



New species of *Mediocytherideis* (Ostracoda, Mediocytherideisinae) in the brackish Messinian of Italy

Silvia LIGIOS, Alessandro BOSSIO & Elsa GLIOZZI

S. Ligios, Dipartimento di Scienze Geologiche, Università degli Studi Roma Tre, Largo S. Leonardo Murialdo, 1 - 00146 Roma, Italy; ligios@uniroma3.it
A. Bossio, Dipartimento di Scienze della Terra, Università degli Studi di Pisa, Via S. Maria, 53 - 56126 Pisa, Italy; bossio@dst.unipi.it
E. Gliozzi, Dipartimento di Scienze Geologiche, Università degli Studi Roma Tre, Largo S. Leonardo Murialdo, 1 - 00146 Roma, Italy and IGAG, C.N.R., Roma, Italy; gliozzi@uniroma3.it

KEY WORDS - *Mediocytherideisinae* (Ostracoda), Messinian, Taxonomy, Central Italy, Mediterranean, Paratethys.

ABSTRACT - The genus *Mediocytherideis* Mandelstam, 1956 with its subgenera *Mediocytherideis* s.s. and *M. (Sylvestra)* Doruk, 1973 are here revised and the emended diagnosis of the two subgenera are given. Six new species have been introduced: *Mediocytherideis (Sylvestra) etrusca* nov. sp., *Mediocytherideis (Sylvestra) fossata* nov. sp., *Mediocytherideis (Sylvestra) ornata* nov. sp., *Mediocytherideis (Sylvestra) punctata* nov. sp., *Mediocytherideis (Sylvestra) sulcata* nov. sp. and *Mediocytherideis (Sylvestra) tetrafoveolata* nov. sp., coming from the Messinian brackish sediments of the Volterra-Radicondoli and Velona basins (Tuscany, central Italy). Three more taxa are described, left in open nomenclature, coming from the Messinian brackish sediments of the Velona Basin, the Taranta Peligna cemetery section (Majella Mt., central Italy) and the Trave Section (Ancona, central Italy).

An overview of the known *Mediocytherideis* s.l. species is given and the stratigraphic distribution and palaeobiogeography of this genus is discussed. The database shows that both *Mediocytherideis* s.s. and *M. (Sylvestra)* appear, more or less at the same time, either in the Mediterranean and in the Paratethys regions during Serravallian, a time interval in which these two palaeodomains were not yet divided. After the closure of the Mediterranean-Paratethys connection, occurred during the late Serravallian, *Mediocytherideis* s.l. continued to spread in each bioprovinces: in the Paratethys it is characteristic of brackish environments or, at least at the very beginning of its evolutive history, of shallow stressed marine environment; in the Mediterranean, on the contrary, since its appearance the genus gave rise to different species adapted to shallow marine environment or brackish environment. Unfortunately the too much-fragmented knowledge on *Mediocytherideis* s.l. species prevents the recognition of the centre of origin of the genus. Similarly, it is impossible to establish whether the brackish Mediterranean *Mediocytherideis* s.l. evolved from a Mediterranean stock or from Paratethyan brackish species migrated westwards by passive dispersal.

RIASSUNTO - [Nuove specie di *Mediocytherideis* (Ostracoda, *Mediocytherideisinae*) nel Messiniano salmastro italiano] - In questo lavoro vengono studiati il genere *Mediocytherideis* Mandelstam, 1956 con i suoi sottogeneri *Mediocytherideis* s.s. e *M. (Sylvestra)* Doruk, 1973 e vengono fornite, per entrambi, le diagnosi emendate. Vengono istituite sei nuove specie: *Mediocytherideis (Sylvestra) etrusca* nov. sp., *Mediocytherideis (Sylvestra) fossata* nov. sp., *Mediocytherideis (Sylvestra) ornata* nov. sp., *Mediocytherideis (Sylvestra) punctata* nov. sp., *Mediocytherideis (Sylvestra) sulcata* nov. sp. e *Mediocytherideis (Sylvestra) tetrafoveolata* nov. sp., rinvenute nei sedimenti messiniani salmastri dei bacini di Volterra-Radicondoli e di Velona (Toscana, Italia centrale). Inoltre, a causa dello scarso materiale rinvenuto, sono state lasciate in nomenclatura aperta tre forme di *Mediocytherideis* s.l. provenienti dai sedimenti salmastri messiniani del bacino di Velona, dalla sezione del cimitero di Taranta Peligna (Montagna della Majella, Italia centrale) e dalla sezione Trave (Ancona, Italia centrale).

Viene effettuata, inoltre, una revisione delle specie di *Mediocytherideis* s.l. note fino ad oggi in letteratura, ponendo particolare attenzione alla loro distribuzione stratigrafica e, sulla base di questi dati, vengono discusse l'origine e la distribuzione stratigrafica e paleobiogeografica del genere. Il database mostra che sia *Mediocytherideis* s.s. sia *M. (Sylvestra)* appaiono più o meno contemporaneamente nell'area mediterranea e in quella paratetidee durante il Serravalliano, quando i due paleodomini non erano ancora separati. Dopo la chiusura della connessione tra Mediterraneo e Paratetide, avvenuta durante il Serravalliano superiore, *Mediocytherideis* s.l. continuò ad evolversi, con differenti specie, nelle due paleobioprovince. Nella Paratetide le specie di *Mediocytherideis* s.l. furono sempre caratteristiche di ambienti salmastri o, nei primi momenti della storia evolutiva del genere, di ambienti marini poco profondi stressati; nel Mediterraneo, al contrario, fin dalla sua prima comparsa il genere diede origine a differenti specie adattate o ad ambienti marini poco profondi o ad ambienti salmastri. Sfortunatamente, le conoscenze troppo frammentarie sulle specie di *Mediocytherideis* s.l. rendono impossibile definire il centro di origine del genere. Allo stesso tempo, è impossibile stabilire se le specie salmastre mediterranee di *Mediocytherideis* s.l. si originarono da uno stock mediterraneo o da forme salmastre paratetidee migrate verso ovest attraverso la dispersione passiva.

