Small is beautiful: diversity of freshwater ostracods (Crustacea, Ostracoda) in marginal habitats of the province of Parma (Northern Italy)

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ABSTRACT

A study on the distribution of ostracods in small freshwater habitats of the province of Parma was conducted from May 2004 to December 2005. Vernal pools, ponds, shallow lakes, fountains, springs, ditches, canals, and streams were among the most common types of aquatic systems included in this survey. Altogether, 90 sites located between 24 and 1557 m a.s.l. were visited, and 125 samples were collected. 41 samples did not contain ostracods, and 7 samples were not considered because only immature specimens or empty valves were found. Consequently, 77 samples from 58 sites were analysed. Whenever possible, ostracod identification was done at the species level based on the morphology of both valves and limbs. Thirty-eight taxa from 20 genera belonging to the families Candonidae, Ilyocyprididae, Cyprididae, and Notodromadidae were recorded. This roughly accounts for one-third of the estimated number of non-marine ostracod species in Italy. Scanning electron microscopy images of valves are provided. The maximum number of species per site was six. The most frequent species were Heterocypris incongruens*,* Eucypris virens*,* Pseudocandona pratensis*,* Cypria ophthalmica*, and* Tonnacypris lutaria*. Of particular relevance is the occurrence of species with a limited known distribution in Italy, viz.* Ilyocypris monstrifica*,* Potamocypris villosa*,* Candona *cf.* lindneri*,* Fabaeformiscandona breuili *and* Physocypria kraepelini*. A putative new species of the genus* Candona*, here left in open nomenclature, is also reported. Our results highlight the importance of so-called "marginal" aquatic habitats as potential biodiversity hotspots, in spite of the general lack of interest shown by freshwater ecologists and taxonomists in undertaking scientific investigations in these environments.*

Key words: inland water bodies, Recent ostracods, taxonomy, biodiversity

1. INTRODUCTION

The ostracods (class Ostracoda) are the most diverse group of crustaceans with an estimated range from 4000 to 30000 living species (Meisch 2000). Their most salient characteristic is the presence of a bivalve carapace that can completely enclose a laterally-compressed and weakly-segmented body. They can be found in inland and marine waters, in interstitial and groundwater environments and also in semi-terrestrial habitats such as leaf litter. All Recent freshwater ostracods belong to the order Pocodocopida. They mainly colonize benthic and periphytic habitats and feed on both living and detrital particles; more rarely, they can be predators or parasites.

This research aims to provide a faunal account of ostracods living in freshwater habitats of the province of Parma (Northern Italy) and investigate their distributional patterns. A previous study (Rossetti *et al*. 2005) examined the composition of the ostracod communities in 20 lowland springs within the province. The considered area is rich in waters, both lentic and lotic. It is characterized by a strong south-north altitudinal gradient from the lowlands to the Apennine ridge (with a maximum elevation of 1861 m a.s.l.) and by a variety of climatic, geological and land-use conditions.

We primarily focussed our attention on the prevalent types of aquatic habitats in this territory, i.e. small water bodies, either natural or artificial. The marginality of these ecosystems is generally related to their isolation, unpredictable duration, natural or anthropic disturbance and, in many cases, deficient regulatory and legislative policies for their protection. This results in biological communities that are mainly composed of species able to cope with harsh environmental conditions, for example, a high variability of hydrological and hydrochemical characteristics. This study was stimulated by preliminary observations indicating an unexpectedly diverse ostracofauna in minor aquatic ecosystems and seeks, along with data recently collected from other parts of the country (e.g., Rossetti *et al*. 2004; Pieri *et al*. 2006a, 2006b), to contribute to the revision and updating of the checklist of Italian ostracods (Ghetti & McKenzie 1981).

2. MATERIALS AND METHODS

Sampling was performed from May 2004 to December 2005 in 90 sites located between 24 and 1557 m a.s.l. Sampling locations were chosen to possibly encompass the most common types of marginal aquatic habitats and to cover the entire altitudinal range of the

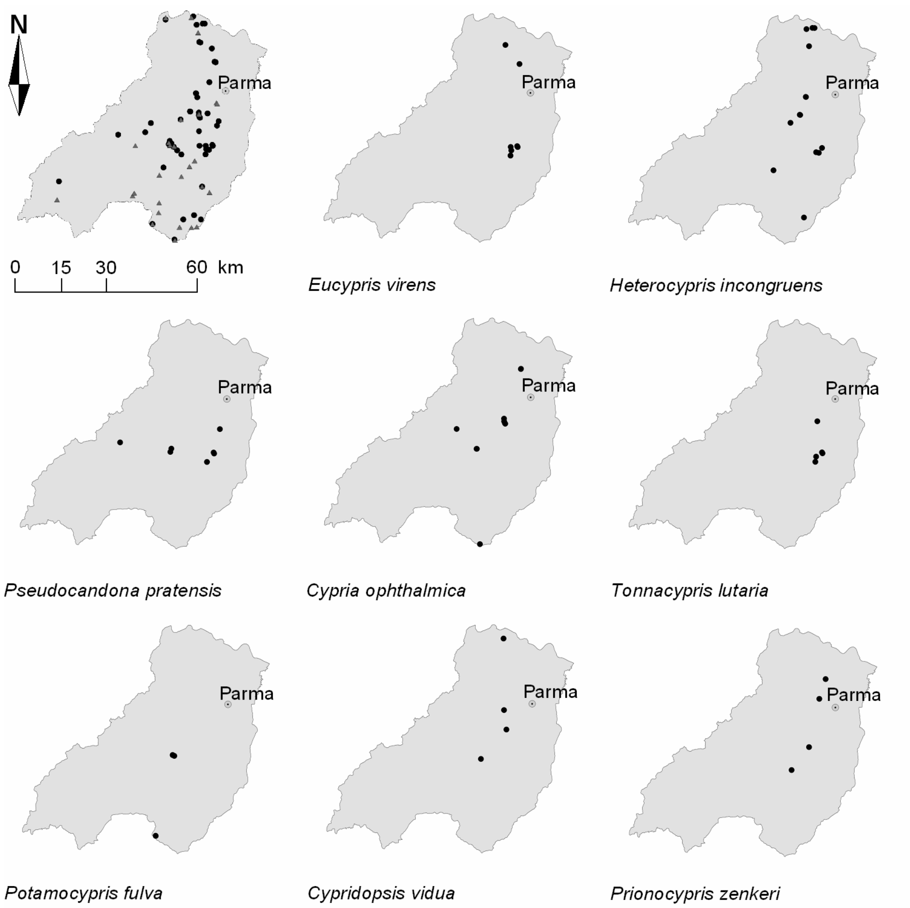

Fig. 1. Map of the province of Parma showing the sampling sites considered in this study (circles) and those not included (triangles) because no ostracods were found or only immature stages or empty valves were present (upper left corner), and distribution of the most frequently found ostracod species.

