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EARLY PLIOCENE BRACKISH AND FRESHWATER OSTRACODA FROM THE VALDELSA BASIN (TUSCANY, CENTRAL ITALY)

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Abstract. The taxonomic study of Early Pliocene ostracods from the Valdelsa Basin (Tuscany, central Italy) has been performed on 12 samples. Fifteen species, referable to eight genera, have been identified. Eight are known species: *Darwinula stevensoni* (Brady & Robertson), *Candona* (*Neglecandona*) *neglecta* Sars, *Pseudocandona albicans* (Brady), *Pseudocandona* cf. *P. eremita* (Vejdovsky), *Candonopsis arida* Sieber, *Ilyocypris* cf. *I. monstrifica* (Norman), *Ilyocypris bradyi* Sars and *Mixtacandona* cf. *M. tabacarui* Danielopol & Cvetkov. Six species are new and have been referred to the genera *Cyprideis* (*C. rectangularis* n. sp.), *Paralimnocythere* (*P. dictyonalis* n. sp. and *P. toscana* n. sp.) and *Candona* (*Neglecandona*) [*C.* (*N.*) *dorsoreticulata* n. sp., *C.* (*N.*) *subtilis* n. sp., *C.* (*N.*) *sambucensis* n. sp.]. Two species have been left in open nomenclature, due to scarcity of material and poor preservation (*Candona* (*Neglecandona*) sp. and Cyclocypridinae indet.).

The Early Pliocene ostracods of the Valdelsa Basin show palaeobiogeographical affinities with both the Central and Western European faunas and the Balkan candonids. The occurrence of ostracods with Balkan and Eastern Europe affinity is also known from the more ancient Italian deposits of the late Tortonian-early Messinian and latest Messinian age. In the first case, the ostracods widespread by passive dispersal, whereas during the latest Messinian they actively dispersed in the Palaeo-Mediterranean area due to its connection with the central and eastern Paratethyan domains.

Riassunto. Lo studio tassonomico degli ostracodi del Pliocene Inferiore del Bacino della Valdelsa (Toscana) è stato condotto su dodici campioni. In essi sono state riconosciute, complessivamente, quindici specie riferibili a otto generi. Otto sono state attribuite a specie già note: *Darwinula stevensoni* (Brady & Robertson), *Candona* (*Neglecandona*) *neglecta* Sars, *Pseudocandona albicans* (Brady), *Pseudocandona* cf. *P. eremita* (Vejdovsky), *Candonopsis arida* Sieber, *Ilyocypris* cf. *I. monstrifica* (Norman), *Ilyocypris bradyi* Sars e *Mixtacandona* cf. *M. tabacarui* Danielopol & Cvetkov. Sei specie sono nuove, riferite ai generi *Cyprideis* (*C. rectangularis* n. sp.), *Paralimnocythere* (*P. dictyonalis* n. sp. e *P. toscana* n. sp.) e *Candona* (*Neglecandona*) [*C.* (*N.*) *dorsoreticulata* n. sp., *C.* (*N.*) *subtilis* n. sp., *C.* (*N.*) *sambucensis* n. sp.]. Due specie sono state lasciate in nomenclatura aperta per la scarsità dei ritrovamenti o per la loro cattiva conservazione (*Candona* (*Neglecandona*) sp. e Cyclocypridinae indet.).

Gli ostracodi del Pliocene Inferiore della Valdelsa mostrano affinità paleobiogeografiche sia con l'Europa centrale ed occidentale sia con le candonine balcaniche. La presenza in Italia di ostracodi con affinità balcanica o europea orientale non è una novità. Simili affinità sono già state riscontrate per associazioni di ostracodi rinvenute in depositi del Tortoniano-Messiniano inferiore e del Messiniano terminale. Nel primo caso gli ostracodi si sono dispersi per via passiva mentre durante la fine del Messiniano essi sono giunti nel Paleo-Mediterraneo attraverso una dispersione attiva consentita dalle connessioni paleogeografiche tra Paleo-Mediterraneo e Paratetide.

Introduction

Pliocene brackish and freshwater ostracods from the peri-Mediterranean and European regions (except Russia and ex-SSSR countries) are poorly known (Carbonnel 1969; Boenigk et al. 1977; Bassiouni 1979; Freels 1980; Guernet & Lauverjat 1986; Mostafawi 1988, 1989; 1994a,b; Ruiz-Munoz & Gonzàlez-Regalado 1993; Olteanu 1995, 2003; Stancheva 1981; Georgiades-Dikeoulia et al. 2002; Krstić & Velitzelos 2002; Krstić 2006 with references therein concerning Balkan ostracod faunas; Anadón et al. 2008). In particular, very few studies concern Pliocene freshwater and brackish ostracods from Italy: Di Napoli Alliata (1962) and Medici & Gliozzi (2008) on the Late Pliocene-Early Pleistocene of the Tiberino Basin – central Italy; Gliozzi (1996) on the Late Pliocene of the Villafranca area, Piedmont – north-

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ern Italy); Gliozzi et al. (1997) with a synthesis of the state of the art on the knowledge of Italian freshwater ostracods; Barra et al. (1998) and Aiello et al. (2005) on the Lower Pliocene brackish/paralic deposits of the Irpinia-Daunia Basin – southern Italy. Instead, Middle and Late Miocene (particularly late Messinian) freshwater and brackish ostracods of the peri-Mediterranean and central Paratethyan areas have been fairly studied (among others Krstić 1968a,b,c, 1971, 1972a,b, 1973; Carbonnel 1969; Sokač 1972; Stancheva 1990; Janz 1992; 1997; Nachite et al. 1993; Anadón et al. 1997, 2003; Pipik & Bodergat 2003a,b, 2004a,b, 2006, 2007; Gliozzi et al. 2002, 2005, 2007 with references therein; Cosentino et al. 2006, 2007; Faranda et al. 2007; Ligios et al. 2008a,b; Grossi et al. 2008; Guerra-Merchán et al. 2010; Ligios et al. 2009). Gliozzi et al. (2007), discussing the biodiversity of the Late Miocene Italian ostracod faunas, have shown that pre-evaporitic Late Miocene peri-Mediterranean (Spain, France and Italy) freshwater and brackish ostracod assemblages mainly consist of Paleo-Mediterranean taxa (i.e. species that were widespread in continental western and central Europe) and by a minor contingent of species (mainly endemic) with Paratethyan affinity at generic level. As a matter of fact, during the last phase of the Messinian salinity crisis (the so-called *lago-mare phase*) (CIESM 2008), the Italian and the whole Paleo-Mediterranean ostracod assemblages were made of Paratethyan species that actively migrated from Paratethys into the Paleo-Mediterranean during a global humid climatic phase.

This paper deals with the taxonomy of the Early Pliocene freshwater and brackish ostracods of the Valdelsa Basin (Tuscany, central Italy) and represents the first study about Early Pliocene continental ostracod faunas in Italy. It provides new data about the biodiversity in freshwater and brackish habitat during Early Pliocene in Tuscany (central Italy), leading to a comparison with the Late Miocene Tuscan assemblages.

Geological and stratigraphical framework

The Valdelsa Basin (Tuscany, central Italy) is one of the widest post collisional basins developed since the Late Miocene (Benvenuti & Degli Innocenti 2001). It extends NW-SE from the middle Arno watercourse to Poggibonsi-Colle Val d'Elsa and it is bounded by reliefs belonging to the Mid Tuscan Ridge, to the W (Fig.1a). Sediment cores and geophysical investigations showed that more than 2000 m-thick Neogene and Quaternary continental and marine sediments filled the Valdelsa Basin. About 1000 m of these sediments are aged Pliocene-Quaternary (Ghelardoni et al. 1968).

Several authors described the stratigraphy of the Neogene sediments exposed in the Val d'Elsa Basin, and different litho-stratigraphical units have been recognized. The basin can be divided in three different areas:

1) a well known central-western area (Dainelli & Videssot 1930; Bossio et al. 1993a; Dominici et al. 1995) where a transgressive-regressive trend has been recognised, consisting of basal transgressive fluvio-deltaic sands, inner shelf silty clays (**Argille Azzurre** Fm.) and a regressive alternation of paralic and shallow marine clays and sands on the top;

2) a less known central-eastern area (Sestini 1970; Bossio et al. 1993a), where recent geological and stratigraphical investigations have been carried out through unconformity-bounded units (UBSU) and lithofacies analysis (Benvenuti & Degli Innocenti 2001; Abbazzi et al. 2008). Five synthems (the base UBSU unit) have been established based on bounding unconformities traceable across this area of the Val d'Elsa basin. According to the new chronostratigraphical scheme of the Quaternary (Mascarelli 2009; Cita 2009; Gibbard et al. 2010) they are all Pliocene in age. The **Certaldo** Synthem (uppermost Zanclean-Piacenzian) deposited in a marine environment and it is interfingered with the fluvio-lacustrine **Fiume Pesa** Synthem; this latter unconformably overlies the palustrine-lacustrine deposits cropping out in the Sambuca area, probably Early Pliocene in age. The Fiume Pesa Synthem is stratigraphically followed by three fluvial and fluvio-deltaic synthems: the **Ponte a Elsa** Synthem (Upper Pliocene), the **S. Miniato** Synthem (Upper Pliocene) and the **S. Casciano-Montelupo** Synthem (Upper Pliocene) (Fig. 1c);

3) a south-eastern area (**Borro Strolla** area) where the older deposits of the Val d'Elsa basin crop out. The succession, which includes the Mio-Pliocene transition, has been described by Bossio et al. (1993b; 2002) and by Abbazzi et al. (2008). The following stratigraphical units or synthems have been recognised: **Argille del Torrente Fosci** Fm. (upper Tortonian-lower Messinian), **Argille del Casino** Fm. (uppermost Messinian **Lago-mare** event), **Borro Strolla** Synthem (lowermost Pliocene), in the upper part partially interfingering with the palustrine-lacustrine deposits cropping out in the Sambuca area, and **Certaldo** Synthem (uppermost Zanclean-Piacenzian) partially interfingering with the **Fiume Pesa** Synthem.

Material and Methods

The brackish and freshwater ostracods studied in this paper were collected from 4 sections located in the Sambuca area (central-eastern portion of the Valdelsa Basin) within the Lower Pliocene palustrine-lacustrine deposits described by Benvenuti & Degli Innocenti (2001) and from the deposits pertaining to the Fiume Pesa Synthem (Fig. 1b). The ages of these deposits have been inferred basing on their stratigraphical relationships with the Certaldo Synthem, whose latest Zanclean-Piacenzian age has been established on the basis of planktonic

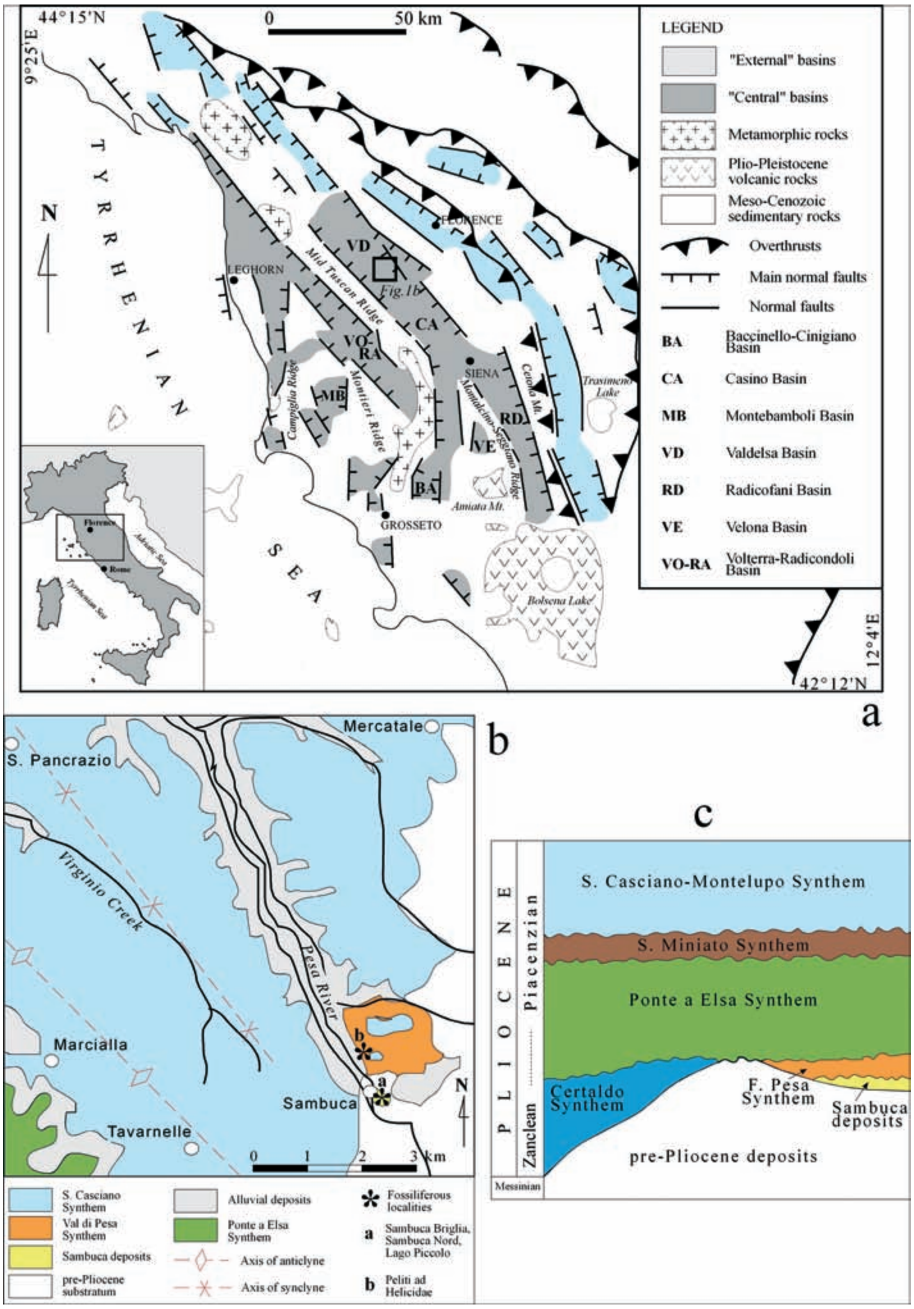


Fig. 1 - a) Structural scheme of the Tuscany region and location of the Valdelsa Basin (redrawn and modified from Martini & Sagri 1993); b) Geological map of the southeastern sector of the Valdelsa Basin (redrawn and modified from Benvenuti & Degli Innocenti 2001); c) stratigraphical relations between the stratigraphic units described in the southeastern sector of the Valdelsa Basin (redrawn and modified from Benvenuti & Degli Innocenti 2001).

foraminifer biostratigraphy (*G. puncticulata*-*G. aemiliana* biozones) (Bossio et al. 1993a).