INTRODUCTION

In 1960 Mandelstam (in Luebimova et al., 1960) established the Subfamily Mediocytherideisinae (Family Cytheridae) as a monogeneric taxon including the genus *Mediocytherideis* Mandelstam 1956. In 1961, Moore in the supplement to the Treatise on Invertebrate Paleontology Part Q Arthropoda 3, Ostracoda, changed this name in *Mediocytherideinae* (sic), but this change is not in agreement with the Article 29.3.3 of the International Code of Zoological Nomenclature (ICZN, 1999 and with its previous 1961, 1985 editions). Anyway,

the subfamily was not reported in the main part of the Treatise, but it is not clear if it lacks for omission or rejection. In 1991 Krstić & McKenzie discussed the subfamily *Mediocytherideinae* (sic) Mandelstam, 1960, retaining it valid, but including it in Family Leptocytheridae. They included in the subfamily two tribes: Tribe *Mediocytherideini* with genera *Mediocytherideis* Mandelstam, 1956 (and its subgenera *Mediocytherideis* s.s. and *Sylvestra* Doruk, 1973), *Chartocythere* Buryndina, 1969 and *Ishizakiella* McKenzie & Sudijono, 1981 and Tribe Tanellini with genera *Tanella* Kingma, 1948, *Mesocythere* Hartmann,

1956, and *Minicythere* Ornellas, 1974. Tribe Tanellini seems confined to the Pliocene-Recent of the Indo-Pacific region and to the South America Atlantic coast, while Tribe Mediocytherideini includes mainly Miocene to Recent genera from Paratethys, Mediterranean, Red Sea and Atlantic Morocco areas, except for *Ishizakiella*, which is signalled from the Plio-Pleistocene of Indonesia (Krstić & McKenzie, 1991).

In several papers dealing with the Upper Miocene brackish deposits of Italy, genera *Mediocytherideis*, *Sylvestra* and *Chartocythere* have been reported, without any specific identification (Bossio et al., 1994a, b, 1996; Krstić & Bossio, 1992; Testa, 1995; Ghetti et al., 2002). In this paper we revise this material, giving the description of several new species and the emended diagnoses for genera and subgenera. At the moment, only genus *Mediocytherideis* and its two subgenera (*Mediocytherideis* s.s. and *Sylvestra*) are retained as valid, while genus *Chartocythere* is probably a preoccupied taxon. *Chartocythere* has been arisen by Buryndina (1969), who used the name *Chartocythere* proposed by Livental (1956, p. 38), never described or illustrated by him, as a subgenus of *Cushmanidea* Blake. Buryndina (1969) did not give a generic diagnosis but described it indirectly on her material of *Chartocythere sublaevis* (Reuss), coming from the middle Sarmatian of the Transcarpathic region. Thus, *Cytherina sublaevis* Reuss, 1850 must be considered the type species of genus *Chartocythere* by monotypy. Unfortunately, the holotype of Reuss species is lost (Zelenka, 1989, p. 252) and the original picture by Reuss (1850, Pl. 8, fig. 16a, b) is so poor that it is impossible to recognize any resemblance with the valves illustrated by Buryndina (1969). Anyway, Buryndina (1969) gave a good description and illustration of its Transcarpathian specimens, particularly concerning the hinge and the inner lamella: "Trapezoidal elongate carapace with maximum height in the posterior third. Smooth surface covered by opaque spots, corresponding to the marginal pore canals. Hinge of the right valve made of a crenulated bar in the antero-median portion. In the posterior portion there is a sulcus, crenulated in the inner part. On the postero-dorsal angle there is a stout bar with 3-4 denticles. The hinge of the left valve shows the correspondent elements. The inner lamella is developed all along the free margin. It reaches its greater width in the ventral part and this is a characteristic of this species and for this Livental assigned this species to the genus *Chartocythere*, which has not been described..." Unfortunately in the good pictures given by Buryndina (1969, Pl. II, Figs. 7-9) neither the crenulated posterior sulcus nor the ventral expansion of the inner lamella are evident. Krstić & McKenzie (1991) gave an emended diagnosis of genus *Chartocythere*, underlining the crenulated posterior sulcus/bar of the hinge, but in the SEM pictures of the right and left hinges of *Chartocythere franzi* Krstić (Krstić & McKenzie, 1991, Pl. 4, Figs. 1, 3), the "crenulated" sulcus/bar seems smooth. Looking at the ventral inner lamella of the *Chartocythere* species illustrated by Krstić & McKenzie (1991) it is possible to observe an angular expansion (which could be the expansion mentioned in Buryndina, 1969 and not illustrated by her) but this angular shape is present also in subgenera *Mediocytherideis* and

Sylvestra, thus it cannot be considered a typical generic character of *Chartocythere*. For all these reasons, at the moment *Chartocythere* cannot be considered a valid genus, unless new good illustrations of the Buryndina specimens will clarify its diagnostic characters. In any case, none of the *Mediocytherideis* specimens revised in this paper shows a crenulated posterior sulcus/bar in the median element.

GEOLOGICAL SETTING AND SAMPLE LOCATION

The *Mediocytherideis* studied in the present paper were collected in two different Tuscan "central" basins (*sensu* Martini & Sagri, 1994), the Radicondoli area of the Volterra-Radicondoli Basin and the Velona Basin, and in the post-evaporitic Messinian successions of Taranta Peligna cemetery (Majella Mt., central Italy) and Trave (Marche, central Italy).

The Volterra-Radicondoli Basin is located west of the Mid Tuscan Ridge (Fig. 1); during the Late Miocene sedimentation, four main palaeoenvironments can be recognized: a brackish one, spanning from the late Tortonian to the early Messinian, corresponding to the "Serie Lignitifera" Auct., a marine littoral one, corresponding to the "Argille a Pycnodonta" Auct., an evaporitic environment, corresponding to the onset of the Messinian Salinity Crisis and, again, a brackish environment linked to the post-evaporitic Messinian *Lago-Mare* facies. The Volterra-Radicondoli Basin has been extensively studied by several authors (Bossio et al., 1978, 1981, 1994a, b, 1996; Sarti & Testa, 1994; Testa, 1995) and it is included in the new geological maps 1:50,000, recently published by the Servizio Geologico d'Italia (2002) Sheets N° 285 Volterra, N° 295 Pomarance and N° 296 Siena (in press). The Radicondoli area represents the southeastern portion of the Volterra-Radicondoli Basin and the samples studied in the present paper were collected in the following Upper Miocene formations (Lazzarotto et al., 2002): "Argille del Torrente Fosci" Fm. (upper Tortonian-lower Messinian), "Torrente Raquese" Fm. (lower Messinian) and "Argille e gessi del Fiume Era Morta" Fm. (evaporitic and post-evaporitic upper Messinian). In particular, the *Mediocytherideis* studied here were collected from massive grey clays with fine sandy intercalations referable to the lower Messinian portion of the "Argille del Torrente Fosci" Fm.: samples RA II 262, 263, 264, 265 in a section located near Podere Olli (43°15'01" N, 1°26'1" W), samples RA II 256, 259 in a section located along the Vallone Ameli (43°16'52" N, 1°28'20" W), sample RA 160 in a section located near Casa Ortali (43°18'7" N, 1°27'50" W) and sample RA 137 in a section 300 m E of Casa Mandria (43°18'24" N, 1°26'45" W). From the same formation also the scattered samples RA 114 and RA 145 were collected; samples RA 32, 41 in a section near Pian di Cecina (43°17'30" N, 1°28'10" W), made of grey or beige clayey-sandy sediments referable to the "Torrente Raquese" Fm. (lower Messinian); samples RA II 82, 81, in a section near Casa Colombaia (43°15'51" N, 1°24'44" W), made of clays and silty-marly clays with intercalations of gypsum lenses referable to the "Argille e gessi del Fiume Era Morta" Fm. (upper Messinian).