province of Parma. Qualitative ostracod samples were collected using a 250 µm hand net or, when not possible due to the limited size of the sampled site, with cloth coffee filters. In total, 125 samples were collected and transferred to the laboratory, where living specimens were picked up under a binocular microscope within 24 hours of sampling and then fixed in 80% ethanol. In 13 sites, ostracods were gathered on different dates. Forty-one samples did not contain ostracods, while an additional 7 samples were not considered because only immature specimens or empty valves were found. Therefore, 77 samples from 57 sites were eventually analysed (Tab. 1, Fig. 1). The specific allocation of the collected material was based on adult specimens; in a few cases (*Candona* sp. B in S72, *Candona* sp. C in S24, and *Pseudocandona* sp. in S57 and S72) the identification remained at the generic level because only a few individuals, damaged material or females were available for the taxonomic analysis. Both soft parts (dissected in glycerine and stored in sealed slides) and valves (stored dry in micropaleontological slides and used for scanning microphotographs) were checked for species identification, using Fox (1965) for *Chlamydotheca incisa*, González-Mozo *et al*. (1996) for the genus *Herpetocypris*, and Meisch (2000) for the remaining taxa. The analyzed material is deposited at the Department of Environmental Sciences, University of Parma (preceded by the code "VP") and in the Ostracod Collection of the Royal Belgian Institute of Natural Sciences, Brussels (preceded by the codes "OC" and "RP"). We used the following abbreviations in our figures: L: left; R: right; V: valve; Cp: carapace; dv: dorsal view; vv: ventral view; lv: lateral view; iv: internal view; ev: external view.

3. RESULTS

Altogether, 38 taxa in 20 genera belonging to 4 families (Candonidae, Ilyocyprididae, Cyprididae, and Notodromadidae) were identified (Tab. 2; Figs 2-5). The maximum number of species reported in a single sample (S58) was 6, namely *Chlamydotheca incisa*, *Heterocypris incongruens*, *H. salina*, *Dolerocypris sinensis*, *Trajancypris clavata* and *Ilyocypris monstrifica*. Other samples with a relatively high number of species were S57 and S67, both containing 4 species. On the other hand, 16 taxa were found only in one site (Tab. 2).

Tab. 1. Geographic characteristics of sampling stations and list of samples used in this study.