Sambuca Briglia is the more ancient studied section. It is 5.80 m-thick, made up by 1.9 m of clays rich in organic matter at the base, unconformably overlaid by a 3.90 m-thick succession made up of conglomerates, and cross-bedded sands, referable to the Fiume Pesa Synthem. Three samples have been collected (SB1, SB2 and SB3) from the clays. Few kms apart and stratigraphically above the clays at the base of the Sambuca Briglia section, the Sambuca Nord composite section crops out, made up of an alternance of sandy gravels and clayey sands, for a total thickness of about 4 meters. The clayey levels have been sampled for ostracod analyses (SBN-1, SBN0, SBN1, SBN2, and SBN3). The third studied section, the Lago Piccolo section (43°35'13"N, 11°13'47"E), rests stratigraphically above the Sambuca Nord section. It is made up by 2 m of clays with intercalated sands in the upper part. Three samples were collected from this section: LP1, LP2, and LP3. The Fiume Pesa Synthem has been sampled along the banks of the Pesa River, where a pelitic succession crops out (43°39'28"N, 11°08'53"E). Six samples were collected: PH1, PH2, PH3, PH4, PH5 and PH6.

Samples were soaked in a H_2O_2 $5\%_{vol}$ solution, washed with current water on a 0.125 mm-mesh sieve and dried. Ostracods were handpicked under the stereomicroscope up to 300 valves/sample, and digital pictures were taken under a multifocus stereomicroscope and Scanning Electron Microscope.

The taxonomical study of *Cyprideis* was performed through the geometric morphometric approach following the methodology proposed by Minati et al. (2008). Thirty-two female right and fifty-four male right valves have been photographed in transmitted light and the valve outlines have been digitalized using TPS-dig software, version 1.37 (Rohlf 2003; Zelditch et al. 2004) and processed with the Morphomatica software (Brauneis et al. 2006 with refs.). Six iterations have been used to better approach the contour data, as suggested by Neubauer & Linhart (2008). Analyses were performed both in normalised and non-normalised modes. In the first case only the outline differences are evidenced; in the second case also the differences in size are taken into account. The obtained outline data were processed through Cluster Analysis (Chord distance measure and the un-weighted pair group method using arithmetic average – UPGMA) using the software PRIMER 6.

In the taxonomical part, the following abbreviations have been used: LV – left valve; RV – right valve; C – carapace; ♀- female; ♂ - male. The choice of the names of the new species has been checked using Kempf (1980; 1997).

Ostracod assemblages

Brackish and freshwater ostracod assemblages from the Valdelsa Basin are rather diversified and generally represented by abundant and well preserved specimens. On the whole, 16 species referable to 9 genera have been recognized, some identified as known species, other established as new and other left in open nomenclature due to the material scarcity and the poor preservation. The following taxa have been recognized:

Palustrine-lacustrine deposits of the Sambuca area (Lower Pliocene p.p.)

Paralimnocythere dictyonalis n. sp.
Paralimnocythere toscana n. sp.
Cyprideis rectangularis n. sp.
Darwinula stevensoni (Brady & Robertson)
Candona (*Neglecandona*) *neglecta* Sars
Candona (*Neglecandona*) *dorsoreticulata* n. sp.
Candona (*Neglecandona*) *sambucensis* n. sp.
Candona (*Neglecandona*) *subtilis* n. sp.
Candona (*Neglecandona*) sp.
Pseudocandona albicans (Brady)
Candonopsis arida Sieber
Cyclocypridinae indet.
Ilyocypris bradyi Sars
Ilyocypris cf. *I. monstrifica* (Norman)

On the whole, the composition of the assemblages recognized within the palustrine-lacustrine deposits in the Sambuca area, always dominated by *Cyprideis rectangularis* n. sp., shows some differences in salinity inferred by the increasing presence of tuberculated *Cyprideis* valves and by the Candoninae abundance, pointing to a brackish lacustrine environment, which evolves from mesohaline to mesohaline/oligohaline waters.

Fiume Pesa Synthem (Lower to Upper Pliocene p.p.)

Mixtacandona cf. *M. tabacarui* Danielopol & Cvetkov
Pseudocandona cf. *P. eremita* (Vejdovsky)

It is an oligotypic and poor assemblage, characterised only by interstitial forms.

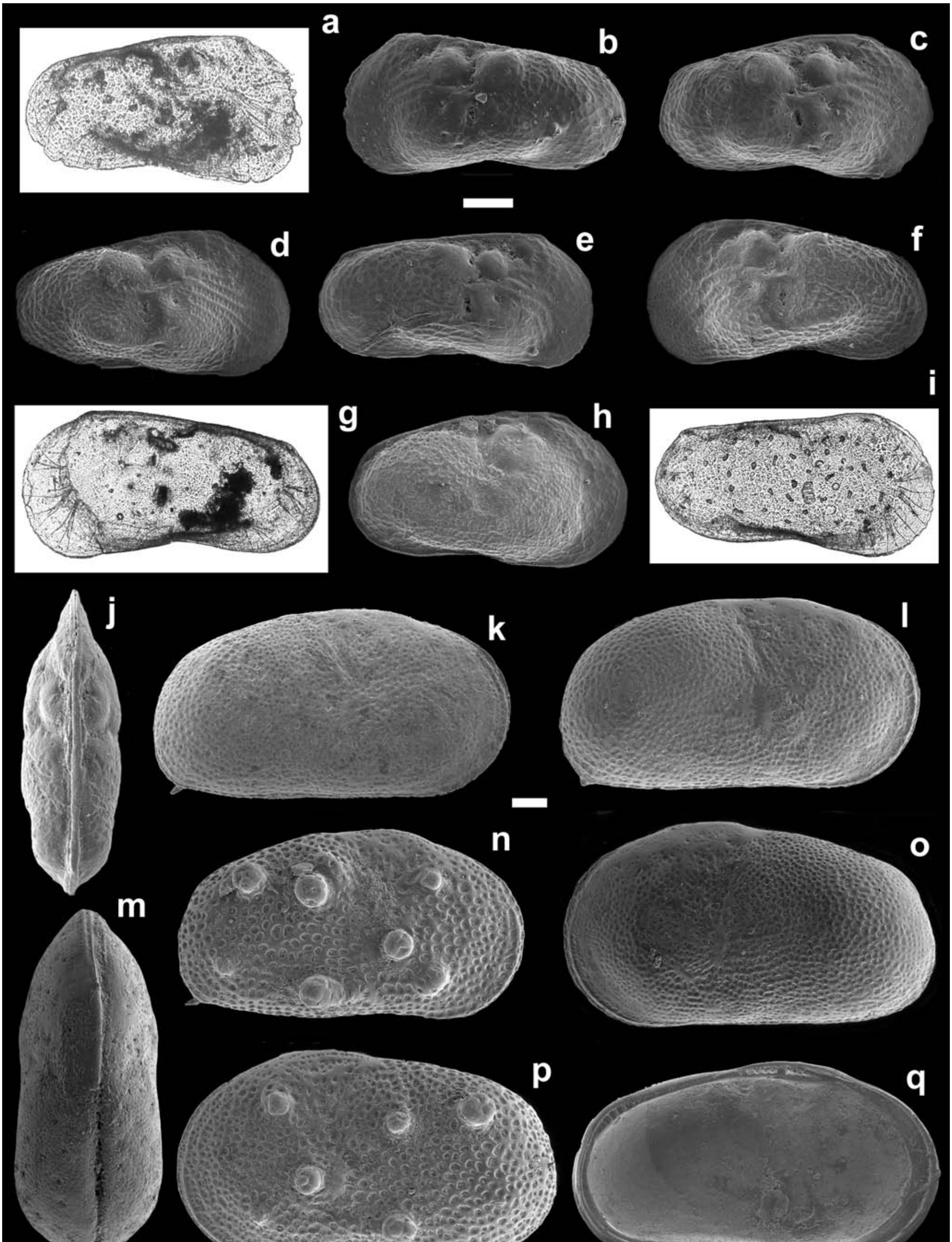
Taxonomy

The taxonomical arrangement of the higher categories follows Hartmann & Puri (1974) and Horne et al. (2002). All the specimens are stored in the Gliozzi's Ostracod Collection (G.O.C.), at the Department of Geological Sciences of Roma Tre University. The synonymy of the known species lists only the quotations of the original description and of the Italian recoveries.

Class **Ostracoda** Latreille, 1802
Subclass **Podocopa** Sars, 1866
Order **Podocopida** Sars, 1866
Suborder **Cytherocopina** Baird, 1850
Superfamily Cytheroidea Baird, 1850
Family Limnocytheridae Klie, 1938

PLATE 1

a) *Paralimnocythere dictyonalis* n. sp., paratype, RV♀ in external view, sample SBN-1. Transmitted light.
b) *Paralimnocythere dictyonalis* n. sp., LV♂ in external view, sample LP 3.
c) *Paralimnocythere dictyonalis* n. sp., RV♀ in external view, sample LP 3.
d) *Paralimnocythere dictyonalis* n. sp., paratype, RV♀ in external view, sample SBN-1.
e) *Paralimnocythere dictyonalis* n. sp., RV♂ in external view, sample LP 3.
f) *Paralimnocythere dictyonalis* n. sp., holotype, LV♀ in external view, sample SBN-1.
g) *Paralimnocythere dictyonalis* n. sp., LV♂ in external view, sample SBN-1. Transmitted light.
h) *Paralimnocythere toscana* n. sp., holotype, RV♀ in external view, sample SBN-3.
i) *Paralimnocythere toscana* n. sp., RV♂ in external view, sample SBN-2. Transmitted light.
j) *Paralimnocythere toscana* n. sp., C♂ in dorsal view, sample LP 1.
k) *Cyprideis rectangularis* n. sp., holotype RV♀ in external view, sample LP 3.
l) *Cyprideis rectangularis* n. sp., paratype RV♀ in external view, sample LP 3.
m) *Cyprideis rectangularis* n. sp., paratype tuberculate RV♀ in external view, sample LP 3.
n) *Cyprideis rectangularis* n. sp., paratype LV♀ in external view, sample LP 3.
o) *Cyprideis rectangularis* n. sp., paratype C♀ in dorsal view, sample LP 3.
p) *Cyprideis rectangularis* n. sp., paratype tuberculate LV♀ in external view, sample LP 3.
q) *Cyprideis rectangularis* n. sp., paratype LV♀ in internal view, sample LP 3.
All scales = 0.1 mm. Large scale bar for *Paralimnocythere*, small scale bar for *Cyprideis*.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Subfamily Limnocytherinae Klie, 1938
Genus *Paralimnocythere* Carbonnel, 1965

Paralimnocythere dictyonalis n. sp.

Pl. 1, figs. a-g

Derivatio nominis: from the Greek δικτυον = net, for the polygonal reticulated ornamentation.

Holotype: LV♀ (L= 0.54 mm; H= 0.29 mm), Pl. 1, fig. f, catalogue number G.O.C. M73/3/5.

Paratypes: two RV♀ (G.O.C. M73/3/4, T25/1), one LV♀ (G.O.C. T25/2).

Stratum typicum: sample SBN-1, palustrine-lacustrine deposits of the Sambuca area, Lower Pliocene.

Locus typicus: Sambuca area, central-eastern portion of the Valdelsa Basin.

Studied material: sample SBN-1: 1 RV♀ and 1 LV♀; sample SBN0: 1 LV♀; sample SBN1: 2 RV♀, 1 RV♂ and 1 LV♂; sample SBN2: 2 RV♀, 3 LV♀, 1 RV♂, 2 LV♂; sample SBN3: 1 RV♀, 1 RV♂, 2 LV♂; sample LP1: 1 RV♀, 2 LV♀, 1 RV♂, 4 LV♂; sample LP3: 1 C♀, 1 RV♀, 2 LV♀, 2 RV♂, 2 LV♂.

Diagnosis: *Paralimnocythere* of small size, with reticulated ornamentation over the entire valve, right female valve sub-trapezoidal in shape. Remarkable sexual dimorphism with male valves proportionally much more elongated than female but almost equal in length.

Description. The carapace is slightly inflated; in dorsal view anterior and posterior ends are pointed. Two dorsal and two ventral tubercles are visible. The left valve overlaps the right one posteriorly. In lateral view, the female valve is subtrapezoidal in shape (L/H=1.79-1.86), with the greater height located anteriorly. The dorsal border is rectilinear, gently arcuated near the anterior cardinal angle, bending posteriorly; the posterior cardinal angle is marked; the anterior border is broadly rounded, the posterior one is rectilinear in the dorsal portion and then rounded; the ventral border is sinuous in the middle, slightly encompassed anteriorly by the ventral protuberance. The primary ornamentation is reticulated, with polygonal (mainly quadrangular) meshes separated by rounded muri. The reticulation is particularly evident in the posterior and ventral area and covers also the ventral protuberance; within the meshes, a secondary ornamentation is visible, made of roundish pits; anteriorly, the reticulation becomes less evident, and sometimes only secondary ornamentation is visible; six to seven transverse costae are superimposed on the reticulation or pits; two blunt tubercles, well visible dorsally (the anterior one less developed than the posterior) are present, divided by a deep sulcus; they are smooth or only faintly reticulated or pitted. Normal pore canals are few and simple; in the posterior area some poroconules are visible on the muri; marginal pore canals are numerous, long and polyfurcated. Sexual dimorphism is remarkable: male valves are elongated (L/H=1.82-2.23), subrectangular in shape, but almost equal in length in comparison with the female valve.