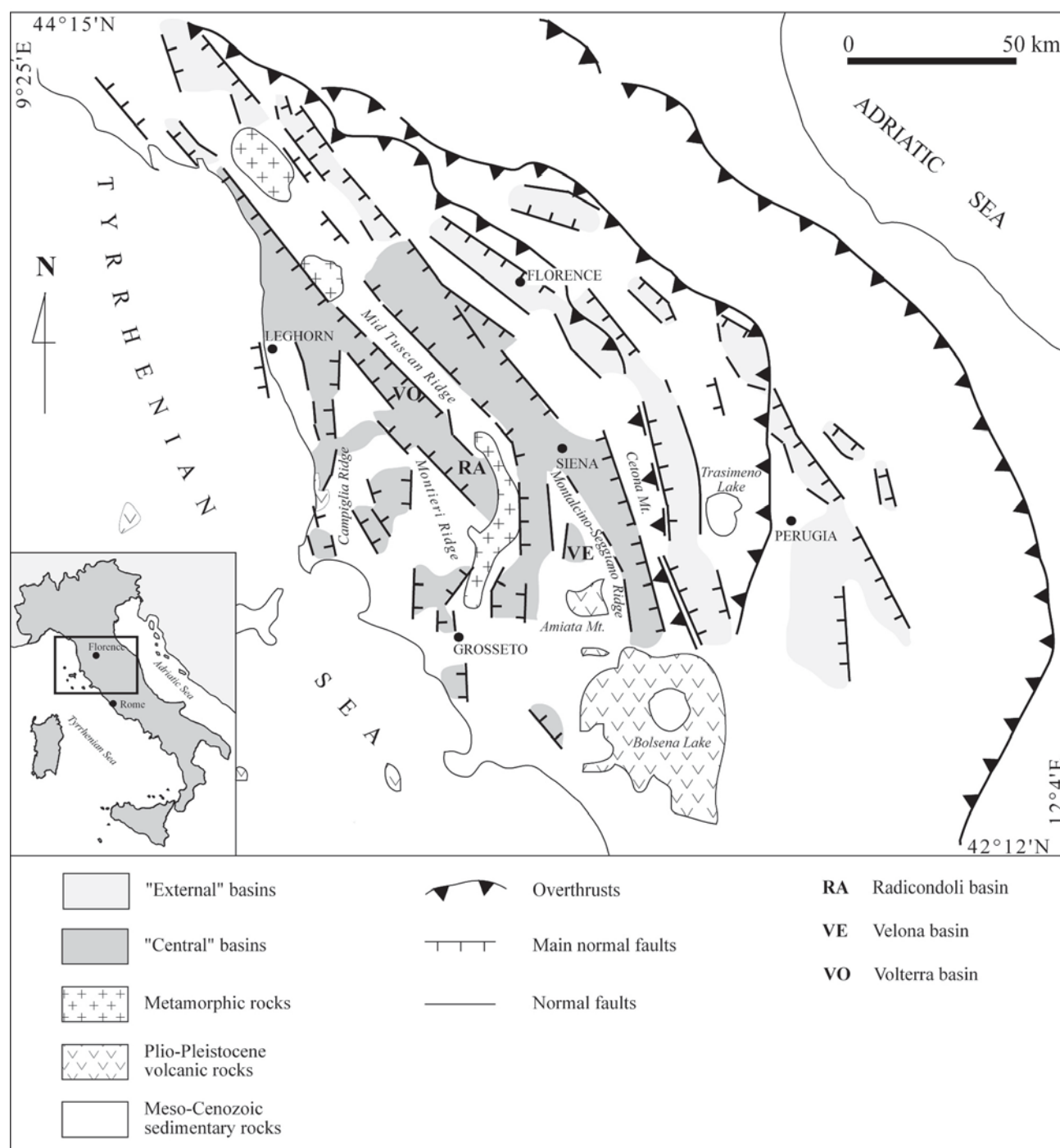


Fig. 1 - Location of the Volterra-Radicondoli and Velona basins within the structural frame of the Tuscan Neogene basins (modified from Martini & Sagri, 1993).

Lago-Mare); the scattered samples RA II 86 and 166 were collected from the same formations.

The Velona Basin is located east of the Mid Tuscan Ridge (Fig. 1) and, during the Messinian, underwent a brackish continental sedimentation, referred by Ghetti et al. (2002) to two different synthems (Lower Synthem, lower Messinian and Upper Synthem, upper Messinian-Early Pliocene). The Lower Synthem was divided into six concordant subunits. The samples studied in the present paper were collected in two sections both referable to the sub-unit B, made of thick lacustrine

sediments composed of a fining-upward succession of conglomerates, sands, and clays: samples VE 6, 8, 16, 36, 53, 57, 59 and 65 come from Fosso Casotto Section (43°00'08" N, 11°33'05" E), while sample OW2/1, OW2/4 and OW2/5 come from Orcia Ovest 2 section, around 300 m N of the previous section (Rook & Ghetti, 1997; Ghetti et al., 2002).

The Trave succession belongs to the central sector of the present-day foredeep basin and foreland ramp of the outer northern Apennine fold and thrust belt and is located along the sea-cliff between Monte dei Corvi

and Mezzavalle, south of Ancona (Marche, central Italy). The analysed samples TRA 63, 69 were collected from the upper portion of the succession, made of coarse-grained sandstone bodies rhythmically alternated to thick laminated mudstones. Two laminated micritic limestones ('colombacci'), up to 1 m thick, are also intercalated. According to Roveri et al. (2006) and Iaccarino et al. (in press) this portion of succession must be referred to the late Messinian post-evaporitic 2 phase of the Messinian *Lago-Mare* biofacies.