Site name	Coordinates	Height (m a.s.l.)	Habitat type	Municipality	Sampling date	Sample code
Montevacà	N44°32'00" E09°36'49"	777	Fountain basin	Bedonia	13 Mar 2005	S01
Calestano	N44°36'39" E10°07'55"	391	Fountain basin	Calestano	16 Jun 2005	S02
SP15 km 12.5	N44°34'20" E10°03'20"	721	Fountain basin	Calestano	19 Sep 2004	S03
Canale del Mulino	N44°44'23" E10°10'20"	107	Canal	Collecchio	05 May 2004	S04
Case Folli	N44°44'00" E10°14'43"	129	Ditch	Collecchio	16 Jun 2005	S05
Corte Giarola	N44°44'25" E10°10'14"	107	Temporary pool	Collecchio	05 May 2004	S06
Lago Chiesuole	N44°46'57" E10°12'08"	73	Artificial lake	Collecchio	05 May 2004	S07
Qualatico	N44°42'58" E10°07'50"	117	Temporary pool	Collecchio	05 May 2004	S08
Rio del Lago Santo	N44°24'05" E10°00'22"	1515	Creek	Corniglio	27 Jul 2005	S09
Fontana del Lago Santo	N44°24'07" E10°00'21"	1510	Fountain basin	Corniglio	27 Jul 2005	S10
Ponte del Cogno	N44°25'37" E10°10'55"	986	Fountain basin	Corniglio	27 Jul 2005	S11
Via Bambozza	N44°41'47" E10°17'05"	153	Ditch	Felino	16 Jun 2005	S12
Fonte Lupo - Rio Lusore	N44°39'07" E10°05'00"	480	Rheocrenic spring	Fornovo di Taro	27 Apr 2005	S13
					17 Nov 2005	S14
Laghetto di Villanova	N44°38'03" E10°06'00"	316	Permanent pond	Fornovo di Taro	04 May 2005	S15
					22 Nov 2005	S16
Prima Bratte	N44°38'22" E10°05'09"	573	Rheocrenic spring	Fornovo di Taro	04 May 2005	S17
					17 Nov 2005	S18
Seconda Bratte	N44°38'28" E10°05'17"	545	Rheocrenic spring	Fornovo di Taro	17 Nov 2005	S19
Rio delle Bighe	N44°38'53" E10°04'57"	490	Streamlet	Fornovo di Taro	24 Mar 2005	S20
					04 May 2005	S21
					17 Nov 2005	S22
Rio di Chiastra	N44°38'32" E10°04'44"	563	Streamlet	Fornovo di Taro	22 Nov 2005	S23
Fontana Sgalara	N44°38'44" E10°05'20"	523	Fountain basin	Fornovo di Taro	17 Nov 2005	S24
Sorgente Sgalara	N44°38'44" E10°05'24"	506	Rheocrenic spring	Fornovo di Taro	10 May 2005	S25
					17 Nov 2005	S26
Case Manfredelli	N44°38'07" E10°15'55"	431	Temporary pool	Langhirano	19 Mar 2005	S27
					22 Apr 2005	S28
					20 Oct 2005	S29
Costa di Castrignano P1	N44°36'35" E10°14'03"	469	Temporary pool	Langhirano	18 Mar 2005	S30
					22 Apr 2005	S31
					20 Oct 2005	S32
Costa di Castrignano P2	N44°36'35" E10°14'03"	469	Temporary pool	Langhirano	18 Mar 2005	S33
					22 Apr 2005	S34
					20 Oct 2005	S35
Mattaleto	N44°37'25" E10°14'57"	385	Temporary pool	Langhirano	22 Apr 2005	S36
Strognano	N44°38'10" E10°14'09"	436	Temporary pool	Langhirano	22 Apr 2005	S37
Tordenaso	N44°38'11" E10°12'33"	431	Temporary pool	Langhirano	22 Apr 2005	S38
Vallo di Sotto	N44°37'31" E10°14'17"	410	Temporary pool	Langhirano	18 Mar 2005	S39
					22 Apr 2005	S40
					10 Jun 2005	S41
Vidiana P1	N44°38'18" E10°15'47"	279	Temporary pool	Langhirano	18 Mar 2005	S42
					22 Apr 2005	S43
					10 Jun 2005	S44
					20 Oct 2005	S45
Capanna Biancani	N44°21'16" E10°05'52"	1557	Bog	Monchio delle Corti	04 Aug 2005	S46
Ponte di Lugagnano	N44°24'52" E10°08'10"	680	Fountain basin	Monchio delle Corti	16 Jun 2004	S47
					04 Aug 2005	S48
La Casella P1	N44°47'40" E10°11'53"	67	Temporary pool	Noceto	05 May 2004	S49
La Casella P2	N44°47'41" E10°11'50"	67	Temporary pool	Noceto	05 May 2004	S50
Vairo Inferiore	N44°24'49" E10°12'37"	731	Fountain basin	Palanzano	04 Aug 2005	S51
Strada Mulattiera	N44°49'39" E10°15'18"	44	Ditch	Parma	15 Jun 2005	S52
Torrazza	N44°42'33" E10°17'29"	139	Ditch	Parma	16 Jun 2005	S53
Ongina Morta	N45°01'06" E10°04'21"	33	Dead river channel	Polesine Parmense	03 May 2004	S54
Cava dei Francesi 2	N45°01'36" E10°11'27"	25	Artificial lake	Roccabianca	08 Jun 2005	S55
Fossa 1	N45°00'16" E10°13'48"	27	Ditch	Roccabianca	15 Jun 2005	S56
Fossa 2	N45°00'15" E10°14'20"	26	Ditch	Roccabianca	15 Jun 2005	S57
Rigosa Vecchia	N45°00'05" E10°12'16"	27	Canal	Roccabianca	17 May 2004	S58
					15 Jun 2005	S59
Bosco della Capannella	N44°44'11" E10°12'29"	164	Temporary pool	Sala Baganza	02 Dec 2004	S60
Castellaro	N44°40'50" E10°12'29"	213	Isolated river pool	Sala Baganza	16 Jun 2005	S61
Lago Antonia	N44°43'15" E10°12'46"	191	Permanent pond	Sala Baganza	02 Dec 2004	S62
Lago di Monte Tinto	N44°43'41" E10°12'29"	179	Permanent pond	Sala Baganza	02 Dec 2004	S63
Lago di Ponte Verde	N44°43'22" E10°12'39"	193	Artificial lake	Sala Baganza	02 Dec 2004	S64

(continued)

Tab. 1. Continuation

Site name	Coordinates	Height (m a.s.l.)	Habitat type	Municipality	Sampling date	Sample code
Case Ziliotti	N44°56'57" E10°12'52"	30	Ditch	San Secondo P.se	21 Jan 2005	S65
Colmignola	N44°56'52" E10°13'10"	30	Ditch	San Secondo P.se	03 May 2004	S66
Lesignano Palmia	N44°37'24" E10°06'52"	370	Fountain basin	Terenzo	26 May 2005	S67
Carpaneto	N44°30'47" E10°13'03"	541	Fountain basin	Tizzano Val Parma	02 Jul 2004	S68
Canale Lazzaretto	N44°53'20" E10°16'43"	24	Ditch	Trecasali	03 May 2004	S69
					21 Jan 2005	S70
Canale Lorno	N44°53'16" E10°17'00"	27	Canal	Trecasali	15 Jun 2005	S71
Cimitero di Trecasali	N45°55'48" E10°16'05"	28	Ditch	Trecasali	15 Jun 2005	S72
La Commenda	N44°53'14" E10°16'59"	28	Limnocrenic spring	Trecasali	15 Jun 2005	S73
Lazzaretto 2	N44°53'17" E10°16'58"	24	Ditch	Trecasali	15 Jun 2005	S74
Bivio Aie - Sitla	N44°40'45" E09°58'50"	377	Stillicide on mosses	Varano de' Melegari	24 Jul 2005	S75
Riviano Chiesa	N44°42'24" E10°00'17"	423	Fountain basin	Varano de' Melegari	20 Nov 2005	S76
Case Buffalora	N44°40'22" E09°51'56"	374	Temporary pool	Varsi	13 Mar 2005	S77

Tab. 2. Taxonomic list of ostracods found in this study, and stations (codes as in Tab. 1) where they were collected.