Dimensions

RV♀	L= 0.49-0.55 mm	H= 0.27-0.31 mm
LV♀	L= 0.46-0.58 mm	H= 0.24-0.32 mm
RV♂	L= 0.53-0.57 mm	H= 0.27-0.29 mm
LV♂	L= 0.48-0.59 mm	H= 0.24-0.31 mm

Comparisons. *Paralimnocythere dictyonalis* n. sp. has been compared to known fossil and extant species. *P. alata* (Klie, 1939), *P. bouleigensis* Carbonnel, 1965, *P. georgevitschi* (Petkovsky, 1960), *P. messanai* Martens, 1992, *P. ochridense* (Klie, 1934) and *P. slavei* (Petkovski, 1969) bear faint ornamentation very different from the remarkable reticulation of *P. dictyonalis* n. sp. Among the living ornamented species, *P. dictyonalis* n. sp. is rather similar to *P. psammophila* (Flössner, 1965), *P. relicta* (Lilljeborg, 1863) and *P. diebeli* (Petkovski, 1969). *P. dictyonalis* n. sp. is less elongated, smaller in size and its ornamentation is more pronounced, with the ventral protuberance that encompasses the ventral border and with more evident dorsal semi-globular lobes. In comparison with the living *P. umbonata* (Klie, 1939) and *P. karamani* (Petkovski, 1960), the new species is smaller in size and its ornamentation is less pronounced, both in the ventral protuberance, not divided in two portions, and in the dorsal lobes that do not encompass the dorsal border. *P. dictyonalis* n. sp. shares with *P. compressa* (Brady & Norman, 1889) similar dimensions, but its anterior cardinal angle (female LV) is more pronounced and its reticulation does not extend to the dorsal lobes. In dorsal view the carapace of *P. dictyonalis* n. sp. is less inflated, the ventral tubercles are less evident, the posterior overlap of the left valve is less remarkable. The new species differs from *P. posterolimba* (Delorme, 1967) in its smaller size, less sub-rectangular shape and bearing a ventral protuberance that does not extend into a posterior ridge. The new species is different from the known fossil species *P. rostrata* (Straub, 1952) from the Astaracian of southern Germany (Straub 1952; Lutz 1965), *P. rostrata* Straub collected by Devoto (1965) in the Middle Pleistocene of the Liri Valley (Latium, central Italy), the late Pannonian *P. tenera* Sokač, 1972 (Croatia, Sokač 1972), *P. bicornis* Fuhrmann, 1991 from the Middle Pleistocene of Germany (Fuhrmann, 1991) and from *P.* aff. *P. bicornis* (Ligios, 2009) from the early Messinian of the Cinigiano-Baccinello Basin (Tuscany, central Italy) for its remarkable smaller size and for details in the ornamentation (more pronounced than *P. rostrata* and *P. tenera* but with less inflated ventral protuberance in comparison with *P. bicornis*). In our opinion, the specimens identified by Devoto (1965) as *P. rostrata* are not referable to that species, owing to the trend of the ventral protuberance, sub-parallel to the ventral border and not divergent as in *P. rostrata* Straub. *P. dictyonalis* n. sp. shares with *P. cretensis* (Mostafawi, 1989) from the Serravallian of Vrisses (Crete) and with *P. dalmatica* Sokač, 1970 from the Middle Pleistocene of Croatia a comparable size. It differs from the first in the presence of more marked lobes, in the absence of a wide flattened posterior area and the lack of two horn-like tubercles that protrude from the anterior ventral margin. It differs from the second in having stouter proportions.

Stratigraphical distribution. This species is known only from the Early Pliocene of the Valdelsa Basin (Tuscany).

Paralimnocythere toscana n. sp.

Pl. 1, figs h-j

Derivatio nominis: from Tuscany, the region of central Italy where the Sambuca area is located.

Holotype: RV♀ (L= 0.55 mm; H= 0.32 mm) Pl. 1, fig. h, catalogue number G.O.C. M73/3/3.

Stratum typicum: sample SBN3, palustrine-lacustrine deposits of the Sambuca area, Lower Pliocene.

Locus typicus: Sambuca area, central-eastern portion of the Valdelsa Basin.

Studied material: sample SBN2: 1 RV♀ and 2 ♂ RV; sample SBN3: 1 RV♀; sample LP1: 2 RV♀, 1 C♂ and 1 LV♂; sample LP3: 2 RV♀.

Diagnosis: Small-sized *Paralimnocythere*. Female valve stout. Remarkable reticulation in the flattened anterior area.

Description. Thin calcified shell. In dorsal view, the right valve slightly inflated, with two dorsal tubercles and a compressed anterior margin. In lateral view, right female valve is rather short and high (L/H=1.76-1.84) with the greater height located anteriorly. The dorsal margin is straight or slightly arched, bending posteriorly, with both cardinal angles from evident to slightly round; both anterior and posterior borders are rectilinear in the dorsal portion and then broadly rounded; the ventral margin is sinuate in the middle. The anterior and posterior surfaces are rather flattened; the central portion of the valve is inflated with one slightly developed anterior lobe; the ventral protuberance is more pronounced posteriorly, and does not encompass the ventral border. The surface is reticulated in the anterior and posterior areas: posteriorly, the irregular polygonal meshes, bounded by rounded muri, include clusters of roundish pits, while anteriorly the secondary ornamentation is less evident; in the central surface the reticulation becomes less evident in comparison with the secondary pitted ornamentation. A mid-dorsal sulcus is evident, separating the anterior lobe from the posterior inflation. The normal pore canals are located on conules in the flattened anterior surface; the marginal pore canals are few, long and polyfurcated. The sexual dimorphism is remarkable: male valves are elongated (L/H= 1.83-2.05), sub-rectangular in shape, and with more sinuate ventral margin.

Dimensions

RV♀	L= 0.54-0.59 mm	H= 0.30-0.33 mm
RV♂	L= 0.50-0.54 mm	H= 0.26-0.28 mm
LV♂	L= 0.64 mm	H= 0.31 mm

Comparisons. *P. bicornis* Fuhrmann, 1991, *P. compressa* (Brady & Norman, 1889), *P. dictyonalis* n. sp., *P. georgevitschi* (Petkovski, 1960), *P. karamani* (Petkovski, 1960), *P. ochridense* (Klie, 1934), *P. psammophila* (Flössner, 1965), *P. posterolimba* (Delorme, 1967), *P. rostrata* (Straub, 1952) and *P. umbonata* (Klie, 1939) display a stronger pattern of ornamentation, very different from the thinly reticulated surface of *Paralimnocythere toscana* n. sp. Among the living less ornamented species, *Paralimnocythere toscana* n. sp. differs from *P. bouleigensis* Carbonnel, 1965 in the smaller size and for the presence of the reticulated ornamentation. It differs from *P. relicta* (Lilljeborg, 1863) in the smaller size, the absence of the transverse costae and for the stouter proportion of the valves. It differs from *P. messanai* Martens, 1992, of similar size, in the presence of the ornamentation on the entire valve surface. It differs from *P. slavei* (Petkovski, 1969) and *P. diebeli* (Petkovski, 1969) in the smaller size and the stouter proportions. *Paralimnocythere toscana* n. sp. differs also from *P. alata* (Klie, 1939) in the smaller size, the higher posterior zone and a ventral protuberance that does not encompass the ventral border.

The known fossil species *P. tenera* Sokač, 1972 from the late Pannonian of Croatia has similar length, but *P. dictyonalis* n. sp. has stouter proportions and a reticulated ornamentation. *P. dictyonalis* n. sp. differs from *P. cretensis* (Mostafawi, 1989) from the Serravallian of Vrisses (Crete) in the slightly larger size, stouter proportions, absence of a wide flattened posterior area and of two horn-like tubercles that protrude from the anterior ventral margin. The new species differs from *P. dalmatica* Sokač, 1970, from the Middle Pleistocene of Croatia, in the slightly larger size, stouter proportions and for the male valves being longer than the female ones. In comparison with *Paralimnocythere* sp. (Devoto 1965), *Paralimnocythere toscana* n. sp. shows a more rectilinear dorsal border in the female valve and a slightly concave dorsal border in the male valve; moreover the anterior height is much greater than the posterior.

Stratigraphical distribution. This species is known only from the Lower Pliocene of the Valdelsa Basin (Tuscany).

Family Cytherideidae Sars, 1925

Genus *Cyprideis* Jones, 1856

The identification of species included in the genus *Cyprideis* Jones is a rather difficult task, because of their

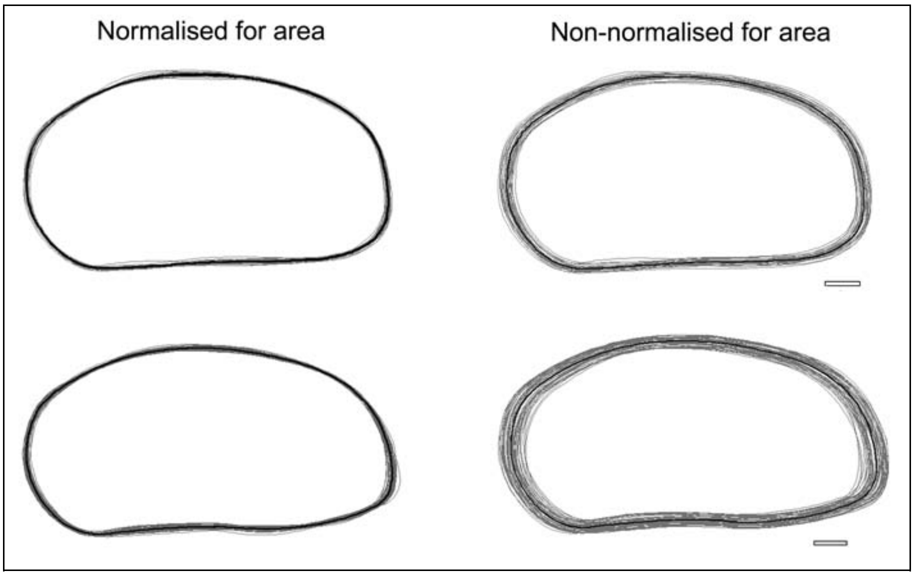

Fig. 2 - Comparison of the outlines (normalised and non-normalised for areas) among the *Cyprideis* specimens collected in the Sambuca area (above: female valves, below: male valves). In grey the outline of each specimen, in black the mean outline.

great ecophenotypical plasticity that prevents to consider as diagnostic several characters such as the ornamentation and, to a certain extent, the size (Sandberg 1964; Hartmann 1964; Kilenyi 1972; Vesper 1972; Van Harten 1975, 1996; 2000; Rosenfeld & Vesper 1977; Peypouquet 1977; Carbonel et al. 1987; Carbonel 1988; Neale 1988; Frenzel 1991; Wouters & Martens 2000; Wouters 2002; Keyser 2005). Recently some authors (Gross et al. 2008; Ligios 2009) have applied the geometric morphometric approach to compare the valve outlines and the multivariate analysis to test statistically the significance of the obtained differences. In particular, Ligios (2009) used the geometric morphometric approach to test the validity of the specific attribution of Decima (1964) who revised the taxonomy of genus *Cyprideis* in Italy. In this paper the valve outline of the *Cyprideis* specimens recovered from the Sambuca area has been compared with the mean outlines drawn by Ligios (2009) from the Italian Neogene known *Cyprideis* species, using the geometric morphometric approach. Fig. 2 illustrates the valve outlines of the *Cyprideis* specimens from the Sambuca area. The morphometric approach does not show any significant difference both in the dimensions and in the outlines. Only few female valves show a more marked antero-dorsal angularity, but this character is linked to the strong tuberculation on the valve surfaces. Thus, the Sambuca *Cyprideis* specimens can be referred to one species. The mean outline of the Sambuca *Cyprideis* valves (except the tuberculated ones) has been compared with the mean outlines of known Mediterranean species of *Cyprideis*: *Cyprideis agrigentina* Decima, 1964, *Cyprideis anlavauxensis* Carbonnel, 1978 *Cyprideis belfortensis* Molinari Paganelli, 1962, *Cyprideis calabra* Decima, 1964, *Cyprideis crotonensis* Decima, 1964, *Cyprideis ruggierii* Decima, 1964, and *Cyprideis torosa* (Jones) obtained by Ligios (2009) (Fig. 3). The non-normalised and the normalised comparisons of the mean outlines of these species with the Sambuca specimens show that these latter are larger in size and with a more rectangular outline. The Cluster Analysis dendrogram (Fig. 4) shows the separation of the Sambuca *Cyprideis* with the other *Cyprideis* species at a dissimilarity level of around 53, suggesting to refer them to the a new species: *Cyprideis rectangularis* n. sp.

Cyprideis rectangularis n. sp.

Pl. 1, figs k-q; Pl. 2, figs a-i; Pl. 3, fig. a

Derivatio nominis: from the sub-rectangular shape of the female right valve.

Holotype: RV♀ (L= 1.04 mm; H= 0.56 mm), Pl. 1, fig. k, catalogue number G.O.C. T29/1.

Paratypes: three C♀ (G.O.C. T40/1-3), five RV♀ (G.O.C. T40/4-9), twenty-eight LV♀ (G.O.C. T41/1-28), two C♂ (G.O.C. T40/10-11), eighteen RV♂ (G.O.C. T42/1-18), eighteen LV♂ (G.O.C. T43/1-18)

Stratum typicum: sample LP3, palustrine-lacustrine deposits of the Sambuca area, Lower Pliocene.

