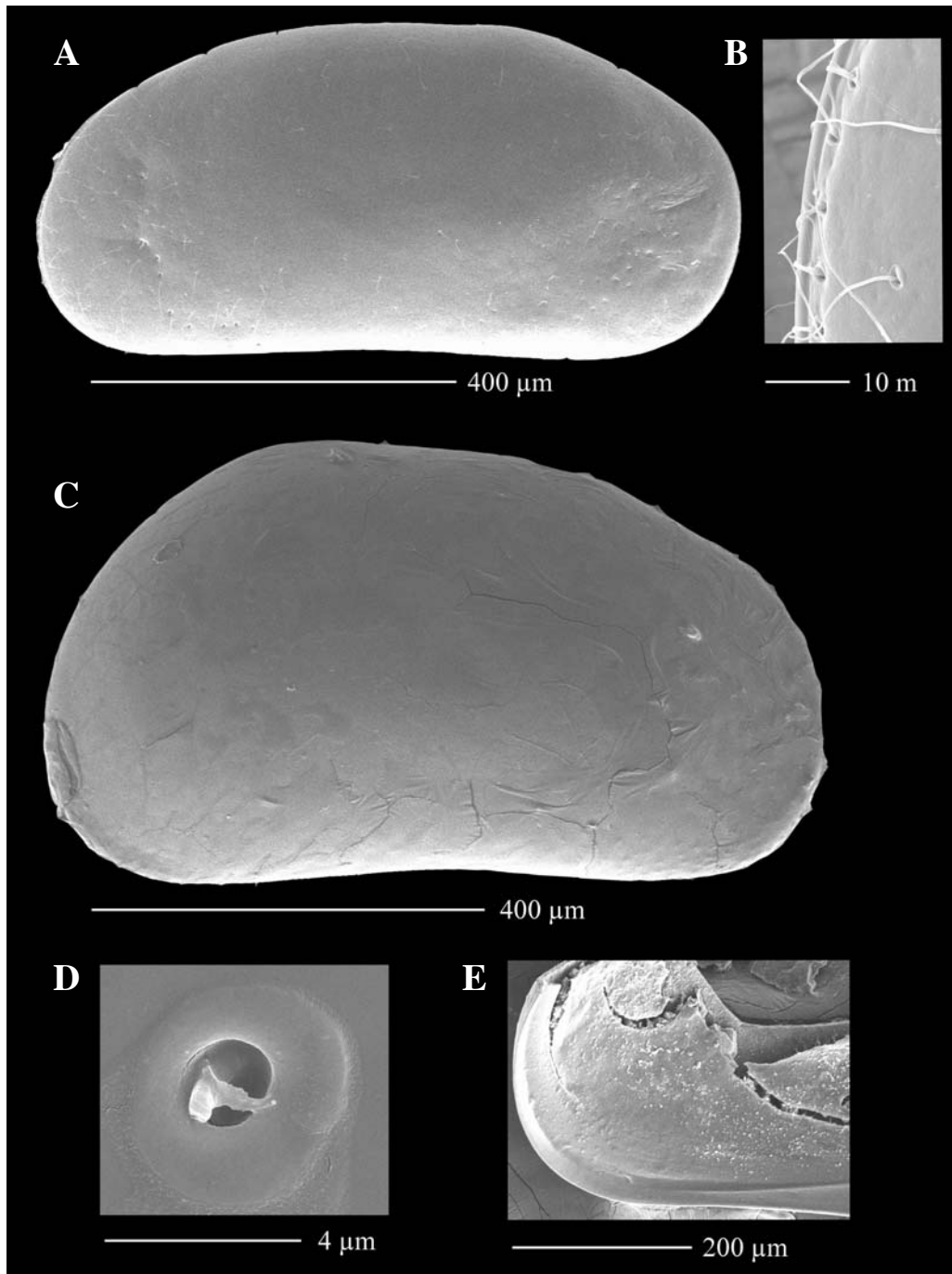
**Material examined.** One female (NIBRIV0000270972) dissected on one slide (shell not kept) from Gangwon-do, South Korea, 2011/04/23, collectors Choi & Kim.