Superfamily Cypridoidea s. str. Baird, 1845	
Family Candonidae Kaufmann, 1900	
Subfamily Candoninae Kaufmann, 1900	
Genus *Candona* s. str. Baird, 1845	
Candona cf. *lindneri* Petkovski, 1969	S63, S70
Candona neglecta Sars, 1887	S19, S25, S26
Candona sp. A	S34, S35
Candona sp. B	S72
Candona sp. C	S24
Genus *Fabaeformiscandona* Krstić, 1972	
Fabaeformiscandona breuili (Paris ,1920) nov. comb.	S13
Genus *Pseudocandona* Kaufmann, 1900	
Pseudocandona lobipes (Hartwig, 1900)	S74
Pseudocandona pratensis (Hartwig, 1901)	S14, S23, S29, S30, S31, S32, S34, S35, S45, S53, S77
Pseudocandona albicans (Brady, 1864)	S67
Pseudocandona sp.	S57, S72
Genus *Candonopsis* Vávra, 1891	
Candonopsis kingsleii (Brady & Robertson, 1870)	S57
Subfamily Cyclocypridinae Kaufmann, 1900	
Genus *Cypria* Zenker, 1854	
Cypria ophthalmica (Jurine, 1820)	S24, S26, S46, S60, S62, S63, S64, S71, S73, S76
Genus *Physocypria* Vávra, 1897	
Physocypria kraepelini (G.W. Müller, 1903)	S54
Genus *Cyclocypris* Brady & Norman, 1889	
Cyclocypris laevis (O.F. Müller, 1776)	S73
Cyclocypris ovum (Jurine, 1820)	S46
Family Ilyocyprididae Kaufmann, 1900	
Subfamily Ilyocypridinae Kaufmann, 1900	
Genus *Ilyocypris* Brady & Norman, 1889	
Ilyocypris gibba (Ramdohr, 1808)	S08, S16
Ilyocypris monstrifica (Norman, 1862)	S55, S58
Ilyocypris decipiens (Masi, 1905)	S16
Ilyocypris bradyi Sars, 1890	S07, S15, S71
Ilyocypris inermis Kaufmann, 1900	S18, S38, S74
Family Notodromadidae Kaufmann, 1900	
Subfamily Notodromadinae Kaufmann, 1900	
Genus *Notodromas* Lilljeborg, 1853	
Notodromas persica Gurney, 1921	S57

(continued)

Tab. 2. Continuation

Family Cyprididae Baird, 1845	
Subfamily Eucypridinae Bronshtein, 1947	
Genus *Eucypris* Vávra, 1891	
Eucypris virens (Jurine, 1820)	S28, S30, S31, S32, S33, S34, S35, S37, S39, S42, S43, S45, S66, S69, S70
Eucypris cf. *pigra* (Fischer, 1851)	S67
Genus *Prionocypris* Brady & Norman, 1896	
Prionocypris zenkeri (Chyzer & Toth, 1858)	S02, S52, S61, S71
Genus *Tonnacypris* Diebel & Pietrzeniuk, 1975	
Tonnacypris lutaria (Koch, 1838)	S05, S27, S28, S29, S30, S31, S39, S40, S42
Genus *Trajancypris* Martens, 1989	
Trajancypris clavata (Baird, 1838)	S58
Subfamily Herpetocypridinae Kaufmann, 1900	
Genus *Herpetocypris* Brady & Norman, 1889	
Herpetocypris cf. *brevicaudata* Kaufmann, 1900	S03, S12
Herpetocypris chevreuxi (Sars, 1896)	S64
Genus *Psychrodromus* Danielopol & McKenzie, 1977	
Psychrodromus olivaceus (Brady & Norman, 1889)	S67, S75
Psychrodromus fontinalis (Wolf, 1920)	S17, S18
Subfamily Cypridinae Baird, 1845	
Genus *Chlamydotheca* (Saussure, 1858)	
Chlamydotheca incisa (Claus, 1812)	S58, S59
Subfamily Cyprinotinae Bronshtein, 1947	
Genus *Heterocypris* Claus, 1892	
Heterocypris incongruens (Ramdohr, 1808)	S03, S04, S06, S08, S11, S36, S39, S41, S44, S49, S50, S56, S57, S58, S65
Heterocypris salina (Brady, 1868)	S58
Heterocypris reptans (Kaufmann, 1900)	S47, S48, S67, S68
Subfamily *Dolerocypridinae* Triebel, 1961	
Genus *Dolerocypris* Kaufmann, 1900	
Dolerocypris sinensis (Sars, 1903)	S58
Subfamily Cypridopsinae Kaufmann, 1900	
Genus *Cypridopsis* Brady, 1867	
Cypridopsis vidua (O.F. Müller, 1776)	S07, S15, S54, S59, S64
Genus *Potamocypris* Brady, 1870	
Potamocypris fulva (Brady, 1868)	S09, S10, S20, S21, S22, S25, S26
Potamocypris villosa (Jurine, 1820)	S01, S51, S68