Locus typicus: Sambuca area, central-eastern portion of the Valdelsa Basin.

Studied material: sample SBN-1: 3 LV♀, 2 RV♂; sample SBN0: 2 C♂, 3 RV♂, 1 LV♂; sample SBN1: 2 RV♀, 8 LV♀, 3 RV♂, 3 LV♂; sample SBN2: 4 RV♀, 3 LV♀, 5 RV♂, 2 LV♂; sample SBN3: 1 C♀, 9 RV♀, 10 LV♀, 1 C♂, 9 RV♂, 3 LV♂; sample SB1; 1 RV♂; sample SB3: 6 RV♀, 17 LV♀, 5 RV♂, 3 LV♂; sample LP1: 24 RV♀, 19 LV♀, 11 RV♂, 16 LV♂; sample LP2: 5 C♀, 20 RV♀, 41 LV♀, 3 C♂, 16 RV♂, 25 LV♂; sample LP3: 3 C♀, 6 RV♀, 28 LV♀, 2 C♂, 18 RV♂, 18 LV♂; several juveniles.

Diagnosis: Middle-sized *Cyprideis*. Female valve elongated, sub-rectangular in shape, with pronounced median sulcus that splits the valve into a more flattened anterior area and a posterior inflated lobe. Both female and male valves have sinuate ventral margins.

Description. In dorsal view the left valve overlaps the right valve and the median sulcus splits the carapace into two lobes. The anterior margin appears rather flattened. In lateral view, the right female valve is elongated

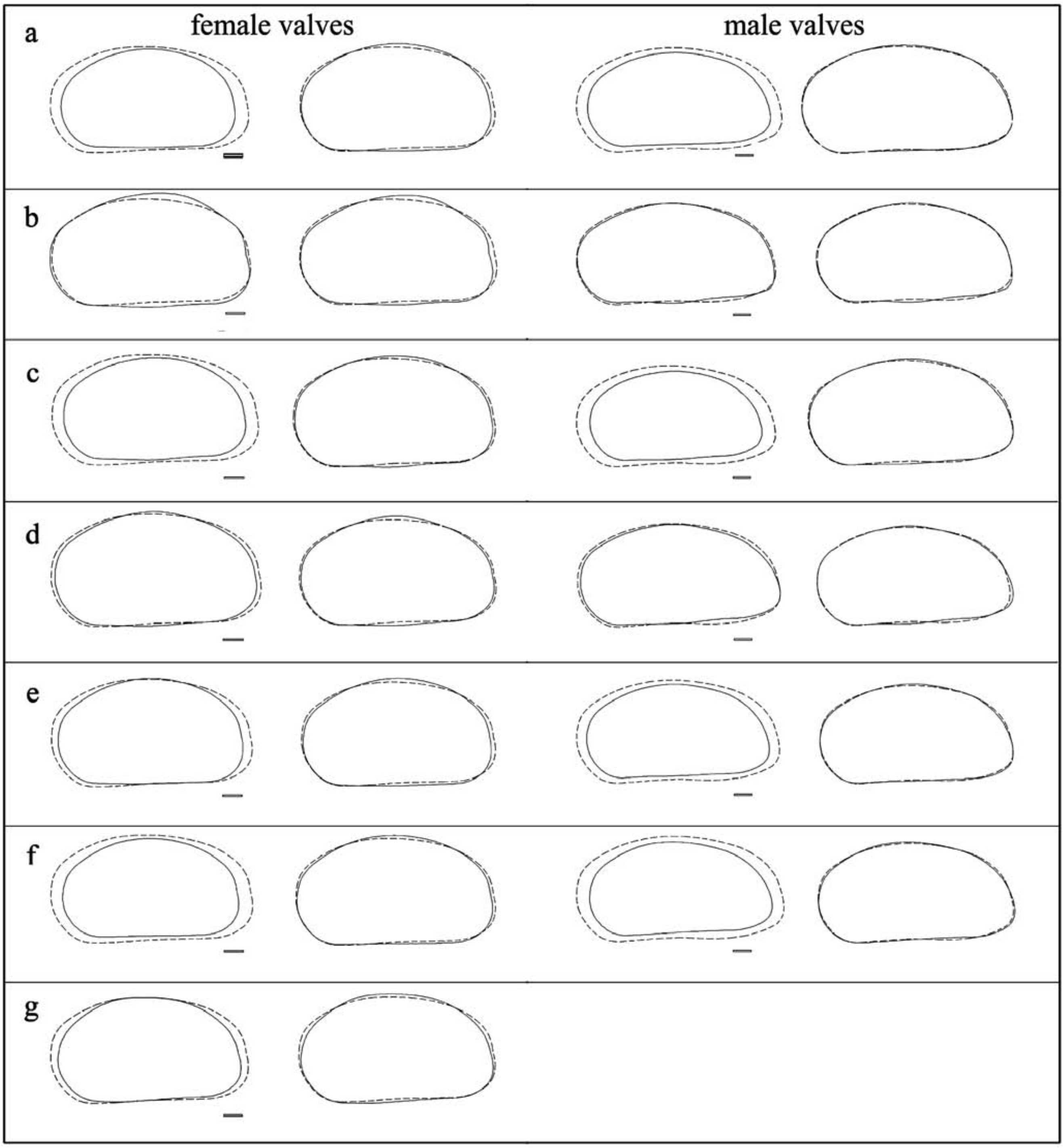

Fig. 3 - Comparison of the mean outlines (non-normalised and normalised for areas) among Mediterranean Neogene and Quaternary *Cyprideis* species. a) *Cyprideis* Sambuca Vs *C. agrigentina*; b) *Cyprideis* Sambuca Vs *C. belfortensis*; c) *Cyprideis* Sambuca Vs *C. calabra*; d) *Cyprideis* Sambuca Vs *C. crotonensis*; e) *Cyprideis* Sambuca Vs *C. ruggierii*; f) *Cyprideis* Sambuca Vs *C. torosa*; g) *Cyprideis* Sambuca Vs *C. anlavauxensis*. Dotted line: the mean outline of *Cyprideis* Sambuca.

(L/H= 1.75-1.91) and inflated in the posterior area. The dorsal margin is arched, the anterior and posterior borders are rounded; the ventral margin is rather rectilinear or slightly sinuate. In the left valve, the posterior end is less inflated and the median sulcus is less evident; the ventral margin is more sinuate with an anterior concavity and a posterior convexity. The sexual dimorphism is remarkable: the male right valve is elongated (L/H= 1.86-2.04), the median sulcus is more evident than in female, and the ventral margin is more sinuate; the anterior margin is rounded while the posterior one can be pointed. In the left valve the ventral margin is less sinuate and the posterior end is more rounded. The surface of the valve is more or less pitted; several valves show a strong tuberculation (an ecophenotypical character linked to low salinities), which masks the general

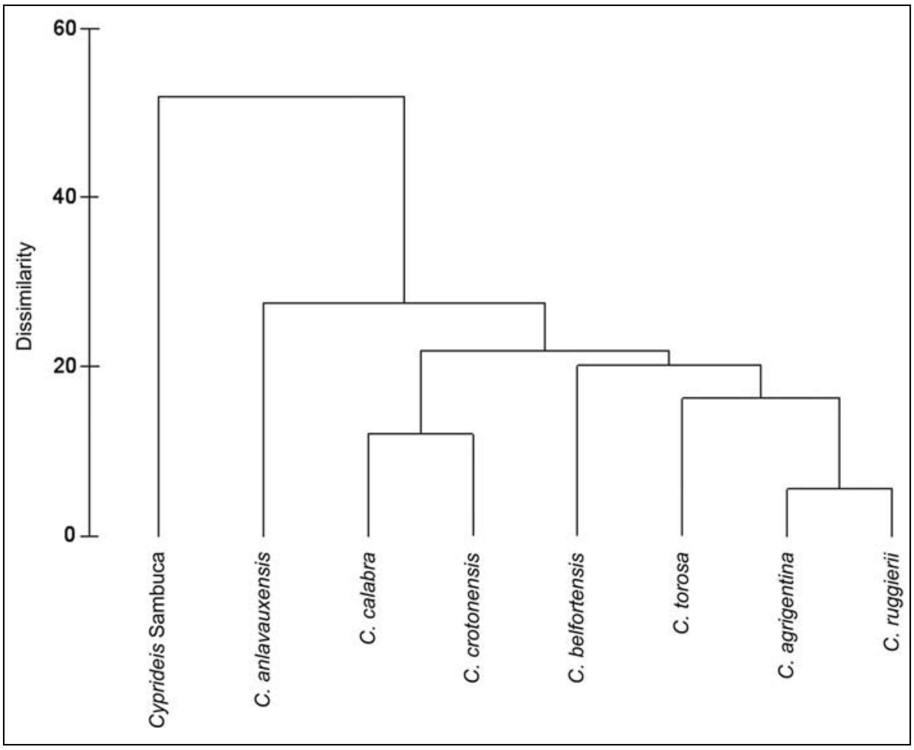

Fig. 4 - Dendrogram resulting from cluster analysis in R-mode using the UPGMA method and the Chord distance applied to the normalised outlines of female LV of the different Mediterranean Neogene and Quaternary species of *Cyprideis*.

outline. In the anterior flattened portion, a more or less pronounced ridge parallel to the anterior border is visible on the more ornate valves. Some valves show anterior denticulation and a postero-ventral stout spine. In the marginal zone the marginal pore canals are straight and only occasionally bifurcate. In internal view the hinge is thin and peripherical. Hinge of the RV with one elongated anterior subtriangular tooth and 11-14 small teeth; the median element is made of a very thin row of small sockets; the posterior element is made of several small toothlets and it ends with 6-7 quadrangular bipartite teeth increasing in size backwards.

Dimensions

RV♀	L= 0.98-1.08 mm	H= 0.52-0.62 mm
LV♀	L= 0.98-1.14 mm	H= 0.54-0.64 mm
RV♂	L= 1.02-1.18 mm	H= 0.52-0.61 mm
LV♂	L= 1.02-1.21 mm	H= 0.51-0.63 mm

Comparisons. *Cyprideis rectangularis* n. sp. has been compared with some *Cyprideis* species from the Mediterranean area. In comparison with other Italian *Cyprideis* species, the Valdelsa species differs considerably from *C. belfortensis, C. torosa*, *C. crotonensis*, *C. agrigentina*, *C. ruggierii* and *C. tuberculata* in the less convex dorsal margin, the different sinuosity of the ventral margin and generally, the slightly greater size of the female valve; similarly, also the male valves are generally larger and with different sinuosity in the ventral margin. *Cyprideis rectangularis* n. sp. differs from all those species also in its more slender hinge with less numerous teeth in the anterior element. Its outline is rather similar to that of *C. calabra* from which it differs in the larger size. *Cyprideis rectangularis* n. sp. is comparable with some Anatolian forms (Bassiouni 1979) such as *Cyprideis* (*Cyprideis*) *kristichae* Bassiouni, 1979 from the Pliocene of Konya and Seydişehir (Turkey), but it is slightly larger and its ventral margin is more undulated. Also *Cyprideis sohni* Bassiouni, 1979 from the Late Pleistocene of Hatay and Bedirge (Turkey) has a similar outline except for the posterior area, which is more

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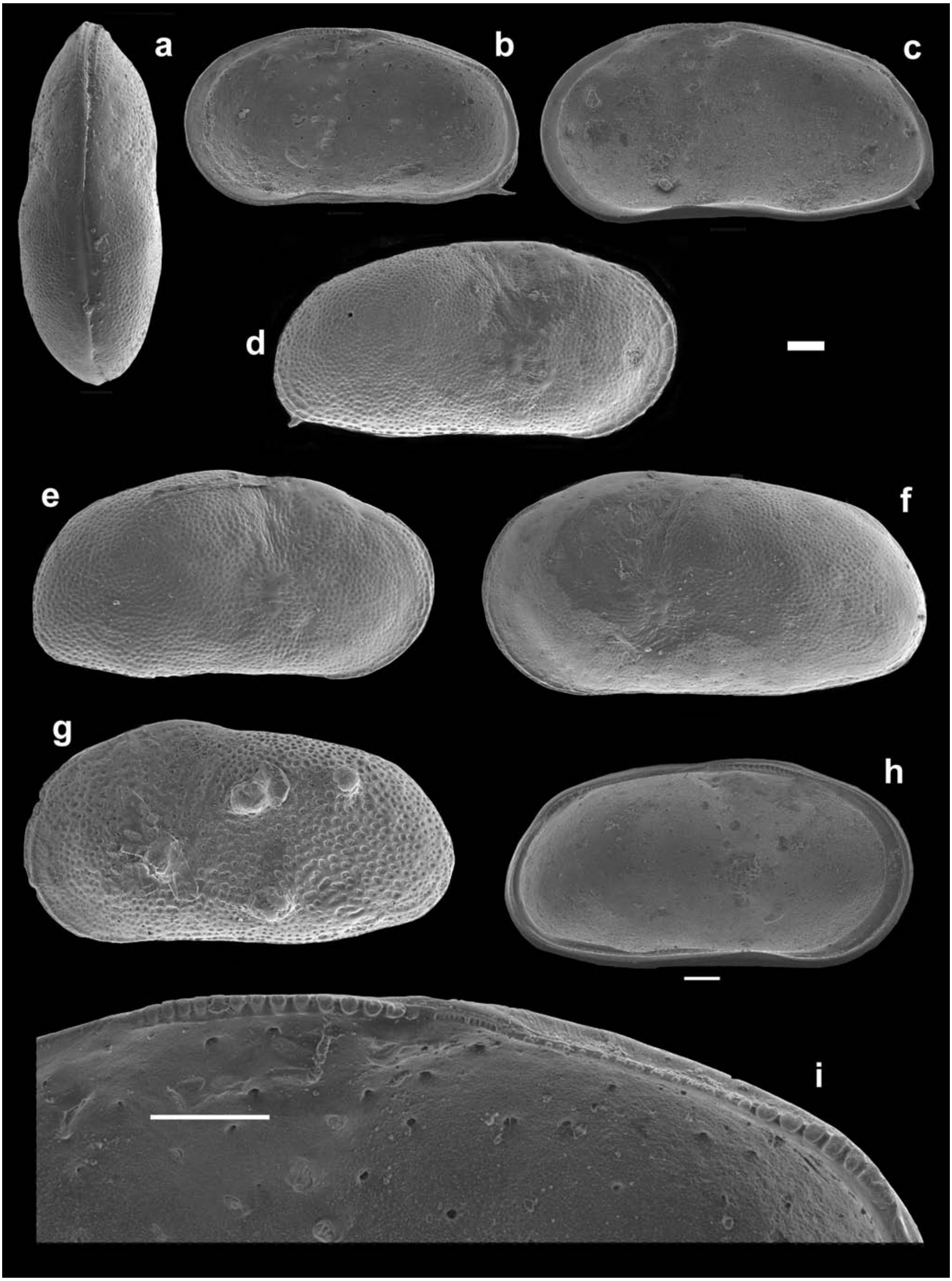
PLATE 2