One female (NIBRIV0000270973) dissected on one slide, shell on SEM stub, one female (NIBRIV0000270974) in alcohol from Banbyeoncheon (River), Andong, Gyeongsangbuk-do, South Korea, 36° 32.386'N 128° 49.036'E, 2012/04/05, collector I. Karanovic.

**Description.** Female: Shell almost rectangular in shape (Fig. 6C), L=0.8 mm. Greatest H situated behind middle, equaling 55% of L. Dorsal margin rounded toward posterior end, and sloping towards anterior end, with a slight sinusoid depression antero-dorsally. Both anterior and posterior margins rounded, posterior one wider. Ventral margin almost straight, except around middle where slightly concave. Anterior and posterior inner calcified lamella narrow (Fig. 6E). Surface of the shell covered with hair-like setae originating from well-defined ringed openings (Fig. 6D).

A1 (Fig. 7A) 7-segmented. First segment anteriorly with one proximal and one distal seta; posteriorly same segment with two long setae situated distally. Second and third segments with one antero-distal seta each (none of the two setae reaching distal margins of following segments). Fourth segment with one short postero-distal and two long antero-distal setae. Fifth segment with the same chaetotaxy as fourth one. Sixth segment with short  $\alpha$ -seta, two long and one short seta. Terminal segment with aesthetasc (ya) which approximately 1.5 times longer than seventh segment, one short posterior seta, and two long setae. L ratio between last five segments equal: 1 : 1.6 : 1.8 : 1.9 : 1.7. Segments one and two, and two and three articulated.

A2 (Fig. 7B) with 3-segmented endopod. Basal segment with two setae. Protopod with one long seta. Exopod reduced to plate with one long and two short setae. First endopodal segment with two postero-distal setae (unequally) long, and aesthetasc Y which not reaching distal end