The Taranta Peligna cemetery section is located along the southeastern margin of the Majella Mt. (Abruzzi, central Italy) and belongs to the Adriatic foreland domain. The 40 m-thick succession is made of clays and silty clays with thin conglomeratic and sandy intercalations, which conformably overlie resedimented gypsarenites deposited during the post-evaporitic Messinian. In a nearby correlatable section (Fonte dei Pulcini section), the upper portion of the clays and silty clays crops out, conformably overlain by Lower Pliocene clays and conglomerates (Cipollari et al., 2002; Cosentino et al., 2005). Thus, the sample MAJ 144 collected in the Taranta Peligna cemetery section can be ascribed to the post-evaporitic Messinian (*Lago-Mare* biofacies).

portion. Slightly inequivalve carapace, with the right valve generally more elongate. In left lateral view, infracurved anterior margin, which can or not encompass the ventral margin. Dorsal margin convex to various degrees. Rectilinear or rounded and tapered short posterior margin. Ventral margin from straight to sinuous. Ornamentation from absent or with feeble punctuations to heavily reticulated. Presence of anterior ribs, which can be arranged concentrically and subparallel to the anterior margin; sometimes they may run subparallel to the anterior portion of the ventral margin. Posterior rib weakly or strongly developed, sometimes with a remarkable posterior pouch. Hinge of the right valve with an anterior elongate lamellar and crenulated tooth, a median element made of a smooth bar and a posterior cube-like or lobate tooth. Hinge of the left valve made of opposite elements. Sometimes in front of the median groove a toothlet is present. Snap-pit and snap-knob present in the middle of the inner ventral margin. Postero-ventral inner angularity present. Muscle scars typical of the Family. Few long and polifurcate marginal pore canals. Very small vestibule. Sexual dimorphism evident, with males with a smaller but proportionally more elongate carapace.

TAXONOMY

The described material is stored in the Gliozzi Ostracod Collection (GOC) at the Dipartimento di Scienze Geologiche, Università degli Studi Roma Tre.

Suborder CYTHEROCOPINA Gründel, 1967
Superfamily CYTHEROIDEA Baird, 1850
Family LEPTOCYTHERIDAE Hanai, 1957
Subfamily MEOCYTHERIDEISINAE Mandelstam, 1960

Genus *Mediocytherideis* Mandelstam, 1952

Type species - *Cytherideis apatoica* Schweyer, 1949 by original designation.

Enlarged and partially emended diagnosis - Small to middle-sized Leptocytheridae with thick and elongate carapace. Maximum height sometimes in the anterior

Subgenus *Mediocytherideis* s.s.

Emended diagnosis - In lateral view, elongate carapace with subparallel dorsal and ventral margins, infracurved anterior margin that does not encompass the ventral margin and ventral margin straight. External surface of the valves partially smooth or covered by small pits. Anterior ribs concentric, posterior rib very feeble or absent. Postero-ventral pouch not evident.

Subgenus *Sylvestra* (Doruk, 1973)

Type species - *Sylvestra posterobursa* Doruk, 1973 by original designation.

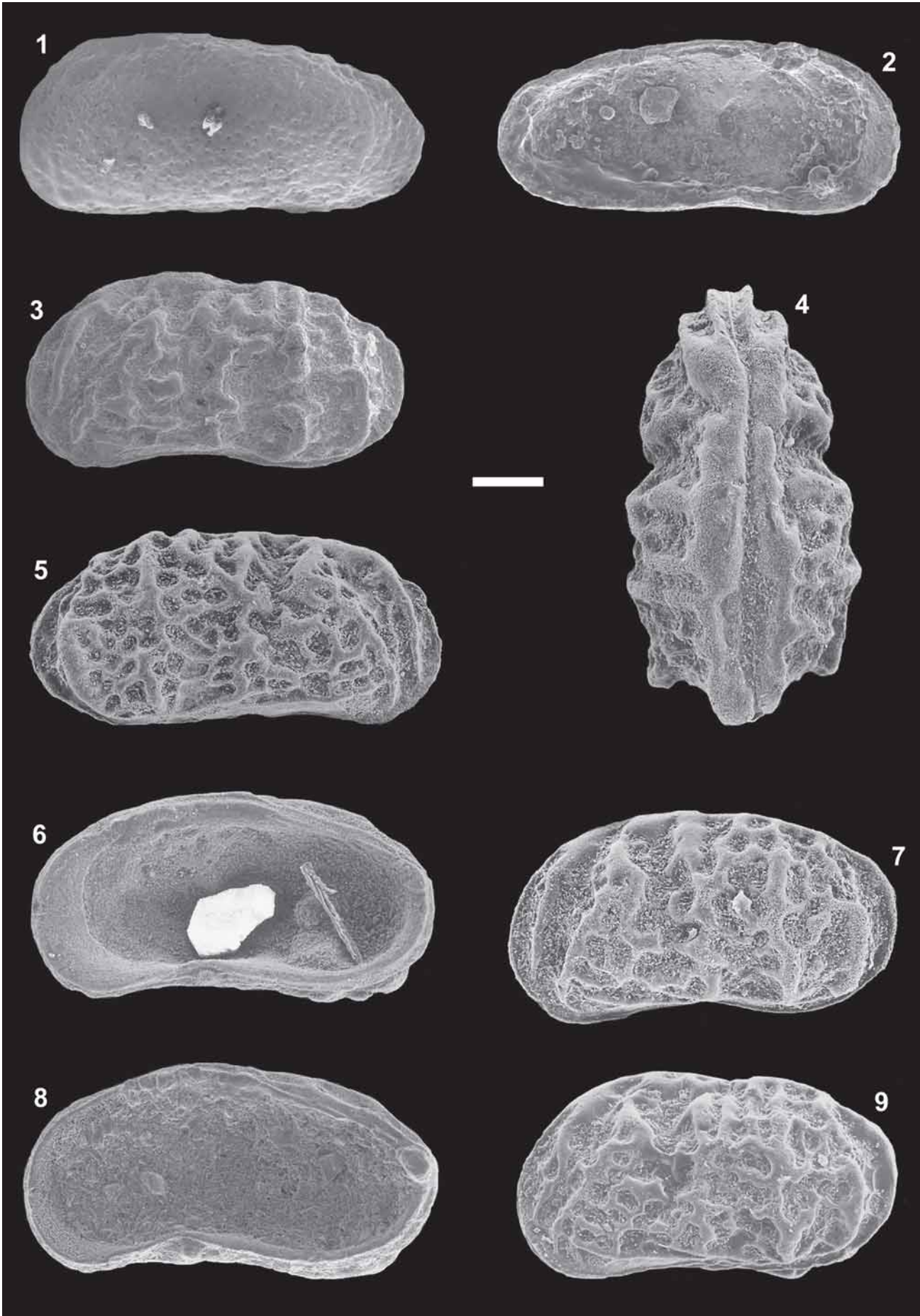
Emended diagnosis - In lateral view, the infracurvature anterior margin encompasses the ventral margin giving to the valve a reniform shape. Sinuous ventral margin.

EXPLANATION OF PLATE 1

figs. 1-2 - *Mediocytherideis (Mediocytherideis)* sp. A
1 - Female LV, lateral external view, sample VE 6.
2 - Female LV, lateral inner view, sample VE 6.

figs. 3-9 *Mediocytherideis (Sylvestra) etrusca* nov. sp.,
3 - Holotype, female LV, lateral external view, sample RA II 263.
4 - Paratype, female carapace, dorsal view, sample RA II 263.
5 - Paratype, female RV, lateral external view, sample RA II 263.
6 - Paratype, female RV, lateral inner view, sample RA II 263.
7 - Paratype, female LV, lateral external view, sample RA II 263.
8 - Female RV, lateral inner view, sample RA 114.
9 - Paratype, female carapace in left external view, sample RA II 263.