a) *Cyprideis rectangularis* n. sp., paratype C♂ in dorsal view, sample LP 3.
b) *Cyprideis rectangularis* n. sp., RV♀ in internal view, sample LP 1.
c) *Cyprideis rectangularis* n. sp., RV♂ in internal view, sample LP 1.
d) *Cyprideis rectangularis* n. sp., paratype RV♂ in external view, sample LP 3.
e) *Cyprideis rectangularis* n. sp., paratype RV♂ in external view, sample LP 3.
f) *Cyprideis rectangularis* n. sp., paratype LV♂ in external view, sample LP 3.
g) *Cyprideis rectangularis* n. sp., paratype tuberculate LV♂ in external view, sample LP 3.
h) *Cyprideis rectangularis* n. sp., LV♂ in internal view, sample LP 1.
i) *Cyprideis rectangularis* n. sp., detail of the right hinge of the RV♀ figured in b.
Scales = 0.1 mm.


a
b
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pointed. *Cyprideis* (*Kolmanella*) *sazkoyensis* Bassiouni, 1979 from the Miocene of Denizli, Acigöl and Sazköy (Turkey) shows a similar ventral margin, but it is smaller in size (L= 0.90 mm).

Stratigraphical distribution. This species is known only from the Lower Pliocene of the Valdelsa Basin (Tuscany).

Suborder **Darwinulocopina** Sohn, 1988
Superfamily Darwinuloidea Brady & Robertson, 1889
Family Darwinulidae Brady & Robertson, 1889
Genus *Darwinula* Brady & Robertson, 1885

Darwinula stevensoni (Brady & Robertson, 1870)

Pl. 3, fig. b

1870 *Polycheles stevensoni* Brady & Robertson, p. 25, Pl. 7, figs 1-7; Pl. 10, figs. 4-14.

1885 *Darwinula stevensoni* nov. comb. – Brady & Robertson, p. 3.

1965 *Darwinula stevensoni* (Brady & Robertson) – Devoto, p.346, Fig. 52 (cum syn).

1978 *Darwinula stevensoni* (Brady & Robertson) – Molinari Paganelli, p. 286, Pl. 3, fig. 4 (cum syn).

1998 *Darwinula stevensoni* (Brady & Robertson) – Gliozzi & Mazzini, p. 70, Pl. 2, fig. e.

1999 *Darwinula stevensoni* (Brady & Robertson) – Barbieri et al., p. 62, Fig. 11.

1999 *Darwinula stevensoni* (Brady & Robertson) – Mazzini et al., p. 299, Tab. 2.

2000 *Darwinula stevensoni* (Brady & Robertson) – Gliozzi, p. 160, Fig. 3i.

Studied material: sample SBN-1: 1 LV ♀; sample SBN1: 1 LV ♀.

Dimensions

LV	L= 0.66-0.67 mm	H= 0.25-0.27 mm

Discussion. The two left valves collected in the Sambuca Nord section can be ascribed to *Darwinula stevensoni* (Brady & Robertson, 1870) for their lateral outline and dimensions

Stratigraphical distribution. *D. stevensoni* is a living species with a wide stratigraphical distribution. It has been signalled from the middle Oligocene of Kazakhstan by Bodina (1961) and has been surely found in the Miocene of Europe and Anatolia (Straub 1952; Malz & Moayedpour 1973; Janz 1997; Freels 1980); according to Meisch (2000) it could be even older.

Suborder **Cypridocopina** Jones, 1901
Superfamily Cypridoidea Baird, 1845
Family Candonidae Kaufmann, 1900
Subfamily Candoninae Kaufmann, 1900
Genus *Candona* Baird, 1846

Klie (1938) subdivided the genus *Candona* s.l. into seven groups of living species, taking into account both the soft parts and the carapace shape. Krstić (1972b), considering also the fossil Paratethyan species, included 21 subgenera within the genus *Candona*, based mainly on the carapace and valve features. Subsequently, Danielopol (1978, 1980) and Baltanas et al. (2003) suggested that the shape of the candonids carapace is cued more by environmental factors than by phylogenetic causes. Recently Krstić & Shao-Zeng (2000) proposed a new taxonomical subdivision of subfamily Candoninae, establishing and/or raising a great number of taxa. Within this new taxonomy *Candona* s.l. is splitted into 69 different fossil and extant genera (sometimes including also subgenera), often characterised by very slight differences, difficult to detect. At the same time Meisch (2000) published his revision of the living freshwater ostracods of Central and Western Europe and proposed a new taxonomical organisation of the Candoninae subfamily, splitting living *Candona* s.l. into 9 different genera. In most cases the diagnostic characters are mainly on the soft parts but also some shell characters are provided.

In the present paper, both the revisions of Meisch (2000) and Krstić & Shao-Zeng (2000) are taken into account and discussed.

Subgenus *Neglecandona* Krstić, 2006

Following Krstić (1993a) the Candoninae related to the "neglectoids group" *sensu* Klie (1939) and Löffler & Danielopol (1978) must be considered within the separate subgenus *Neglecandona* Krstić, 1993, included within the genus *Candona*. According to her diagnosis, *Neglecandona* is characterised by a rather thin and posteriorly finely reticulated shell (rather heavy shell and never reticulated included in *Candona* s.s.) and males considerably larger than females. Although not clearly stated in Krstic (1993a), it was supposed *Candona neglecta* Sars as the type-species of the subgenus *Neglecandona*. Krstić & Shao-Zeng (2000) raised the *Neglecandona* subgenus to the generic rank. Meisch (2000) retains both the informal *candida*- and *neglecta*-groups within genus *Candona* s.s. Anyway, besides the previously mentioned differences stated by Krstić (1993b), Meisch (2000) adds also one more difference in the appendages: the species of the *candida*-group have 5 setae on the second segment of the mandible, while those referred to the *neglecta*-group shows only 4 setae. Meisch & Wouters (2002) reject *Neglecandona* mainly for formal reasons, i.e. Krstić 1993b did not indicated the type species. Anyway, in their paper, these authors recognized the presence of peculiar sieve-pore canals on *C. neglecta* valves and suggested that, if this feature should be recognized also on valves of other species of the *neglecta*-group, it would be reasonable to include them into a different genus. We have performed SEM pictures in internal view of the valves of other living "neglectoid" species (*Candona lindneri* Petkovski, 1969, *Candona meerfeldiana* Scharf, 1983, and *Candona angulata* Müller, 1900), but sieve-pore canals such as those described by Meisch & Wouters (2002) have not been recognized with certainty (Fig. 5). Nevertheless, taking into account that at present all the authors agree to recognize at least three slightly different characters between "*candida*" and "*neglecta* groups" both on shell and soft parts, it seems reasonable to consider *Neglecandona* as a valid taxon, even if at a sub generic level. According to the International Code of Zoological Nomenclature (ICZN 1999, Art. 13.3, 42.3.2, 67.4.1) a genus or subgenus established after 1930 without the designation of the type species is not valid and must be treated as a *nomen nudum,* thus Meisch & Wouters (2002) were right in rejecting *Neglecandona*. Anyway ICZN 1999 (Glossary "*nomen nudum*") states that "...[*nomina nuda*] may be available later for the same or a different concept; in such a case it would take authorship and date (Arts. 50, 21) from that act of establishment, not from earlier publication as a *nomen nudum*". In 2006, Krstić corrects her omission in the designation of the type species and chooses the species *Candona lindneri* Petkovski, 1969 as type species for the genus *Neglecandona*. For the diagnosis of the genus she refers to her 1993b and 1995 articles. Thus, following the ICZN (1999) the taxon *Neglecandona* is validated and must be quoted as *Neglecandona* Krstić, 2006.

Candona (Neglecandona) neglecta Sars, 1887

Pl. 3, figs c-d

1887 *Candona neglecta* Sars, p. 279, pl. 15, figs 5-7; pl. 19, figs. 1-21.

1964 *Candona neglecta* Sars - McKenzie, p. 8, pl. 1, fig. 3.

1978 *Candona neglecta* Sars - Molinari Paganelli, p. 280, pl. 2, fig. 2 (cum syn).

1994 *Candona neglecta* Sars - Calderoni et al., p. 54, fig. 10f.

1995 *Candona neglecta* Sars - Barberi et al., p. 524, fig. 6a-c.

1996 *Candona neglecta* Sars - Gliozzi, p. 96.

1996 *Candona neglecta* Sars - Belis et al., p. 112.

1998 *Candona neglecta* Sars - Gliozzi & Mazzini, p. 70, Pl. 1, fig. e.

1999 *Candona neglecta* Sars - Mazzini et al., p. 299, Tab. 2, Pl. 2, fig. 2.

1999 *Candona neglecta* Sars - Gliozzi, p. 62, Fig. 12a.

1999 *Candona neglecta* Sars - Barbieri et al., 62, Fig. 11.

Studied material: sample SB1: 1 RV♀, 1 LV♀; sample SB3: 4 RV♀; sample SBN-1: 1 RV♀, 1 LV♀; 1 broken LV♂; sample SBN1: 1 LV♀; sample SBN2: 1 RV♀; sample SBN3: 1 RV♀, 2 LV♀; sample LP1: 5 RV♀; sample LP2: 4 RV♀, 6 LV♀.

Dimensions

RV♀	L= 0.94-1.16 mm	H= 0.50-0.61 mm
LV♀	L= 0.94-1.01 mm	H= 0.44-0.52 mm
LV♂	L= 1.13 mm	H= 0.61 mm

Discussion. The average H/L ratio= 0.53 and the general outline of the female valves suggest to refer the collected specimens either to *C.* (*N.*) *neglecta* Sars or to *Candona* (*Neglecandona*) *lindneri* Petkovski that, according to Meisch (2000) and Krstić (2006) share the same outline and display only small size differences (being *C.* (*N.*) *lindneri* a little smaller). *C.* (*N.*) *lindneri* has an angular postero-ventral border whereas the rounded shape of the postero-ventral border of the broken left male valve recovered in sample SBN-1 allows to refer all the collected valves to *C.* (*N.*) *neglecta*. This species shows a remarkable intraspecific variability, particularly in the H/L ratio and in the dorsal portion of the anterior border, which can be more or less inclined (for example, compare *C.* (*N.*) *neglecta* illustrations in Klie 1938) and Meisch 2000). The valve sizes fall within

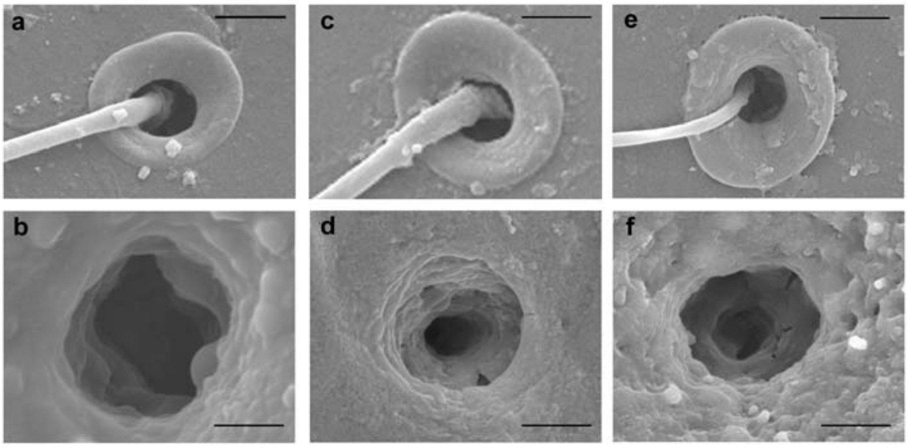


Fig. 5 - SEM pictures of the normal pore canals of different species of *Candona* (*Neglecandona*).
a) *Candona (Neglecandona) angulata* (external view);
b) *Candona (Neglecandona) angulata* (internal view);
c) *Candona (Neglecandona) lindneri* (external view);
d) *Candona (Neglecandona) lindneri* (internal view);
e) *Candona (Neglecandona) neglecta* (external view);
f) *Candona (Neglecandona) neglecta* (internal view). Scale = 2 μm.

the minimum values of the variability field of *C. neglecta* (data from Meisch 2000).

Stratigraphic distribution. Serravallian-Recent.

Candona (Neglecandona) dorsoreticulata n. sp.

Pl. 3, figs e-h

Derivatio nominis: the name refers to the characteristic dorsal reticulation of the shell.

Holotype: LV ♀ (L= 1,16 mm; H= 0,60 mm), Pl. 3, fig. e, catalogue number G.O.C. T26/1.

Paratypes: eleven RV♀ (G.O.C. T26/2-12), two LV♀ (G.O.C. M130/3/3, T26/13), one RV♂ (G.O.C. T26/14).