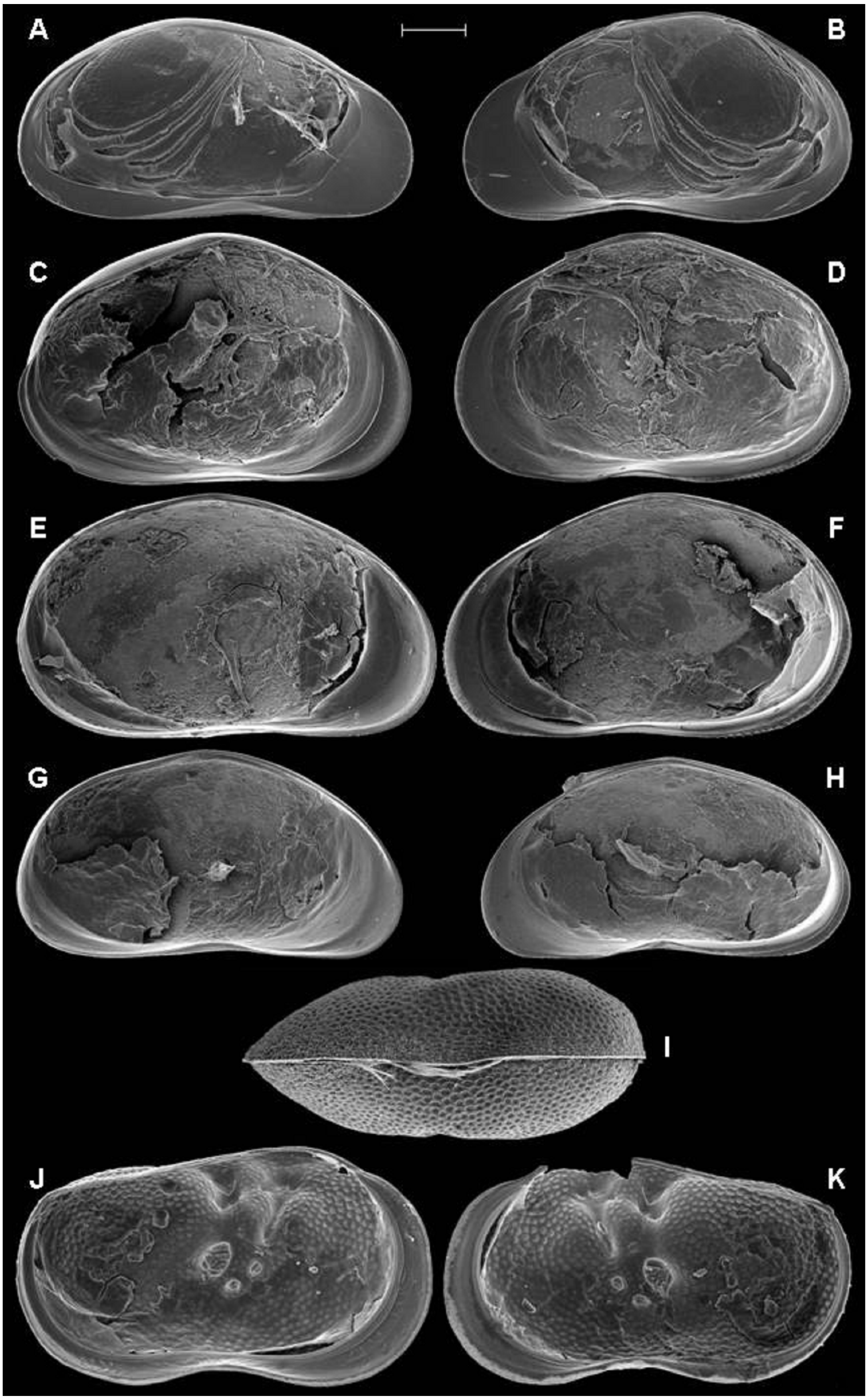

Fig. 2. *Candonopsis kingsleii* (**A**–**B**); *Heterocypris salina* (**C**–**D**); *Heterocypris incongruens* (**E**–**F**); *Heterocypris reptans* (**G**–**H**); *Ilyocypris gibba* (**I**–**K**). All adult specimens. (**A**): VP0621, male, LV, iv; (**B**): idem, RV, iv; (**C**): VP0045, female, LV, iv; (**D**): idem, RV, iv; (**E**): VP0226, female, LV, iv; (**F**): idem, RV, iv; (**G**): VP0060, female, LV, iv; (**H**): VP0060, idem, iv; (**I**): VP0313, Cp, vv; (**J**): VP0034, female, LV, iv; (**K**): idem, RV, iv (partially damaged). Scale bar: 167 µm for A–B; 200 µm for C–H; 130 µm for I–K.