Scale bar = 0.1 mm.



Generally strongly ornamented but, in some cases, with small pits or rather smooth. Anterior ribs present with no evident concentric arrangement. Posterior rib present. Postero-ventral pouch or tubercle present.

Mediocytherideis (Sylvestra) etrusca nov. sp.
(Pl. 1, figs. 3-9)

Derivatio nominis - From Latin *etruscus*, -a, -um, relative to the ancient Italic population who inhabited the Etruria, a region located between the northern Latium and the central-southern Tuscany, where this species was collected.

Holotype - Left valve GOC M80/2/12; size: L = 0.55 mm; h = 0.28 mm.

Paratypes - 5 adult and 2 juvenile carapaces, 3 left female valves, 3 female right valves, 1 male right valve, 3 left A-1 valves.

Locus typicus - Radicondoli area (southern sector of the Volterra-Radicondoli Basin).

Stratum typicum - Sample RA II 263, upper portion of the "Argille del Torrente Fosci" Fm. from the section near Podere Olli.

Age - Early Messinian.

Diagnosis - Medium-sized *Mediocytherideis (Sylvestra)* with a heavy carapace. In dorsal view the female carapace is inflated with an anterior *sulcus*, underlining a more inflated posterior zone. In lateral outer view dorsal border feebly arched, anterior margin infracurved with a parallel strong rib. Ventral margin sinuous, posterior border slightly rounded. Very strong ornamentation with evident thick, vertical, rounded, dendritic ribs. Very pronounced posterior rib that borders an evident postero-ventral pouch. Hinge typical of the genus, with a posterior 4-lobate tooth. Instars are strongly ornamented. In males the ornamentation shows thinner vertical ribs and a more evident reticulation.

Size -

Female left valve	L = 0.54-0.57 mm	h = 0.28-0.30 mm
Female right valve	L = 0.55-0.56 mm	h = 0.27-0.30 mm
Male right valve	L = 0.56 mm	h = 0.29 mm

Studied material - Sample RA 145 (Radicondoli area, upper portion of the "Argille del Torrente Fosci" Fm. from the section 500 m E of Casa Pietrasanta, along the road from Poggio Macignano to Monteguidi, early Messinian): 2 female carapaces, 1 left female valve, 8 instars.

Sample RA 114 (Radicondoli area, upper portion of the "Argille del Torrente Fosci" Fm. from the section near Poggio Macignano on the road to Monteguidi, early Messinian): 1 juvenile valve.

Sample RA 137 (Radicondoli area, upper portion of the "Argille del Torrente Fosci" Fm. from the section 300 m E of Casa Mandria, early Messinian): 1 right A-1 male valve, 1 juvenile carapace.

Geographic and stratigraphic distribution - Early Messinian of the Radicondoli area.

Mediocytherideis (Sylvestra) fossata nov. sp.
(Pl. 2, figs. 1-10)

Derivatio nominis - From Latin *fossa*, -a, -um for the large and deep pits characteristic of the ornamentation.

Holotype - Left female valve GOC M80/1/6; size: L = 0.62 mm; h = 0.31 mm.

Paratypes - 8 female, 3 male and 9 juvenile carapaces, 3 left female valves, 1 female right valve.

Locus typicus - Radicondoli area (southern sector of the Volterra-Radicondoli Basin).

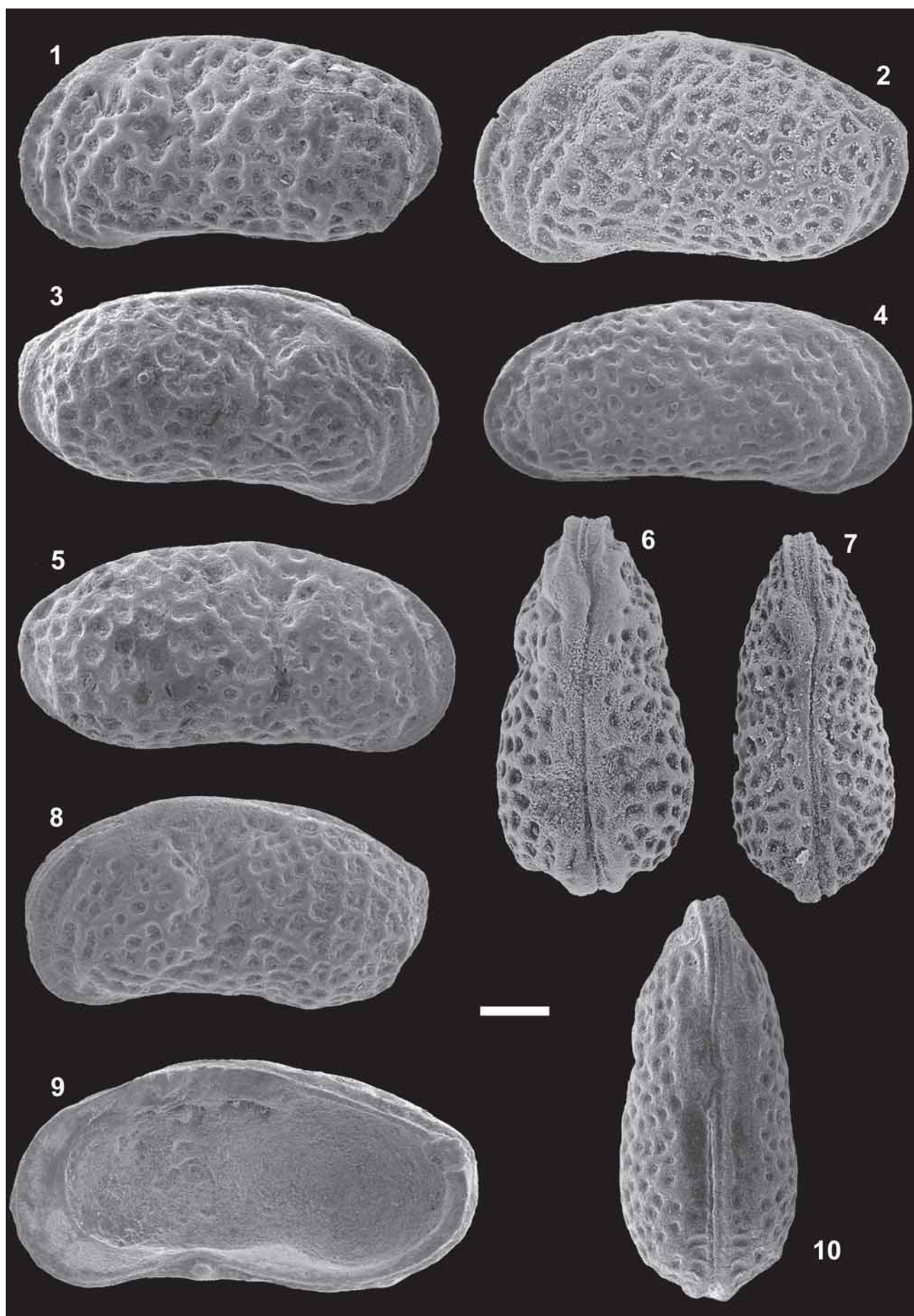
Stratum typicum - Sample RA II 263, upper portion of the "Argille del Torrente Fosci" Fm. from the section near Podere Olli.