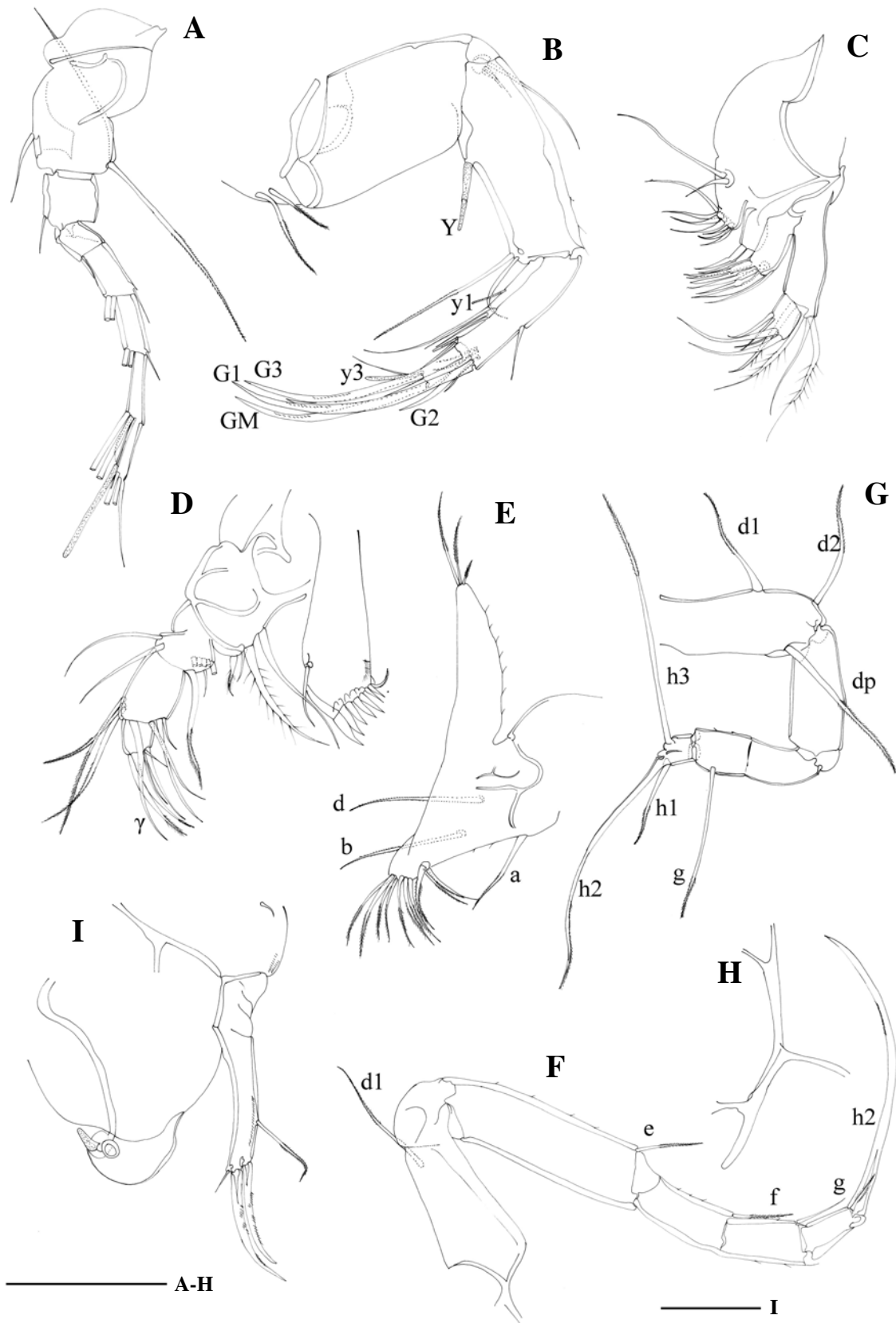


**Fig. 6.** SEM. A, B. *Earicandona mounchyon* n. gen. n. sp., paratype female. C-E. *Typhlocypris (Pseudocandona) pratensis* (Hartwig, 1901). A. shell, lateral view from the left side. B. detail of the anterior margin. C. shell, lateral view from the right side. D. opening of the surface seta. E. RV, postero-ventral margin, inside view.

of first endopodal segment. Aesthetasc y1 situated slightly above four t setae, one more short seta present posteriorly on same segment. Claw G2 reduced, but exceeding terminal segment, claws G1, G3, GM, long, Gm equaling 2/3 of GM. All z-setae normal and not transformed in claws. Aesthetasc y2 short, y3 as long as terminal segment.

L ratio between endopodal segments: 4.3 : 2.8 : 1.

Md (Fig. 7D) with 4-segmented palp, stout coxa and exopod carrying vibratory setae. First segment internally with two long setae (pappose one being S1), seta S2 short and plumose, while  $\alpha$ -seta smooth and tiny. Following segment with two long setae externally and a group of 5



**Fig. 7.** *Typhlocypris (Pseudocandona) pratensis* (Hartwig, 1901). A. A1. B. A2. C. Mx1. D. Md. E. L5. F. L6. G. L7. H. attachment of the UR. I. UR. Scales=0.1 mm.

+2 setae internally on segment. Third segment with three long outer extero-distal setae, two medio-distal setae ( $\gamma$ -seta smooth) and two intero-distal setae (one long, other short). Terminal segment with two strong claws and three setae situated more internally on segment.

Mxl (Fig. 7C). Palp 2-segmented. First segment with four setae distally, three plumose, one smooth. Terminal segment with two claws and four setae. Third endite with several claws and several setae.

L5 (Fig. 7E). Protopod of with one a, one b, and one d-seta. Endopod with three apical setae unequal in L.

L6 (Fig. 7F) 5-segmented. Penultimate segment with posterior margin sometimes undivided. Basal segment with d1 seta. All setae (e, f, and g) present on endopod. Terminal segment with one strong claw, only lightly serrated. Terminal claw 1.3 times as long as three terminal segments combined.

L7 (Fig. 7G) 5-segmented, penultimate segment subdivided. Basal segment with d1 and d2 setae shorter than dp, all three setae serrulate. Setae e and f missing, while seta g long and serrulate. Terminal segment with one short and two long setae. Length ration between h1, h2 and h3 setae: 1 : 2.7 : 2.7.