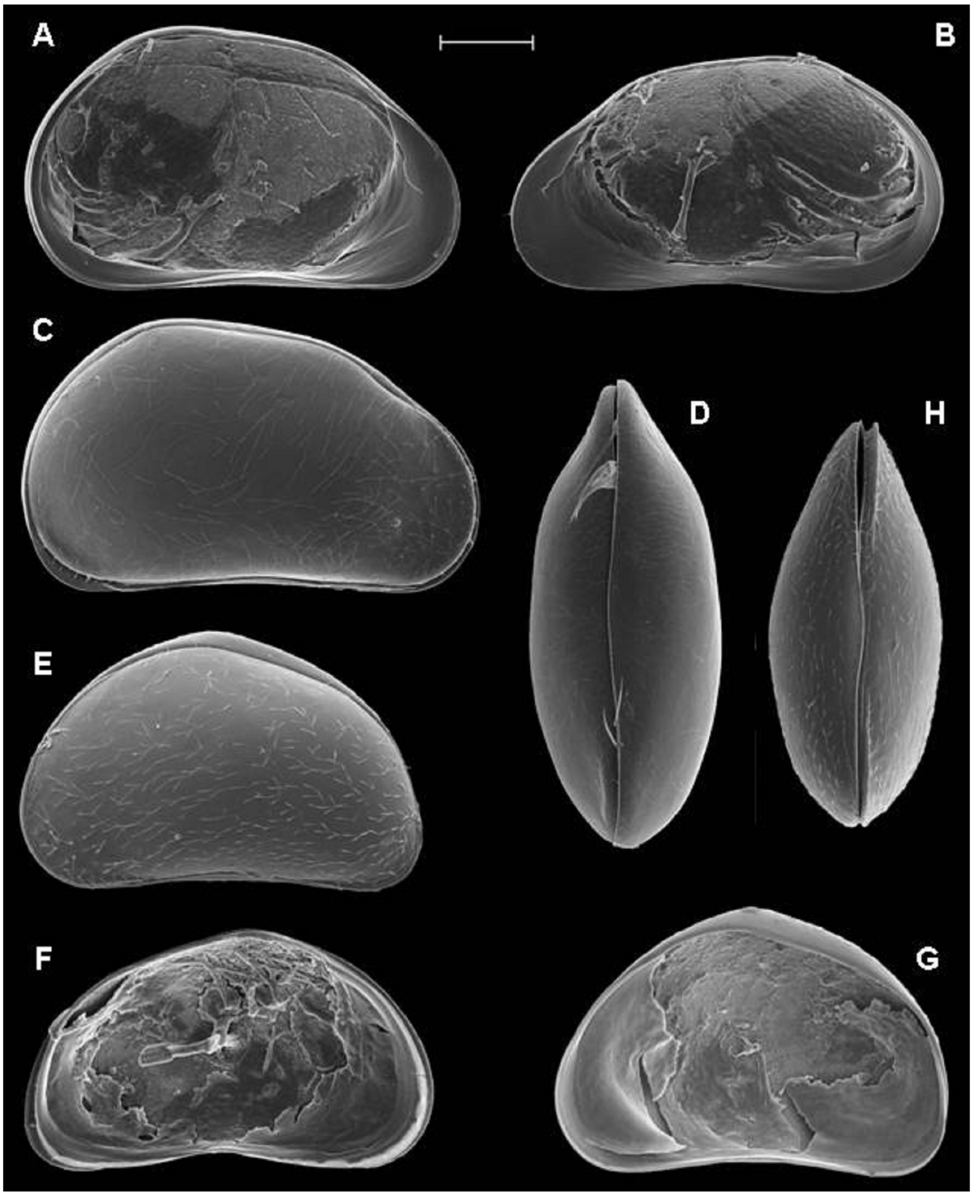

Fig. 3. *Pseudocandona pratensis* (**A**–**D**); *Potamocypris villosa* (**E**–**H**). All adult specimens. (**A**): VP0623, male, LV, iv; (**B**): idem, RV, iv; (**C**): VP0638, female, Cp, Rlv; (**D**): VP0639, female, Cp, vv; (**E**): VP0308, female, Cp, Llv; (**F**): VP0076, female, LV, iv; (**G**) idem, RV, iv; VP0307, female, Cp, vv. Scale bar: 200 µm for **A**–**D**, 160 µm for **E**–**H**.

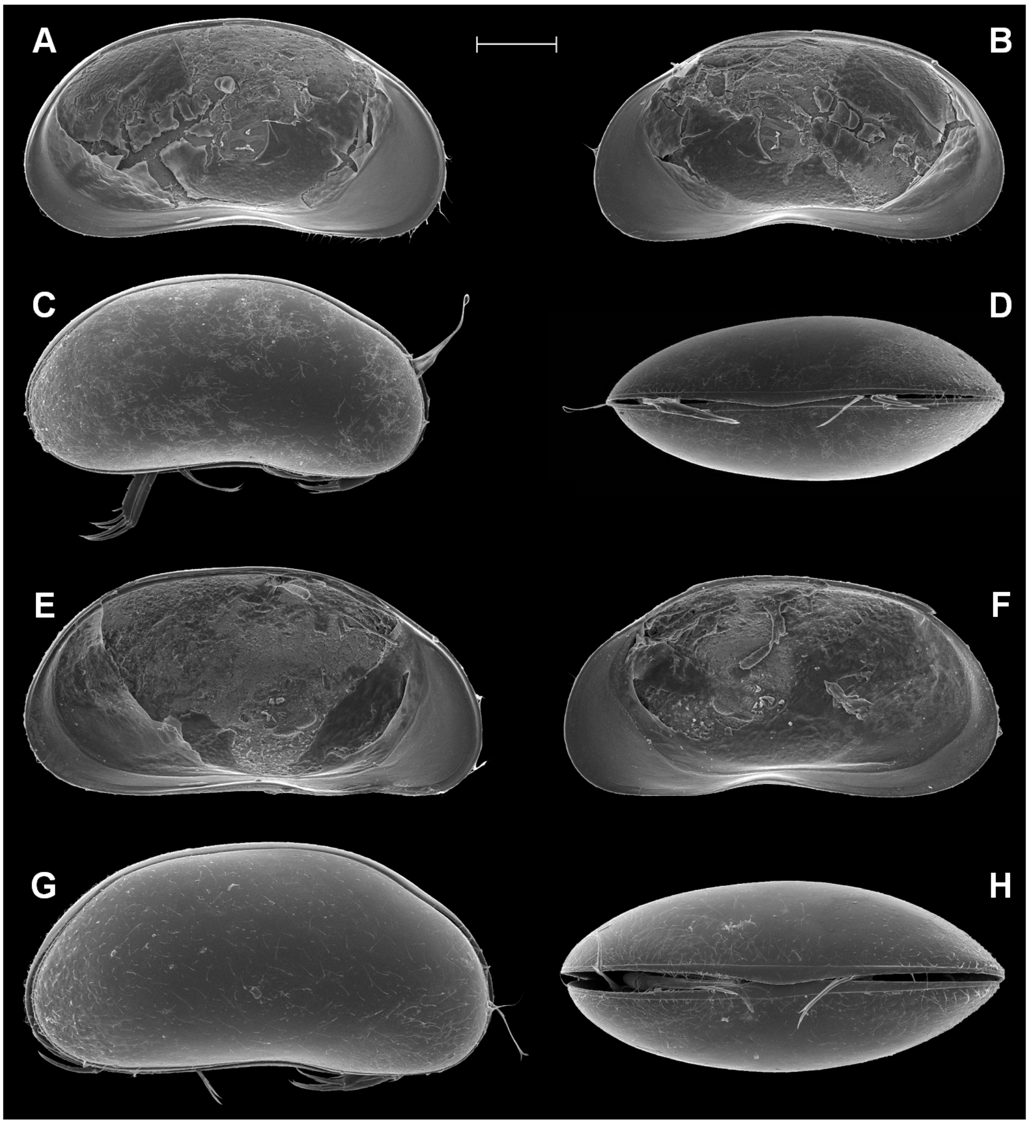

Fig. 4. *Psychrodromus fontinalis* (**A–D**); *Psychrodromus olivaceus* (**E–H**). All adult specimens. (**A**): VP0470, female, LV, iv; (**B**): idem, RV, iv; (**C**): VP0645, female, Cp, Rlv; (**D**): VP0646, female, Cp, vv; (**E**): VP0622, female, LV, iv; (**F**): idem, RV, iv; (**G**): VP0647, female, Cp, Rlv; (**H**): VP0648, female, Cp, vv. Scale bar: 229 µm for **A-D**; 200 µm for **E-H**.