EXPLANATION OF PLATE 2

figs. 1-10 - *Mediocytherideis (Sylvestra) fossata* nov. sp.

- 1 - Holotype, female LV, lateral external view, sample RA II 263.
- 2 - Paratype, female LV, lateral external view, sample RA II 263.
- 3 - Paratype, female carapace in right lateral view, sample RA II 263.
- 4 - Male RV, lateral external view, sample RA 32.
- 5 - Paratype, female RV, lateral external view, sample RA II 263.
- 6 - Paratype, female carapace, dorsal view, sample RA II 263.
- 7 - Paratype, male carapace, dorsal view, sample RA II 263.
- 8 - Paratype, female carapace in left external view, sample RA II 263.
- 9 - Female RV, lateral inner view, sample RA 75.
- 10 - Male carapace, ventral view, sample RA 32.

Scale bar = 0.1 mm.



Age - Early Messinian.

Diagnosis - Medium-sized *Mediocytherideis* (*Sylvestra*). In lateral outer view dorsal border arched, anterior margin strongly infracurved with two or more ribs. Ventral margin sinuous, posterior border subquadrate in the females and almost pointed in the males. Surface of the female valve rather inflated posteriorly behind a remarkable antero-dorsal *sulcus*. Ornamentation consists in sub-rounded meshes with thick muri. The *sulcus* zone is underlined by some elongate and inclined pits. A posteroventral rib limits the *bursa*. Hinge typical of the genus with a posterior 4-lobate tooth.

Size -

Female left valve	L = 0.62-0.70 mm	h = 0.31-0.37 mm
Female right valve	L = 0.63-0.66 mm	h = 0.31-0.36 mm
Male left valve	L = 0.60-0.64 mm	h = 0.30-0.33 mm
Male right valve	L = 0.57-0.67 mm	h = 0.30-0.33 mm

Studied material - Sample RA II 86 (Radicondoli area, "Argille e Gessi del F. Era Morta" Fm. from the section near 200 m S of Casa La Colombaia, late Messinian): 1 A-1 female carapace, 1 A-1 female right valve.

Sample RA 160 (Radicondoli area, upper portion of the "Argille del Torrente Fosci" Fm. from the section near Casa Ortali, early Messinian): 6 female carapaces, 2 male carapaces, 3 left female valves, 2 right female valves, 1 left male valve, 1 right male valve, 1 A-1 left valve, 14 instars.

Sample RA II 265 (Radicondoli area, upper portion of the "Argille del Torrente Fosci" Fm. from the section near Podere Olli, early Messinian): 1 A-1 male carapace, 1 instar.

Sample RA 32 (Radicondoli area, "Torrente Raquese" Fm. from the section near Pian di Cecina locality, early Messinian): 12 female carapaces, 3 female left valves, 8 female right valves, 1 male left valve, 6 male right valves, 2 A-1 male valves, 14 instars.

Geographic and stratigraphic distribution - Early-late Messinian of the Radicondoli area.

Comparisons - In the general outline and dimensions *M. (Sylvestra) fossata* nov. sp. is similar to the marine *M. (Sylvestra) posterobursa* Doruk from the Tortonian-early Messinian of the Mediterranean area. It differs

from the marine species for a less inflated and ventrally protruding *bursa*, for a deeper mid-dorsal *sulcus* and for the different pattern of the stronger reticulation.

Mediocytherideis (Sylvestra) ornata nov. sp.
(Pl. 3, figs. 1-8)

2002 *Sylvestra* sp. - GHETTI ET AL., p. 8, Tab. 2 (*partim*).

Derivatio nominis - From Latin *ornatus*, -a, -um = ornate.

Holotype - Left female valve, GOC M122/1/8; size: L = 0.67 mm; h = 0.35 mm.

Locus typicus - Velona Basin (Tuscany).

Stratum typicum - Sample OW2/1, Orcia Ovest 2 section, subunit B of the Lower Synthem.

Age - Early Messinian.

Diagnosis - Medium-sized *Mediocytherideis* (*Sylvestra*). In lateral outer view dorsal border slightly arched, anterior margin infracurved with two or three thin ribs. Ventral margin sinuous, posterior border subquadrate. The surface is reticulated and the roundish meshes include clusters of two or more pits. One irregular sinuous ridge runs across the median and the posterior portion of the valve and its termination draws the ventral pouch. Hinge typical of the genus with a posterior 4-lobate tooth.

Size -

Female left valve	L = 0.63-0.67 mm	h = 0.32-0.35 mm
Male left valve	L = 0.66 mm	h = 0.33 mm

Studied material - Sample VE 16 (Velona Basin, Fosso Casotto Section, subunit B of the Lower Synthem, early Messinian): 1 left female valve.

Sample VE 59 (Velona Basin, Fosso Casotto Section, subunit B of the Lower Synthem, early Messinian): 1 A-1 left female valve.

Sample VE 53 (Velona Basin, Fosso Casotto Section, subunit B of the Lower Synthem, early Messinian): 1 left ?male valve.

EXPLANATION OF PLATE 3

figs. 1-8 - *Mediocytherideis (Sylvestra) ornata* nov. sp.

- 1 - Holotype, female LV, lateral external view, sample OW2/1.
- 2 - Female LV, lateral external view, sample VE 16.
- 3 - Holotype, female LV, lateral inner view, sample OW2/1.
- 4 - Female LV, lateral external view in transmitted light, sample OW2/4.
- 5 - Detail of the LV hinge of fig. 6, sample VE 16.
- 6 - Female LV, lateral inner view, sample VE 16.
- 7 - Female LV, lateral external view, sample VE 53.
- 8 - Male LV, lateral external view, sample VE 53.

Scale bar = 0.1 mm.



Sample OW2/4 (Velona Basin, Orcia Ovest 2 Section, subunit B of the Lower Synthem, early Messinian): 1 A-1 left female valve.

Geographic and stratigraphic distribution - Early Messinian of the Velona Basin.

Mediocytherideis (Sylvestra) punctata nov. sp.
(Pl. 4, figs. 1-10; Pl. 5, figs. 1-2)

Derivatio nominis - From Latin *punctum* = little hole.