Stratum typicum: sample LP3, palustrine-lacustrine deposits of the Sambuca area, Lower Pliocene.

Locus typicus: Sambuca area, central-eastern portion of the Valdelsa Basin.

Studied material: sample SBN0: 1 LV♀; sample SBN2: only instars; sample LP1: 13 RV♀, 3 LV♀; sample LP3: 11 RV♀, 5 LV♀, 1 RV♂; several juveniles.

Diagnosis: middle-sized *C.* (*Neglecandona*) species with typical reticulation located in the dorsal area of each valve, visible only in transmitted light.

Description. Middle-sized *C. (Neglecandona)* with stout proportions. The dorsal margin is only slightly sloping forwards, jointed with a well rounded anterior margin without any cardinal angle; the ventral margin is strongly concave in the middle and bends slightly downwards in the posterior portion, so that the postero-ventral angle is lower than the anterior one. The surface of the valves is smooth but in transmitted light a characteristic internal reticulation of the shell, limited to the dorsal area, becomes visible. The normal pore-canals are evident in transmitted light; the marginal pore-canals are straight and rather dense.

Dimensions

RV♀	L= 0.98-1.18 mm	H= 0.47-0.66 mm
LV♀	L= 1.03-1.15 mm	H= 0.48-0.60 mm
RV♂	L= 1.19 mm	H= 0.66 mm

Comparisons. No known species shows the same characteristic dorsal reticulation of the shell typical of *C.* (*N.*) *dorsoreticulata* n. sp. However *C.* (*N.*) *dorsoreticulata* n. sp. has been compared with rather similar Plio-Pleistocene candonids. *Candona* (*Neglecandona*) *banatica* Krstić, 1985, from the middle Pleistocene of Serbia, shows smaller size [LV ♀ L= 0.91, h= 0.45], less rounded anterior outline and posterior end more inflated and rounded. *Candona* (*Neglecandona*) *permanenta* Krstić, 1985, from the Late Pliocene-Middle Pleistocene of Serbia, is comparable in size [LV ♀ L=1.13-1.18, h=0.56-0.61] but shows a dorsal margin more inclined forwards, a less acute postero ventral angle and a more developed vestibule. *Candona* (*Neglecandona*) *laodicena* Freels, 1980, from the Plio-Pleistocene of Turkey, shows slightly larger size [female left valve L= 1.216, h= 0.624], a dorsal margin more inclined forward, the anterior end with more pronounced cardinal angle and a more inflated posterior margin.

Stratigraphical distribution. This species is known only from the Lower Pliocene of the Valdelsa Basin (Tuscany).

Candona (Neglecandona) sambucensis n. sp.

Pl. 3, fig. I; Pl. 4, figs. a-b

Derivatio nominis: from Sambuca, the area of the Valdelsa Basin from which the species have been collected.

Holotype: LV ♀ (L= 1.06 mm; H= 0.52 mm), Pl. 3, fig. i, catalogue number G.O.C. 28/1.

Paratypes: ten RV ♀ (G.O.C. T44/1-10), eighteen LV ♀ (G.O.C. T45/1-18)

Stratum typicum: sample LP1, palustrine-lacustrine deposits of the Sambuca area, Lower Pliocene.

Locus typicus: Sambuca area, central-eastern portion of the Valdelsa Basin.

Studied material: sample LP1: 10 RV ♀, 19 LV ♀; sample LP3: 2 LV ♀; few juveniles

Diagnosis: Small-size neglectoid candonid with parallel dorsal and ventral margin, angular-postero ventral border and large normal pore canals.

Description. Small-size neglectoid candonid with elongated outline, parallel dorsal and ventral margin and pointed postero-ventral angle. The surface of the valve is smooth, but in transmitted light the valves appear dotted by large normal pore-canals. The marginal pore canals are well developed. No male valves have been recovered.

PLATE 3

a) *Cyprideis rectangularis* n. sp., detail of the left hinge of the LV♂ figured in Pl. 2,h.

b) *Darwinula stevensoni* (Brady & Robertson), LV in external view, sample SBN-1.

c) *Candona* (*Neglecandona*) *neglecta* Sars, RV♀ in external view, sample LP 1.

d) *Candona* (*Neglecandona*) *neglecta* Sars, RV♀ in external view (transmitted light), sample LP 1.

e) *Candona* (*Neglecandona*) *dorsoreticulata* n. sp., holotype, RV♀ in external view (transmitted light), sample LP 3.

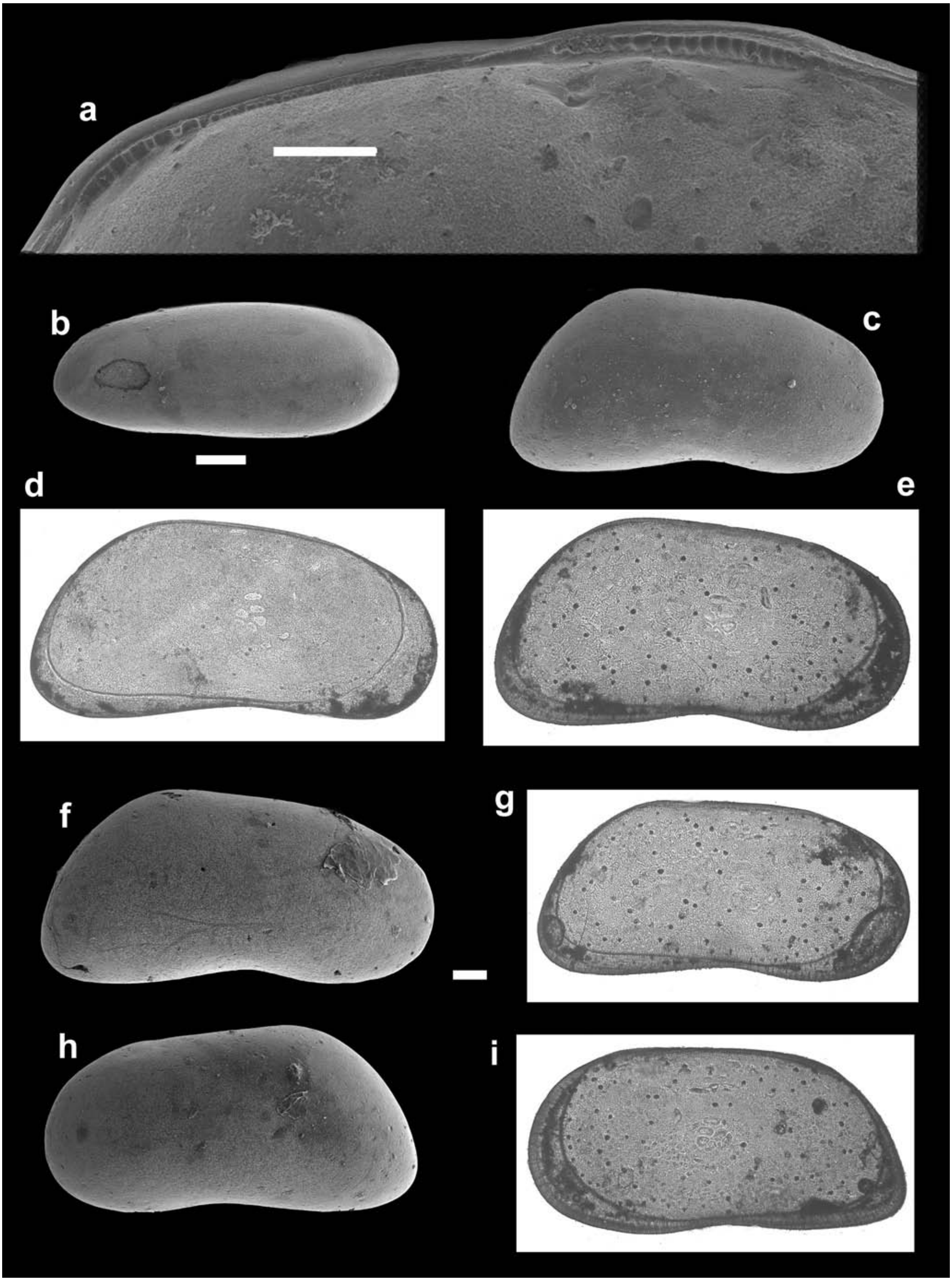
f) *Candona* (*Neglecandona*) *dorsoreticulata* n. sp., paratype, RV♀ in external view, sample LP 3.

g) *Candona* (*Neglecandona*) *dorsoreticulata* n. sp., RV♀ in external view (transmitted light), sample LP 1.

h) *Candona* (*Neglecandona*) *dorsoreticulata* n. sp., paratype, LV♀ in external view, sample LP 3.

i) *Candona* (*Neglecandona*) *sambucensis* n. sp., holotype, LV♀ in external view (transmitted light), sample LP 1.

All scales = 0.1 mm. Large scale bar for *Darwinula*, small scale bar for *Candona*.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Dimensions

RV♀	L= 0.96-1.11 mm	H= 0.48-0.54 mm
LV♀	L= 0.98-1.11 mm	H= 0.48-0.58 mm

Comparisons. *Candona* (*Neglecandona*) *sambucensis* n. sp. has been compared with some similar Plio-Pleistocene species. *Candona* (*Neglecandona*) *banatica* Krstić, 1985, from the Middle Pleistocene of Serbia, is smaller [LV ♀ L= 0.91, H= 0.45], shows an anterior margin less rounded, a dorsal margin more inclined and a ventral margin less sinuous. *Candona* (*Neglecandona*) *dardanica*, Krstić, 1998, from the Late Pliocene of Methoija, Serbia, shows similar size [LV ♀ L= 1.03, H= 0.55], a more arched dorsal margin, a less sinuous ventral margin, a more pointed and elongated postero ventral angle.

Stratigraphical distribution. This species is known only from the Lower Pliocene of the Valdelsa Basin (Tuscany).

Candona (Neglecandona) subtilis n. sp.

Pl. 4, figs c-g

Derivatio nominis: from Latin *subtilis* = narrow.

Holotype: LV♀ (L= 0.97 mm; H= 0.49 mm), Pl. 4, fig. c, catalogue number G.O.C. T27/1

Paratypes: eight RV♀ (G.O.C. T46/1-8), four RV♂(G.O.C. T46/9-12), three LV♂ (G.O.C. 46/13-15)

Stratum typicum: sample LP1, palustrine-lacustrine deposits of the Sambuca area, Lower Pliocene.

Locus typicus: Sambuca area, central-eastern portion of the Valdelsa Basin.

Studied material: sample LP1: 8 RV♀, 1 LV ♀, 4 RV♂, 3 LV♂; sample LP3: 1 RV♀, 1 LV♀, 6 RV♂, 4 LV♂, several juveniles.

Diagnosis: Small-sized neglectoid candonid characterised by an elongated shape and sub parallel dorsal and ventral margins.

Description. Small-sized *C.* (*Neglecandona*). In dorsal view, the valves are narrow and show rounded posterior and anterior ends. In lateral view *Candona* (*Neglecandona*) *subtilis* n. sp. is elongated in shape; the dorsal margin is slightly arched and tilted forward, the ventral margin is sinuate in the middle. The anterior margin is rounded and slightly infracurved, the posterior margin is arched and the postero-ventral margin is rounded. The surface of the valve is smooth; in transmitted light, short and simple marginal pore-canals are visible. The sexual dimorphism is remarkable: the male valves are elongated, with more inclined dorsal margin and more inflated posterior end.

Dimensions

RV♀	L= 0.98-1.15 mm	H= 0.47-0.61 mm
LV♀	L= 0.97-1.05 mm	H= 0.49-0.53 mm
RV♂	L= 1.03-1.30 mm	H= 0.50-0.72 mm
LV♂	L= 1.15-1.28 mm	H= 0.61-0.71 mm

Comparisons. *C.* (*N.*) *subtilis* n. sp. has been compared with some similar Late Miocene and Plio-Pleistocene species. *Candona* (*Neglecandona*) *prolonga* Krstić, 2006, from the Lower Paludinian Beds (Messinian) of Serbia, shows a comparable size [LV♀ L= 1.02, h= 0.49], the dorsal margin more tilted forward, the anterior end less inflated, and a kind of reticulation visible in transmitted light that is absent in *Candona (Neglecandona) subtilis* n. sp. *Candona* (*Neglecandona*) *churmensis* Freels, 1980, from the Early Pliocene of the Elbistan Basin, central-southern Turkey, is much larger [LV♀ L= 1.392, H= 0.656], but shows a very similar ventral margin; the dorsal margin is more inclined forwards and the inner margin is more developed anteriorly.

Stratigraphical distribution. This species is known only from the Lower Pliocene of the Valdelsa Basin (Tuscany).

Candona (Neglecandona) sp.