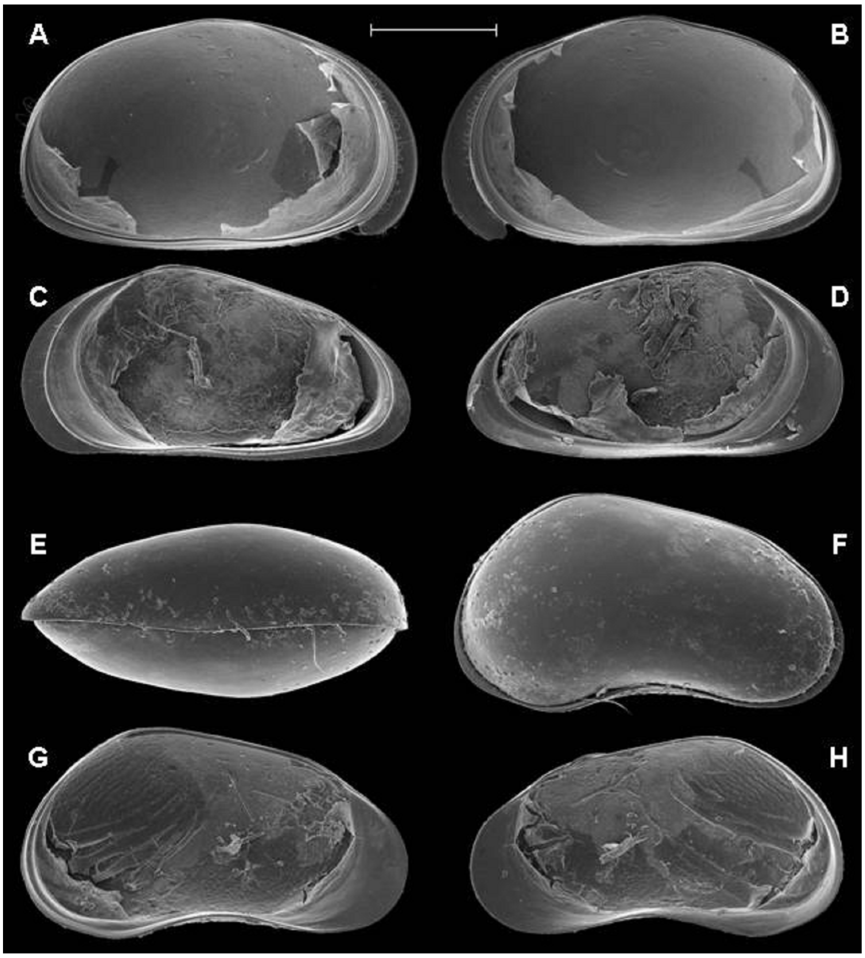

Fig. 5. *Chlamydotheca incisa* (**A**–**B**); *Trajancypris clavata* (**C**–**D**); *Candona* sp. A (**E**–**H**). All adult specimens. (**A**): RP312, female, LV, iv; (**B**): idem, RV, iv; (**C**): VP0027, female, LV, iv; (**D**): idem, RV, iv; (**E**):VP0644, female, Cp, vv; (**F**): VP0643, male, Cp, Rlv; (**G**): VP0619, male, LV, iv; (**H**): idem, RV, iv. Scale bar: 800 µm for **A**–**B**, 750 µm for **C**–**D**, 500 µm for **E**-**H**.

Eucypris virens and *Heterocypris incongruens* were the most common species, both with 15 records. *Eucypris virens* was found at altitudes below 500 m a.s.l., mostly in temporary waters and during winter months. *Heterocypris incongruens* was reported across a wider range of altitudes (up to 986 m a.s.l., S11), in different habitat types and over a broader temporal span. Moreover, *H. incongruens* was the only species found in 10 samples out of 15 in contrast to *E. virens* which was often found with *Pseudocandona pratensis* (in 6 samples) and *Tonnacypris lutaria* (in 5 samples). Apart from the above mentioned cases, no other recurrent species associations were observed.

Other species which occurred frequently were *Cypria ophthalmica* (in 10 samples taken from environments with distinct features), *Pseudocandona pratensis* and *Tonnacypris lutaria* (respectively in 11 and 9 samples, predominantly from temporary pools), and *Potamocypris fulva* (in 7 samples collected from sites characterised by moderate water turbulence) (Tabs 1, 2; Fig. 1).

The presence of *Heterocypris reptans* was restricted to samples taken from fountain basins (S47, S48, S67, S68). The coexistence of congeneric species was detected in two samples, S16 (*Ilyocypris* decipiens and *I. gibba*) and S58 (*Heterocypris incongruens* and *H. salina*). *Chlamydotheca incisa* was the sole species that did not belong to the fauna of the considered area.

Of particular interest is the record of *Candona* sp. A (Fig. 5E-H) in the temporary pool Costa di Castrignano P2 (Tabs 1, 2). This candonid ostracod, left in open nomenclature, is probably a new species, whose formal taxonomic description will be given elsewhere. However, some important morphological features are reviewed here. *Candona* sp. A belongs to the *neglecta*-group, together with *C. neglecta*, *C. lindneri*, *C. meerfeldiana*, *C. muelleri* and *C. angulata* (Meisch 2000). This species-group is characterised by the presence of a setal group with 4 setae on the second segment of the mandibular palp. The closest congeners of *C.* sp. A are doubtlessly *C. neglecta* and *C. lindneri*. Nevertheless, *C.* sp. A can be distinguished from both the preceding species by its unique combination of valve and soft part features. In particular, the G2 claw on the antenna of the female is slightly shorter than G1 and G3 (while it is distinctly reduced in size in both *C. neglecta* and *C. lindneri*), the female genital lobe has a conspicuous conical process that is directed posteriorly (in the two other species the genital lobe has no posterior process, but only a small, tit-shaped posterior lobe), and a clearly larger carapace, with a length of 1.60-1.63 mm in adult females (n=3) and 1.56-1.72 mm in adult males (n=2) (both *C. neglecta* and *C. lindneri* are about 1.0-1.3 mm). In addition, the M-process of the penis of *C.* sp. A is distally rounded as in *C. lindneri*, but the outer lobe is approximately triangular with rounded corners (the outline is decidedly subsquarish in *C. lindneri*) (Fig. 6).