Holotype - Left female valve, GOC M80/2/1; size: L = 0.60 mm; h = 0.30 mm.

Paratypes - 5 female carapaces, 1 A-1 female left valve, 4 right female valves, 2 right male valves, and 3 instars.

Locus typicus - Radicondoli area (southern sector of the Volterra-Radicondoli Basin).

Stratum typicum - Sample RA II 81, "Argille e Gessi del F. Era Morta" Fm. from the section 250 m E of Casa la Colombaia.

Age - Late Messinian.

Diagnosis - Medium-sized *Mediocytherideis* (*Sylvestra*). In lateral outer view dorsal border feebly arched, anterior margin infracurved with two or more ribs. Ventral margin slightly sinuous, posterior border rounded. The whole surface is pitted; pits are rather large and rare in the anterior surface and small and denser in the posterior. Some ventral ribs are present in the anterior portion. The *bursa* is evident and underlined by a protruding ridge. Hinge typical of the genus with a posterior 4-lobate tooth.

Size -		
Female left valve	L = 0.60-0.63 mm	h = 0.30-0.33 mm
Female right valve	L = 0.55-0.59 mm	h = 0.28-0.29 mm
Male left valve	L = 0.56-0.61 mm	h = 0.26-0.29 mm
Male right valve	L = 0.51-0.64 mm	h = 0.23-0.31 mm

Studied material - Sample RA II 82 (Radicondoli area, "Argille e Gessi del F. Era Morta" Fm. from the section 250 m E of Casa la Colombaia, late Messinian): 1 female and 1 male carapaces, 3 instar carapaces.

Sample RA II 86 (Radicondoli area, "Argille e Gessi del F. Era Morta" Fm. from the section 250 m S of Casa la Colombaia, late Messinian): 1 female carapace, 1 instar carapace.

RA II 263 (Radicondoli area, upper portion of the "Argille del Torrente Foschi" Fm. from near Podere Olli, early Messinian): 1 female carapace, 1 instar carapace, 2 left and 1 right juvenile valves.

Sample RA 41 (Radicondoli area, "Torrente Raquese" Fm. from the section near Pian di Cecina locality, early Messinian): 40 female, 3 male and 1 instar carapaces, and 1 female right valve.

Sample RA 32 (Radicondoli area, "Torrente Raquese" Fm. from the section near Pian di Cecina locality, early Messinian): 1 left female valve.

RA II 264 (Radicondoli area, upper portion of the "Argille del Torrente Foschi" Fm. from near Podere Olli, early Messinian): 12 deformed carapaces.

Sample RA II 166 (Radicondoli area, "Argille e Gessi del F. Era Morta" Fm. from the section 300 m E of Podere Gatteresi, late Messinian): 9 deformed carapaces.

Geographic and stratigraphic distribution - Early-late Messinian of the Radicondoli area.

Mediocytherideis (Sylvestra) sulcata nov. sp.
(Pl. 5, figs. 3-9)

2002 *Sylvestra* sp. - GHETTI ET AL., p. 8, Tab. 2 (*partim*).

2005 *Mediocytherideis (Sylvestra)* aff. *M. (S.) grvida* Bonaduce, Russo & Barra - GLIOZZI ET AL., p. 289, Fig. 2, Pl. 1, fig. g.

Derivatio nominis - From Latin *sulcus* = groove.

Holotype - Left female valve GOC M47/3/1; size: L = 0.67 mm; h = 0.34 mm.

Locus typicus - Velona Basin.

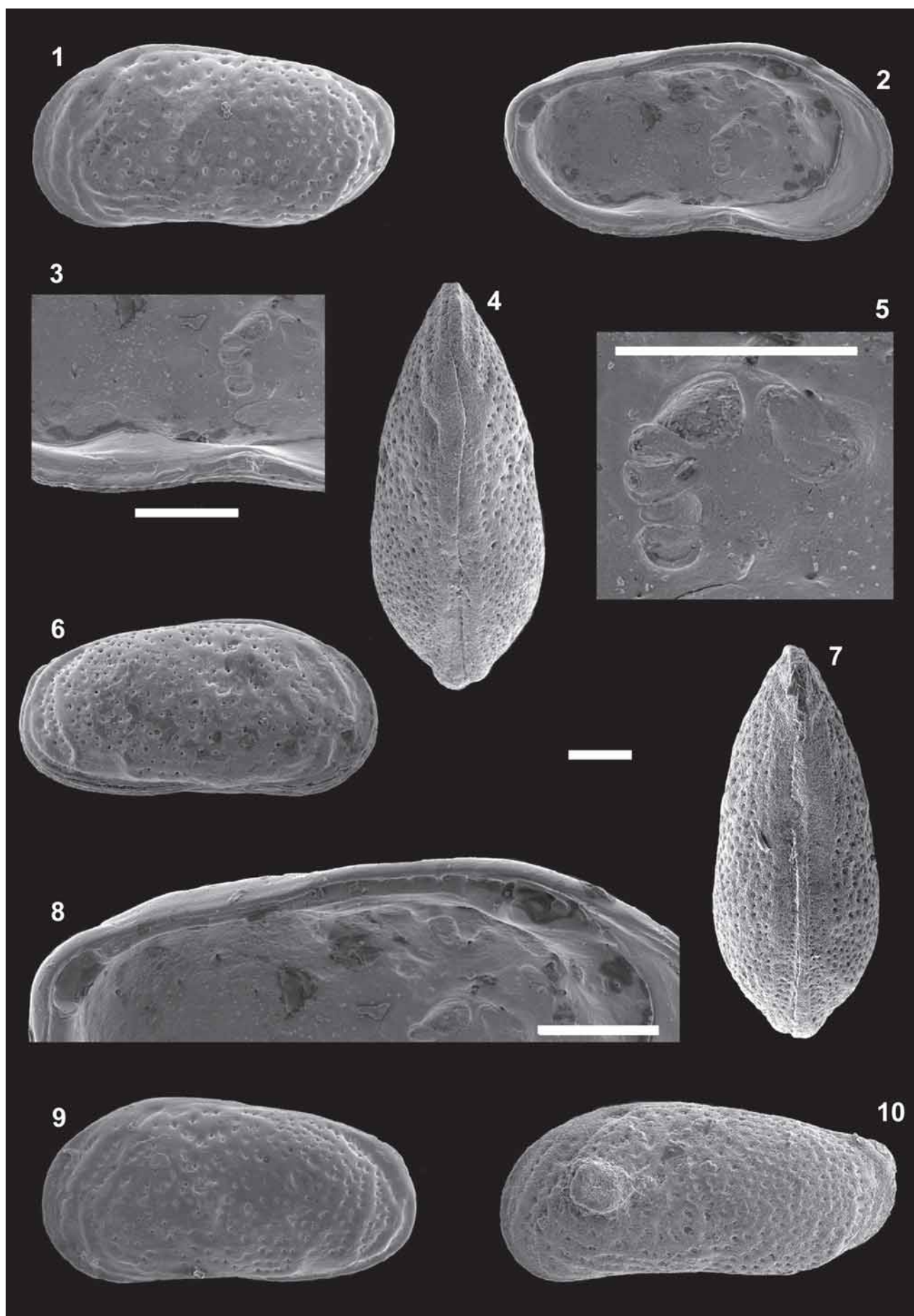
Stratum typicum - Sample VE 53, Fosso Casotto section, subunit B of the Lower Synthem.