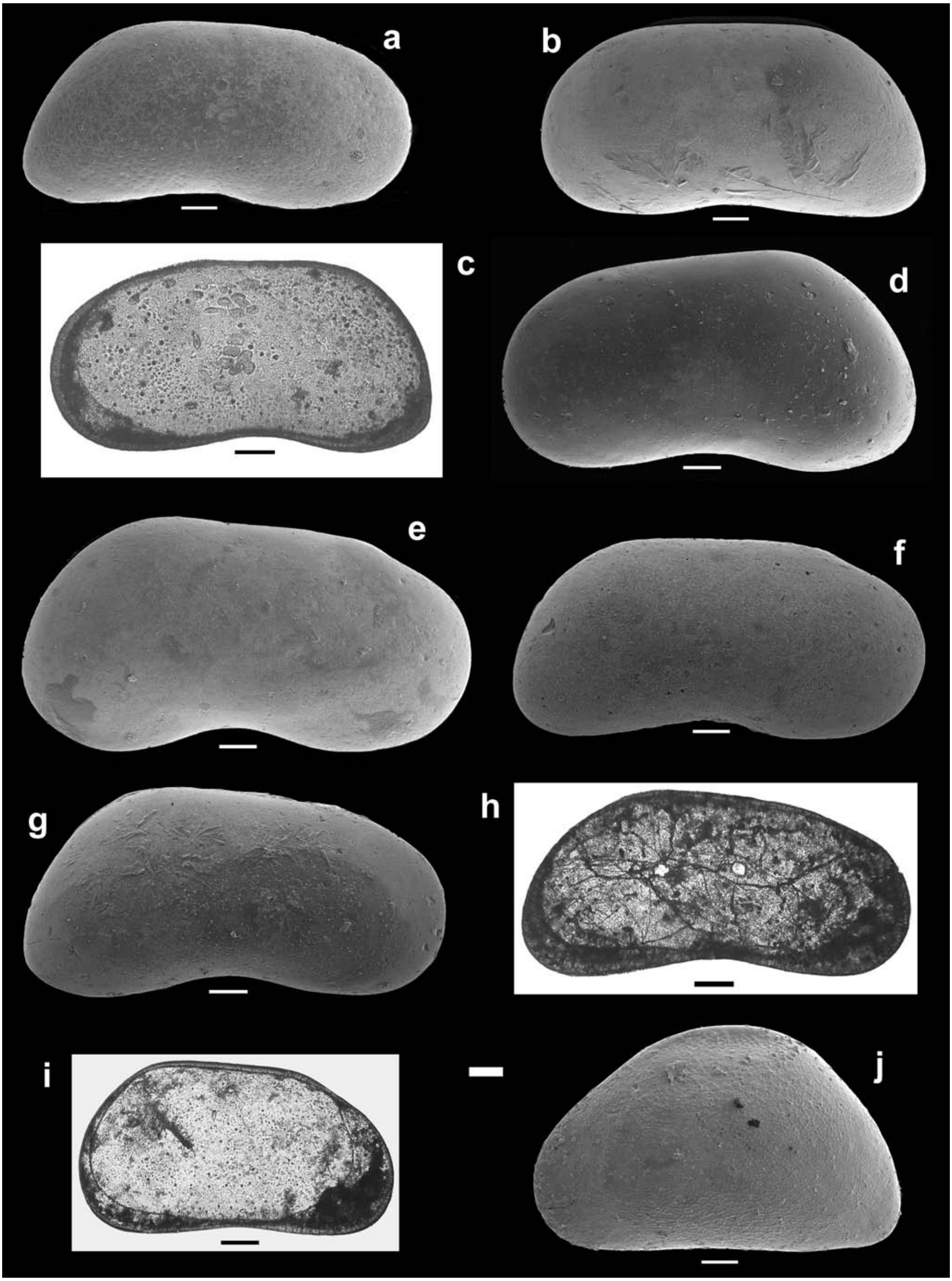
Pl. 4, fig. h

Studied material: sample SBN0: 1 RV♀.

Description. Middle-sized neglectoid candonid with very elongated female valves (H/L= 0.50). The maximum height is shifted backwards, nearly at ¾ of the total length so the anterior height is quite shorter than the posterior one. The dorsal border is gently arched and inclined forwards. The ventral border is remarkably concave at ½ of the length. The posterior border is gently arched backwards and joins the ventral border with a rounded postero-ventral angle. The surface of the valve is smooth.

PLATE 4

a) *Candona* (*Neglecandona*) *sambucensis* n. sp., paratype, RV♀ in external view, sample LP 1.
b) *Candona* (*Neglecandona*) *sambucensis* n. sp., paratype, LV♀ in external view, sample LP 1.
c) *Candona* (*Neglecandona*) *subtilis* n. sp., holotype, LV♀ in external view (transmitted light), sample LP 1.
d) *Candona* (*Neglecandona*) *subtilis* n. sp., paratype, LV♂ in external view, sample LP 1.
e) *Candona* (*Neglecandona*) *subtilis* n. sp., RV♂ in external view, sample LP 3.
f) *Candona* (*Neglecandona*) *subtilis* n. sp., paratype, RV♀ in external view, sample LP 1.
g) *Candona* (*Neglecandona*) *subtilis* n. sp., paratype, RV♀ in external view, sample LP 1.
h) *Candona* (*Neglecandona*) sp., RV♀ in external view (transmitted light), sample SBN 0.
i) *Pseudocandona albicans* (Brady), RV♀ in external view (transmitted light), sample SBN 3.
j) *Pseudocandona* cf. *P. eremita* (Vejdovsky), RV♀ in external view, sample PH 2.
Scale = 0.1 mm.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Dimensions

RV♀	L= 0.99 mm	H= 0.50 mm

Comparisons. *Candona* (*Neglecandona*) sp. has been compared with several Plio-Pleistocene neglecandonids of central-western Europe and of the Balkans (Paludinian beds and Ohrid Lake) but, generally, all the known species are proportionally less slender. Thus, this unique recovered valve has been left in open nomenclature. Choosing to compare only the most elongated forms, the most similar species are: *Candona permanenta* Krstić, 1985, from the Late Pliocene-Early Pleistocene of Serbia, which shows a more evident, even if obtuse, anterior cardinal angle; *Candona* aff. *C.* (*Neglecandona*) *paludinica* Krstić from the Late Pliocene-Early Pleistocene of Serbia (Krstić 1993b) and *Candona* aff. *C.* (*Neglecandona*) *lindneri* Petkovski (Krstić 1993a) from the Middle Pleistocene of Serbia, from which it seems stouter; *C.* (*Neglecandona*) *lindneri* Petkovski from the Middle Pleistocene-Recent of Germany, Slovak and Czech Republic, that shows a more straight dorsal margin, less inclined forwards.

Genus *Mixtacandona* Klie, 1938

About the validity of genus *Mixtacandona* see the discussion in Karanovic & Pesce (2000) and Namiotko & Danielopol (2002). Taking into account the ICZN indications, we suppose that the use of the name *Mixtacandona laisi* by Klie (1938, p. 28) is sufficient to make this genus valid and referable to Klie.

Mixtacandona cf. **M. tabacarui** Danielopol & Cvetkov, 1979

Pl. 5, fig. c

Studied material: sample PH2: 1 LV

Dimensions

LV	L= 0.63 mm	H= 0.38 mm

Discussion. For its shape and size, the collected left valve is comparable to *M. tabacarui* but shows a slightly rounded and more prominent dorsal protuberance (16.6% of the total length against 12.5% in *M. tabacarui*), a more acute dorsal angle (101° against ca. 120°) and fine pits in the central area, not described by Danielopol & Cvetkov (1979). For these slight differences and owing to the scarce material it is preferable to maintain the specimen in open nomenclature.

Stratigraphical distribution. Up to present, *Mixtacandona tabacarui* is not known as fossil. If the doubtful attribution suggested in this paper would be confirmed, its origin will date back to Pliocene.

Genus *Pseudocandona* Kaufmann, 1900

Pseudocandona albicans (Brady, 1864)

Pl. 4, fig. i

1864 *Candona albicans* Brady, 13, p. 61, pl.4: 6-10.

1973 *Pseudocandona albicans* (Brady) nov. comb. – Danielopol, p. 240.

1999 *Pseudocandona albicans* (Brady) – Mazzini et al., p. 297, Tab. 2.

2003 *Pseudocandona albicans* (Brady) – Rossi et al., p. 4, Tab. 1

2005 *Pseudocandona albicans* (Brady) – Rossetti et al., p. 291, Tab. 2, Fig. 4E-F.

2009 *Pseudocandona albicans* (Brady) – Pieri et al., p. 4, Tab. 1.

2009 *Pseudocandona albicans* (Brady) – Stoch et al., p. 155.

Studied material: sample SBN3: 1 RV♀ and two instars.

Dimensions

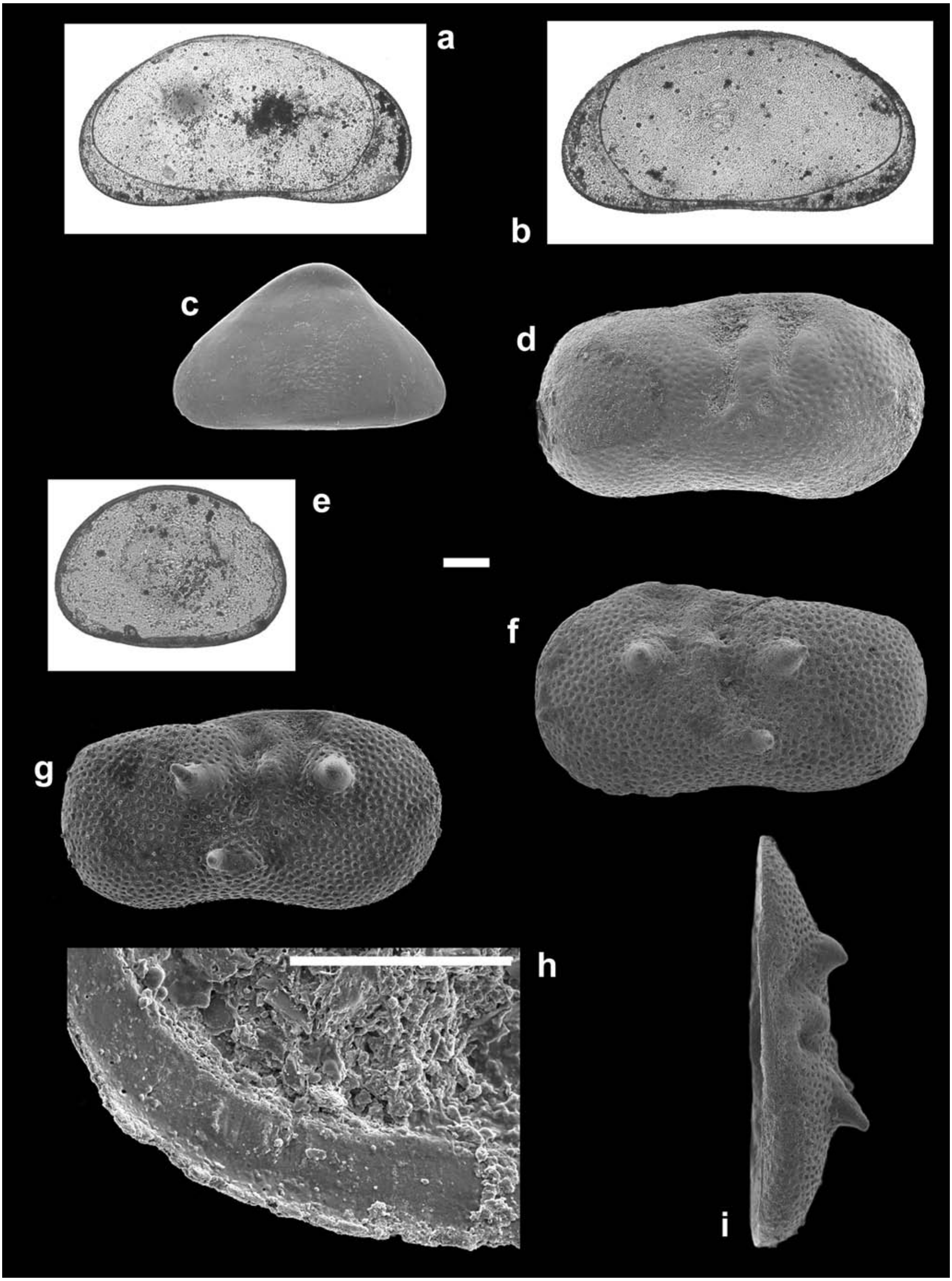
RV♀	L= 0.86 mm	H= 0.47 mm

Discussion. The shape (in particular the lack of a beak-shaped anterior end) and the small dimensions of the female right valve collected in the Sambuca Nord section are comparable to those of *P. albicans*. This attribution is confirmed by the recovery of two pitted instars.

Stratigraphical distribution. *P. albicans* was known from Early Pleistocene (Lüttig 1968; Széles 1968; Sokač 1975, 1978) to Present. This recovery extends its stratigraphical distribution down to the Early Pliocene.

PLATE 5

a) *Candonopsis arida* Sieber, RV♀ in external view (transmitted light), sample SBN 0.
b) *Candonopsis arida* Sieber, LV♀ in external view (transmitted light), sample SBN 0.
c) *Mixtacandona* cf. *M. tabacarui* Danielopol & Cvetkov, LV in external view, sample PH 2.
d) Cyclocypridinae indet., sample SBN 2.
e) *Ilyocypris bradyi* Sars, LV in external view, sample LP 1.
f) *Ilyocypris* cf. *I. monstrifica*, RV in external view, sample LP 1.
g) *Ilyocypris* cf. *I. monstrifica*, LV in external view, sample LP 1.
h) *Ilyocypris* cf. *I. monstrifica*, LV in inner view, detail of the marginal ripples, sample LP 1.
i) *Ilyocypris* cf. *I. monstrifica*, RV in dorsal view, sample LP 1.
Scale = 0.1 mm.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Pseudocandona cf. **P. eremita** (Vejdovsky, 1882)
Pl. 4, fig. j

Studied material: sample PH2: 2 LV♀ and some instars.

Dimensions

LV♀	L= 1.00-1.02 mm	H= 0.62 mm

Discussion. For its triangular shape and for the presence of pits in the muscle scar area this valve probably belongs to the *P. eremita* group (Meisch 2000). Comparisons have been made with the following stygophile forms: *P. eremita* Vejdovsky, from the Middle-Late Pleistocene of central, eastern and southern Europe, shows similar dimensions but a more pointed anterior area; *P. dispar* Hartmann, 1964, living in SE Europe and Turkey seems to have a similar morphology but is less pointed and displays a smaller size (L= 0.84-0.87 mm); *P. szoecsi* Farkas, 1958, from Middle Pleistocene-Recent of central, eastern and south-eastern Europe, is smaller and more elongated. According to Meisch (2000), *P. dispar* and *P. eremita* could be synonyms; according to some authors (see discussion in Meisch 2000) also *P. szoecsi* could be synonym of *P. eremita*.