UR (Fig. 7I) with stout ramus and both claws and setae present. Posterior seta exceeding distal margin of ramus. Anterior claw slightly longer than posterior one. L ratio between anterior margin, anterior and posterior claws equaling: 1.4 : 1.2 : 1. Both claws serrated. Attachment of UR (Fig. 7H) with one dorsal and one ventral branch. Genital field rounded without any projections.

**Remarks and affinities.** *Typhlocypris* (*Pseudocandona*) *pratensis* (Hartwig, 1901) is relatively common species in Europe (Meisch, 2000), with a wide ecological tolerance and often unequal proportion of males and females in its populations. It belongs to the *compressa*-group of the genus, defined by the presence of 5+2 setae on the inner side of the second segment of the Md-palp, a 5-segmented L7, and the seta h1 on the terminal segment of the same appendage much longer than the segment itself.

Although we have not found males, we positively identify the species collected from Korea as *P. pratensis* because of the valve shape, morphology of the UR, and the length of G2, which is longer than the terminal segment. This last feature clearly distinguishes *T. (P.) pratensis* from, *T. (P.) compressa* (Koch, 1838), *T. (P.) insculpta* (Müller, 1900), *T. (P.) regisnikolai* (Karanovic & Petkovski, 1999), and *T. (P.) sucki* (Hartwig, 1901) where the G2 on the female A2 is considerably shorter. Only *T. (P.) albicans* (Brady, 1864) has the same length of the G2 claw as *T. pratensis*, but these two species can easily be distinguished by the carapace shape, because the posterior end is much higher in *T. pratensis*, and *T. albicans* is more elongated in lateral view.

### Key to the genera of the tribe Candonini (adapted after Karanovic, 2012)

1. "f" seta on L7 present ..... 2
- "f" seta on L7 absent ..... 3
2. Carapace strongly ornamented .....  
..... *Paracandona* Hartwig, 1899
- Carapace smooth ..... *Acandona* Karanovic, 2003
3. Posterior seta on UR reduced and G2 on female A2 very short, not reaching distal and of penultimate segment ..... *Phreatocandona* Danielopol, 1973
- Posterior seta on UR not reduced and G2 on female A2 exceeding distal and of penultimate segment ... 4
4. Basal seta on L6 present ..... 5
- Basal seta on L6 absent .....  
..... *Trajancandona* Karanovic, 1999
5. Zenker organ with seven whorls of spines ..... 6
- Zenker organ with six whorls of spines ..... 11
6. Seta "d2" on L7 present ..... 7
- Seta "d2" on L7 absent ..... 8
7. Left and right valves asymmetrical so that the left valve is trapezoidal or rectangular ... *Marmocandona*  
Danielopol, Namiotko & Meisch, 2012
- Valves mostly symmetrical, but if valves asymmetrical, left one triangular .....  
..... *Typhlocypris* Vejdovský, 1882
8. Lobe "g" (part "M") on hemipenis weakly sclerified ...  
..... *Earicandona* gen. nov.
- Lobe "g" (part "M") on hemipenis strongly sclerified ..... 9
9. Most posterior seta on the penultimate segment of A1 absent, right prehensile palp extremely helmet-shaped, left one with dorsal bumps .....  
..... *Fabaeformiscandona* Krstic, 1972
- Most posterior seta on the penultimate segment of A1 present, right prehensile palp not extremely helmet shaped, left one without dorsal bumps ..... 10
10. Male A2 with "z1" short, "z2" long-claw like, medial lobe on the hemipenis absent .....  
..... *Eucandona* Daday, 1900
- Male A2 with both "z1" and "z2" long claw-like, 1 medial lobe on the hemipenis present .....  
..... *Candona* Baird, 1845
11. Carapace strongly ornamented .....  
..... *Baicalocandona* Mazepova, 1976
- Carapace not ornamented .....  
..... *Schellencandona* Meisch, 1996

## DISCUSSION

*Earicandona* is the 42<sup>nd</sup> genus of the subfamily Candoninae, and it belongs to the nominotypical tribe - Candonini, together with the following genera: *Acandona* Karanovic, 2003, *Baicalocandona* Mazepova, 1976;