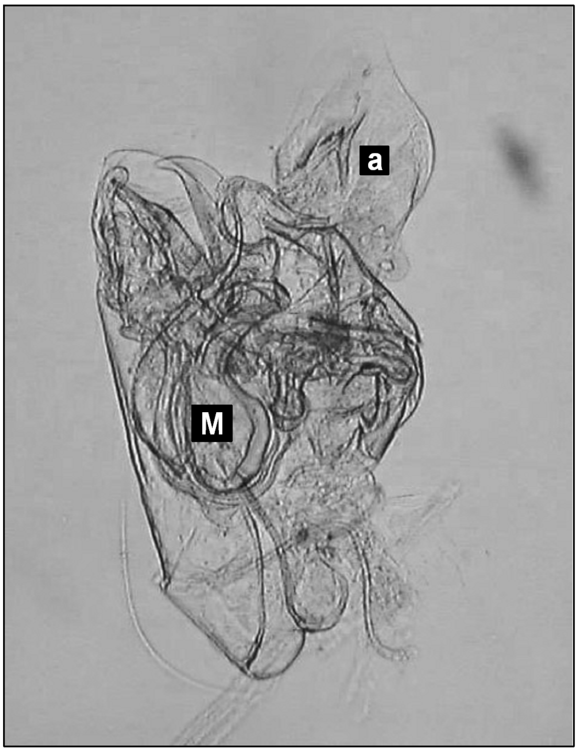

Fig. 6. Optical microscope figure of the penis of *Candona* sp. A (VP0619). **M**: M-process; **a**: outer lobe.

4. DISCUSSION AND CONCLUSIONS

This study led to the identification of an unexpectedly high number of ostracod taxa, although most of the sampled sites were visited only once, meaning that seasonal changes in the community structure were not adequately taken into account. This achievement is in part a consequence of the sampling effort which included most of the freshwater habitat types that are present in the province of Parma. Indeed, even admitting that the obtained faunal inventory is only a fraction of the taxa actually existing at the provincial scale, it still includes at least one-third of the estimated number of species present in mainland Italy and neighboring islands (Rossetti *et al*. 2004). The above list of ostracod taxa can be further increased by adding two species, *Ilyocypris salebrosa*, recorded in a study carried out in 2001 in lowland springs of the province of Parma (Rossetti *et al*. 2005). The presence of *I. salebrosa* (Fig. 7), erroneously identified as *I. decipiens* by Rossetti *et al*. (loc. cit., Figs 4K,L) and assigned here to its correct taxonomic status based on a personal communication with Dr David J. Horne (November 21, 2005), is of great interest. In fact, this species was widespread in the Holarctic Region during the Pleistocene, but recent representatives were assumed to be restricted to relict populations in Canada and China (Matzke-Karasz *et al*. 2004). However, other studies have shown that living populations of *I. salebrosa* exist in England (Bates *et al*. 2002) and Turkey (Özuluğ 2005).

Other species recorded in this study raise some interest, due to their little known occurrence in Italy. That is the case for *Ilyocypris monstrifica*, *Potamocypris villosa*, *Psychrodromus olivaceus*, *Ps. fontinalis*, *Candona* cf. *lindneri* and *Physocypria kraepelini*. Such a result could be due to a reduced number of investigations conducted on Recent freshwater ostracods. For example, *P. kraepelini* was repeatedly found in different habitats during recent surveys carried out in northern Italy (Pieri V., unpublished data).

The identified taxa overwhelmingly belong to the European fauna of temperate latitudes (Meisch 2000). The lone exception is *Chlamydotheca incisa*, a species originating from South America (Martens & Behen 1994), that was found in two samples (S58 and S59). It is, however, a species already established in northern Italy, having been reported in ricefields (Rossi *et al*. 2003) and, more recently, in a lowland spring (Pieri *et al*. 2006b). In the checklist of the Italian non-marine ostracods prepared by Ghetti & McKenzie (1981), the "ospiti esteri", i.e. exotic species passively introduced by man (McKenzie & Moroni 1986), roughly accounted for 10% of the total ostracofauna. The proportion of allochtonous species found in this study is thus sensibly lower.

With few exceptions, the ostracod assemblages found in the investigated aquatic environments were characterised by a limited number of species. These observations are in accordance with data obtained in other studies which have analysed the ostracod communities of small freshwater ecosystems in Italy (Crema *et al*. 1996; Rossi *et al*. 2003; Rossetti *et al*. 2004, 2005; Meisch 2006; Pieri *et al*. 2006a, b). Moreover, no consistent differences in species richness were observed between natural and man-made ecosystems, or between sites located in protected or highly impacted areas.

As might be expected in marginal water bodies, this faunal survey confirmed a high prevalence of tolerant species able to withstand varied environmental conditions and, as a consequence, no general distributional patterns can be recognized. In only a few cases, the ostracod occurrence was clearly dependent upon the characteristics of the sampled stations (e.g., altitude, habitat persistence, and water turbulence).

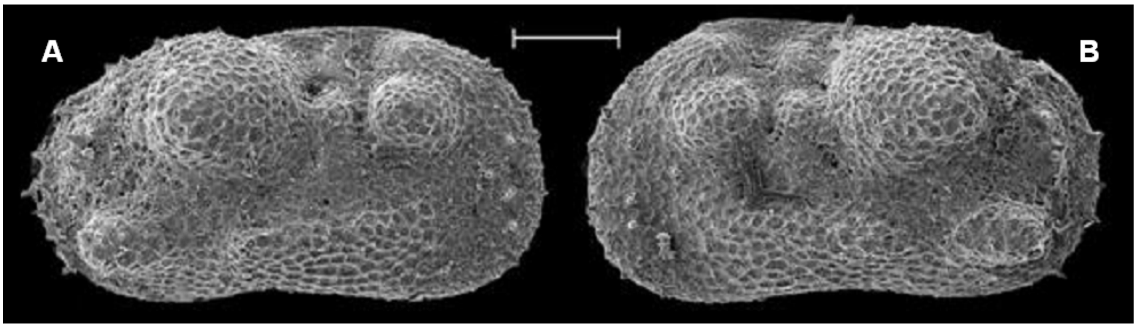

Fig. 7. *Ilyocypris salebrosa* (errouneously identified as *I. decipiens* by Rossetti *et al*. 2005; see text). (**A**): OC2824, adult female, RV, ev. (**B**): idem, LV, ev. Scale bar: 200 µm.

In conclusion, the most remarkable aspect of this study lies in the faunal analysis of aquatic bodies which are hardly considered in traditional limnological works. Indeed, minor freshwater ecosystems may represent, when considered in their whole extent, vast reservoirs of biological diversity, and in this regard they appear to be as important as larger environments.

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