Stratigraphical distribution. Up to present, *P. eremita* was known from Middle Pleistocene (Sokač 1978; Krstić et al. 1981; Krstić 1988) to Present. If confirmed, this recovery would extend its stratigraphical distribution down to the Early Pliocene.

Genus *Candonopsis* Vávra, 1891

Candonopsis arida Sieber, 1905
Pl. 5, figs a-b

1905 *Candonopsis arida* Sieber, pp. 332-333, fig. 4, pl. 8, figs 15-19.

Studied material: sample SBN0: 1 RV♀; sample SBN1: 1 juvenile RV; sample SBN3: 1 LV♀

Dimensions

RV♀	L= 0.73 mm	H= 0.38 mm
LV♀	L= 0.79 mm	H= 0.42 mm

Discussion. Shape, outline proportion, size and morphology of the inner lamella are comparable to those of *Candonopsis arida* Sieber.

Stratigraphical distribution. *C. arida* was known only from the Middle Miocene deposits of the Steinheim Basin (Sieber 1905; Lutz 1965; Janz 1992, 1997). The present recovery extends its stratigraphical distribution to the Early Pliocene.

Subfamily Cyclocypridinae Kaufmann 1900

Cyclocypridinae indet.
Pl. 5, fig. d

Studied material: sample SBN2: 1 juvenile right valve or small size adult valve

Dimensions

RV	L= 0.48 mm	H= 0.35 mm

Discussion. Only one right valve referable to subfamily Cyclocypridinae has been collected from the Sambuca area. The general outline, characterised by a slightly convex ventral margin, the small size and the moderate h/L ratio (0.73) are comparable with *Physiocypria suborbicularis* (Sieber, 1905) illustrated by Sieber (1905) and Janz (1992). However, no denticulation of the anterior-ventral and postero-ventral margins are visible. According to Janz (1992, tab. 6) the length of the Sambuca right valve could fit within the A-1 measurement range (average 0.482 mm) or could correspond to the minimum value of the adult valve (0.488 mm).

Several European fossil and living species of *Cypria*, compared with the Sambuca specimen, show higher proportions and constant differences in the shape of the ventral margin.

Family Ilyocyprididae Kaufmann, 1900

Subfamily Ilyocypridinae Kaufmann, 1900

Genus *Ilyocypris* Brady & Norman, 1889

Ilyocypris bradyi Sars, 1890
Pl. 5, fig. e

1890 *Ilyocypris bradyi* Sars, p. 59.

1978 *Ilyocypris brady* Sars – Molinari Paganelli, pp. 284-285, ffig. 1 (cum syn)

1999 *Ilyocypris bradyi* Sars – Barbieri et al., p. 62, fig. 11.

1999 *Ilyocypris bradyi* Sars – Mazzini et al., p. 297, tab. 2, pl. 2, fig. 4.

2007 *Ilyocypris bradyi* Sars – Aiello et al., p. 188, tab. 1.

2009 *Ilyocypris bradyi* Sars – Pieri et al., p. 6, tab. 1.

Studied material: sample LP1: 1 RV.

Dimensions

RV	L= 0.95 mm	H= 0.50 mm

Stratigraphical distribution. *Ilyocypris bradyi* is a living species with a wide stratigraphical distribution.

It is signalled from the Late Miocene and Pliocene of Siberia (Kazmina 1975), Anatolia (Turkey) (Tunoglu & Celik 1995) and Verde Valley (Arizona, USA) (Forester 1991) and from Pleistocene to Recent of Europe, North Africa, the Middle East, central Asia, China and North America (Meisch 2000).

Ilyocypris cf. **I. monstrifica** (Norman, 1862)

Pl. 5, figs. f-i

Studied material: sample LP1: 1 RV; 1 LV.

Dimensions

RV	L= 0.91 mm	H= 0.49 mm
LV	L= 0.91 mm	H= 0.50 mm

Discussion. The two valves recovered in the Sambuca area show several characters in common with the living *I. monstrifica*, such as a general slender shape, the presence of three protruding tubercles, the backward projection of the postero-dorsal spine and similar ripplet pattern on the left inner posterior margin (Janz 1994). However, they show poorly developed marginal spines, a spinous and well developed postero-ventral tubercle and slightly greater dimensions (length of *I. monstrifica*: 0.72-0.90 mm, Meisch 2000). For these differences, these valves are referred only dubitatively to *I. monstrifica*.

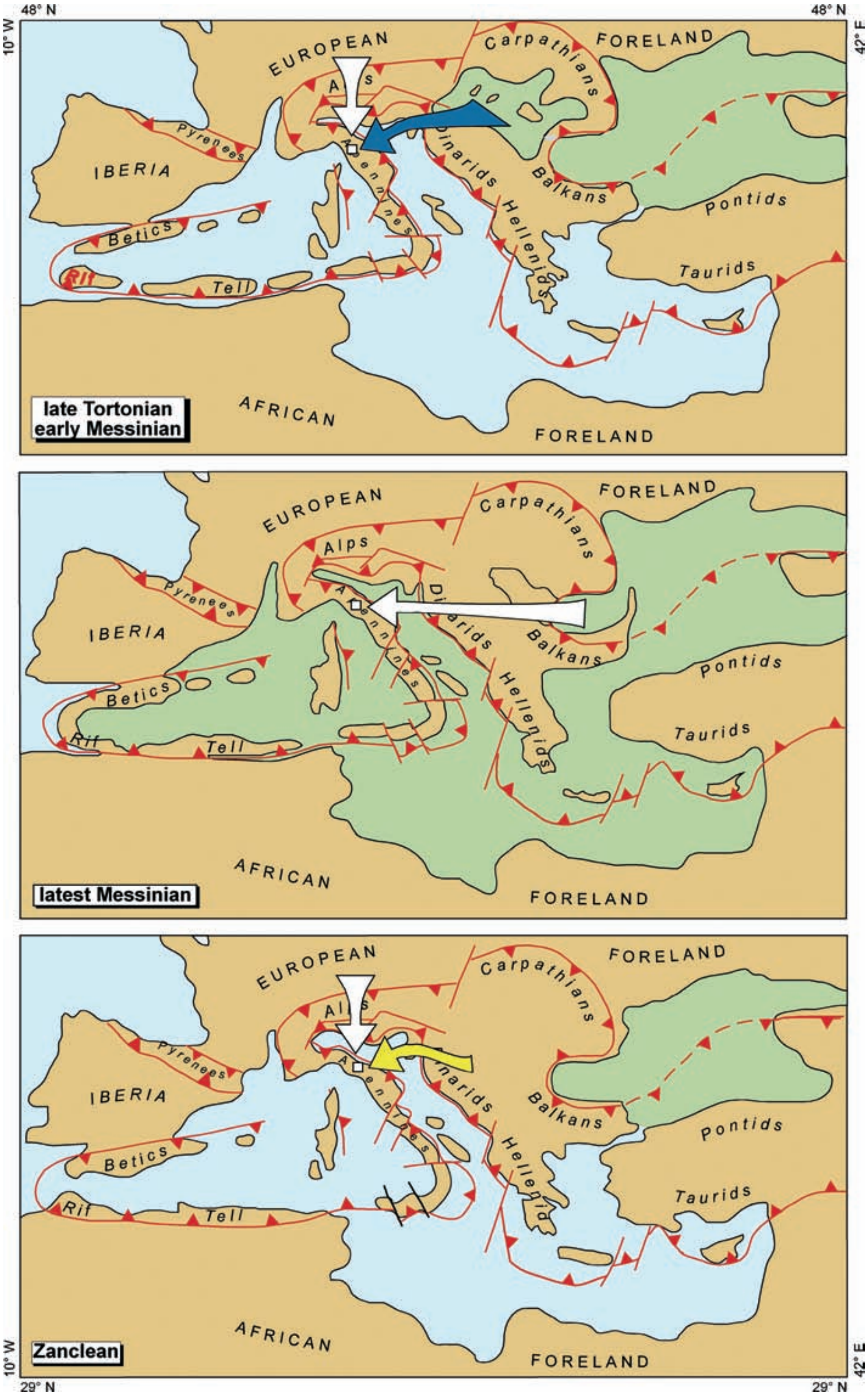
Stratigraphical distribution. The fossil record of *I. monstrifica* is scarce. It has been recorded as *I.* cf. *I. monstrifica* by Sokač & Gagić (1974) from the Lower Pleistocene deposits of the Vojvodina region (former Yugoslavia) and from several Middle and Late Pleistocene localities of Europe (Gagić 1968a,b; Sokač & Gagić 1973, 1974; Urumović & Sokač 1974; Diebel & Pietrzeniuk 1975; Sokač 1976; Babić et al. 1978; Robinson 1978; Krstić 1988, 2006; Krstić & Schornikov 1993; Calderoni et al. 1994 (under the name *I. gibba*); Barbieri et al. 1999; Gliozzi 2000; Frogley et al. 2001). If confirmed, its recovery in the Sambuca area would extend its stratigraphical distribution down to the Early Pliocene.

Discussion and conclusions

The large number of new species of ostracods described in the present paper from the Lower Pliocene deposits of the Valdelsa Basin mirrors the scarcity of taxonomical studies on the Pliocene brackish and freshwater Italian and European ostracods. Six species have been established as new and two have been left in open nomenclature due to the scarcity of material.

All the species are referable to European well known and more or less widespread genera or subgenera (*Paralimnocythere*, *Darwinula*, *Cyprideis*, *Candona* (*Neglecandona*), *Pseudocandona*, *Mixtacandona*, *Candonopsis* and *Ilyocypris*). From a taxonomical and palaeobiogeographical point of view, the neglecandonids represent the more interesting group among the ostracods collected in the Valdelsa basin, since, except *C.* (*N.*) *neglecta*, they are all referable to new species. Although *C.* (*N.*).) *dorsoreticulata* n. sp., *C.* (*N.*) *subtilis* n. sp., and *C.* (*N.*) *sambucensis* n. sp. differ at a specific level, they share a rather elongated outline and subparallel dorsal and ventral margins. This character distinguishes them from other neglecandonids of western and central Europe and makes them comparable to some Plio-Pleistocene Balkan species.

The presence of Italian ostracods that show affinities with Balkan or eastern European species is not a novelty (Gliozzi et al. 2007). During late Middle Miocene (late Serravallian) the Paratethyan area became completely isolated from the Palaeo-Mediterranean owing to the uplift of the Carpathian belt, and this isolation gave origin to a Paratethyan bioprovince (Meulenkamp & Sissingh 2003; Popov et al. 2004). However, during Late Miocene, western and central Paratethyan genera, or even species, are well documented in the brackish deposits of the Italian peninsula, particularly in the Tuscan area. In late Tortonian-early Messinian (Fig. 6), the passive dispersal of several Paratethyan genera gave rise to endemic Tuscan species, described by Faranda et al. (2007) and Ligios et al. (2008b). During the latest Messinian Lago-Mare phase (CIESM 2008), the whole Palaeo-Mediterranean area was actively invaded by Paratethyan species (Carbonnel 1978; Grekoff & Molinari 1963; Gliozzi 1999; Cipollari et al. 1999a; b; Gliozzi et al. 2002 with references therein; Gliozzi et al. 2007, with references therein; Grossi et al. 2008, Guerra-Mérchan et al. 2010) that successfully occupied the ecological niches emptied by the local extinction of the Palaeo-Mediterranean fauna during the Messinian Salinity Crisis (Ruggieri 1962; Benson 1990). In fact, during this time-interval, the palaeogeography and the relationships between Palaeo-Mediterranean and Paratethys were very different from the present day conditions. Following the Messinian Salinity Crisis acme (CIESM 2008), during which thousands of meters of evaporites were deposited on the bottom of the Palaeo-Mediterranean triggering the establishment of an environment not suitable for life (hyperhaline in the shallower areas and anoxic in the deeper zones), the Bethic and Riff straits closed, isolating the Mediterranean from the Atlantic Ocean (Krijgsman et al. 2001; Blanc 2006). The onset of a humid climatic global event (Griffin 2002) caused the dilution of the hyperhaline Palaeo-Mediterranean waters to hypohaline/brackish condition, disrupting


late Tortonian early Messinian

latest Messinian

Zanclean

Fig. 6 - Palaeogeographic sketch map of the Palaeo-Mediterranean and central-eastern Paratethys during late Tortonian-early Messinian, latest Messinian and Zanclean. Arrows indicate the paleobiogeographic affinity of the Tuscan ostracod assemblages during the different time intervals. Legend: light brown: emerged lands; light blue: marine domain; light green: caspibrackish domain; white arrows: same species; blue arrow: same genera; yellow arrow: affinity at specific level.

the ecological barrier which divided the Palaeo-Mediterranean and Paratethyan biota and leading to the spreading of the Paratethyan fauna into the highly impoverished Palaeo-Mediterranean area (Fig. 6). The "Zanclean flooding" or the "Zanclean deluge" (Rouchy & Caruso 2006) occurred abruptly at the end of the Messinian Salinity Crisis (5.33 Ma) when the connection between the Atlantic Ocean and the Palaeo-Mediterranean Sea were restored and the Palaeo-Mediterranean basin was refilled with marine water. In the Early Pliocene, the continental ostracod faunas of Italy lost their "Paratethyan affinity" and the few similarities between the Palaeo-Mediterranean and Paratethyan biota were limited: 1) to the recovery of one endemic species referable to a Paratethyan genus [*Euxinocythere* (*Maeotocythere*) *nasseri* Barra & Bonaduce] and to the doubtful recovery of *Loxoconcha* cf. *L. krajinae* Krstić in the Lower Pliocene paralic/brackish deposits of the Irpinia-Daunia Basin (southern Italy) (Barra et al. 1998); 2) to the similarity of the neglecandonids of the Valdelsa Basin with those of the Serbian Paludinian beds (Fig. 6).

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