*Candona*, *Eucandona*, *Fabaeformiscandona*, *Marmocandona* Danielopol, Namiotko & Meisch, 2012, *Paracandona* Hartwig, 1899; *Phreatocandona* Danielopol, 1973; *Pseudocandona*, *Schellencandona* Meisch, 1996; *Trajancandona* Karanovic, 1999; and *Typhlocypris*. This tribe is defined by two long and one short seta on the terminal segment of L7, and completely developed UR. Most of the genera also lack the “f” seta on the L7. On the cladistic tree proposed by Karanovic (2007) this is the only paraphyletic Candoninae tribe. With the exception of the new genus, *Acandona*, *Paracandona*, *Phreatocandona*, and *Trajancandona* which also have one or two species, other genera are more speciose, and with time have accumulated many species, broadening the generic boundaries so much that majority of these genera need revision. This variability of characters in large genera such as *Candona*, *Fabaeformiscandona*, *Pseudocandona*, and *Typhlocypris* is the main reason for Candonini being a paraphyletic tribe.

The broad definition of *Fabaeformiscandona* (see Meisch, 2000; Smith & Janz, 2008) would easily accommodate *Earicandona mounchyon* into the *fabaeformis*-group of species. In fact, it's only congener, *Earicandona okuboi*, was a member of this group, but already Smith & Janz (2008) point out that it (and some other species) belongs to a distinct lineage (*fabaeformis*-group, lineage B). In fact, the only characters that places two *Earicandona* species into *fabaeformis*-group is the presence of three setae in the setal group on the inner side of the second segment of Md-palp. All other characters, both of the carapace and soft parts, indicate that they form a separate genus. According to these characters, the group *fabaeformis* is not even the closest relative of *Earicandona*. Morphologically much closer relatives of *Earicandona* belong to the *breuili*-group, which have four setae in the setal group on the Md-palp. It has already been shown by Karanovic (2005) that in the case of *Typhlocypris albicans* the number of setae in this setal group can even vary on one specimen. In the remarks section of *E. mounchyon* I postulated that *Fabaeformiscandona condylea* may belong to the new genus, but have left it out because of the peculiar hemipenis. This species is also a member of the *fabaeformis*-group, lineage B, but has a remarkable resemblance to some members of the *breuili*-group, also noticed by Smith and Janz (2008). Karanovic and Lee (2012a) indicated that some species from Lake Biwa, such as *F. dolabella* Smith and Janz, 2008 (another member of the *fabaeformis*-group, lineage B), are more closely related to the North American species of the *acuminata*-group (the group also has four setae in the setal group on the Md-palp) (see Karanovic, 2006) than to members of their own group. This points out that the number of setae in the setal group of the Md-palp does not bare a significant phylogenetic signal, at least not in

*Fabaeformiscandona*. Significance of the hemipenis morphology in the Candoninae taxonomy is known for a long time (Petkovski, 1969; Danielopol, 1969), but homologous structures among genera are still not well understood. In addition, prehensile palps should offer additional clues in the phylogeny of Candoninae, such as in *Fabaeformiscandona s. str.* (sensu Karanovic, 2006).

Although Danielopol *et al.* (2012) propose that the *compressa*-group should remain in the genus *Pseudocandona*, we here keep *Typhlocypris pratensis* in the subgenus *Pseudocandona*. The main reason is that there are many species from the Baikal Lake which remain in *Pseudocandona* (see Mazepova, 1990). The main common character of the Baikal *Pseudocandona* is the absence of the male sexual setae on the A2, which defines also the type species of *Pseudocandona*, *P. insculpta* (Müller, 1900), not known from the Baikal Lake, but it has a wide European distribution (Meisch, 2000). Even though the male A2 setae are not regarded as very important on the genus level in the *Pseudocandona* case (see Danielopol, 1978; Karanovic & Petkovski, 1999; Karanovic, 2005, etc.) it is still possible that the revision of the Baikal *Pseudocandona* will shed more light on the systematics of this genus, and the genus diagnosis will change.

## ACKNOWLEDGEMENTS

This publication is supported by the grant from the National Institute of Biological Resources (NIBR), funded by the Ministry of Environment (MOE) of the Republic of Korea (NIBR No. 2013-02-001).

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