EXPLANATION OF PLATE 4

figs. 1-10 - *Mediocytherideis (Sylvestra) punctata* nov. sp.

- 1 - Holotype, female LV, lateral external view, sample RA II 81.
- 2 - Holotype, female LV, lateral inner view, sample RA II 81.
- 3 - Holotype, detail of the ventral angularity of the inner margin, sample RA II 81.
- 4 - Female carapace, dorsal view, sample RA 41.
- 5 - Holotype, detail of the muscle scars, sample RA II 81.
- 6 - Paratype, female carapace in lateral right view, sample RA II 81.
- 7 - Female carapace, ventral view, sample RA 41.
- 8 - Holotype, particular of the left hinge, sample RA II 81.
- 9 - Paratype, female carapace in lateral left view, sample RA II 81.
- 10 - Male LV, lateral external view, sample RA 41.

Scale bar = 0.1 mm.



Age - Early Messinian.

Diagnosis - Medium-sized *Mediocytherideis* (*Sylvestra*). In lateral outer view dorsal border slightly arched, anterior margin feebly infracurved with one rib. Anterior and posterior margins flattened. Ventral margin sinuous. The surface of the valve is rather inflated and the anterior and posterior areas are divided by a remarkable dorsal sulcus. The *bursa* is evident, underlined by a ridge only in male valves. The surface is ornate with rare pits located mainly anteriorly and around the *sulcus*. Posteriorly the inflated area is rather smooth or with few isolated pits. Males are more pitted all over the surface. The inner ventral angularity is very feeble. Hinge typical of the genus with a posterior lobate tooth and with a median toothlet in the left valve.

Size -

Female left valve	L = 0.60-0.67 mm	h = 0.31-0.35 mm
Male right valve	L = 0.74 mm	h = 0.36 mm

Studied material - Sample VE 18 (Velona Basin, Fosso Casotto Section, subunit B of the Lower Synthem, early Messinian): 1 female left valve.

Sample VE 65 (Velona Basin, Fosso Casotto section, subunit B of the Lower Synthem, early Messinian): 1 male right valve.

Sample OW2/4 (Velona Basin Orcia Ovest 2 section, subunit B of the Lower Synthem, early Messinian): 1 female left valve, 1 A-1 male right valve.

Sample OW2/5 (Velona Basin, Orcia Ovest 2 section, subunit B of the Lower Synthem, early Messinian): 1 female left valve.

Geographic and stratigraphic distribution - Early Messinian of the Velona Basin.

Comparisons - *Mediocytherideis* (*Sylvestra*) *sulcata* nov. sp. is similar to *Sylvestra gravida* Bonaduce, Russo & Barra from the early Messinian of the Gulf of Gabes (Bonaduce et al., 1990) for the presence of a remarkable dorsal *sulcus* and for the faint pitted ornamentation; it differs from this species for the general shape, that is

less sub-rectangular, the presence of one anterior ridge instead of two, a less infracurved anterior margin, a more tapered posterior border and the greater size.

It is also similar to *M. (Sylvestra) maximus* Olteanu from the middle Pontian (early Messinian) of Romania (Pannonian Basin) (Olteanu, 1989), from which differs for a more deep mid-dorsal *sulcus*, the more elongate shape, a more straight ventral border and the slightly larger size.

Mediocytherideis (*Sylvestra*) *tetrafoveolata* nov. sp.
(Pl. 6, figs. 1-7)

2002 *Sylvestra* sp. - GHETTI ET AL., p. 8, Tab. 2 (partim).

Derivatio nominis - From Greek τετρα and Latin *foveolatus*, -a, -um = four pits.

Holotype - Right female valve GOC M47/2/4; size: L = 0.55 mm; h = 0.29 mm.

Paratypes - 1 left female valve, 3 right female valves (one broken and one lost).

Locus typicus - Velona Basin.

Stratum typicum - Sample VE 57, Fosso Casotto Section, subunit B of the Lower Synthem.

Age - Early Messinian.

Diagnosis - Medium-sized *Mediocytherideis* (*Sylvestra*) with a sub-rectangular shape. In lateral outer view dorsal border feebly arched, anterior margin infracurved with two ribs. Ventral margin slightly sinuous, posterior border slightly squared. Postero-dorsal angle underlined by a thick rim. Strong reticulated ornamentation with 4 (or more) pits clustered into a large mesh. Near the feeble postero-ventral ridge the meshes are arranged in slightly arched dorso-ventral rows. A rounded keel underlines the ventral pouch. Hinge typical of the genus, with a posterior 5-lobate tooth.

EXPLANATION OF PLATE 5

figs. 1-2 - *Mediocytherideis* (*Sylvestra*) *punctata* nov. sp.
1 - Female carapace in lateral right view, sample RA 41.
2 - Female carapace in lateral left view, sample RA 41.

figs. 3-9 - *Mediocytherideis* (*Sylvestra*) *sulcata* nov. sp.
3 - Holotype, female LV, lateral external view, sample VE 53.
4 - Holotype, female LV, lateral inner view, sample VE 53.
5 - Female LV, lateral external view, sample VE 18.
6 - Female LV, lateral inner view, sample VE 18.
7 - Male RV, lateral external view in transmitted light, sample OW2/4.
8 - Female LV, lateral external view in transmitted light, sample OW2/4.
9 - Particular of the left hinge of the female valve illustrated in fig. 6, sample VE 18.

Scale bar = 0.1 mm.



Size -
Female right valve L = 0.55-0.67 mm h = 0.29-0.34 mm

Studied material - Sample VE 36 (Velona Basin, Fosso Casotto section, subunit B of the Lower Synthem, early Messinian): 1 female right valve.

Sample VE 16 (Velona Basin, Fosso Casotto section, subunit B of the Lower Synthem, early Messinian): 1 female right valve (broken).

Geographic and stratigraphic distribution - Early Messinian of the Velona Basin.

Comparisons - *M. (Sylvestra) tetrafoveolata* nov. sp. is similar in the general outline to the marine *M. (Sylvestra) intermedia* Bonaduce, Russo & Barra from the Recent of the Gulf of Aqaba, from which differs for the greater size and the ornamentation pattern: the anterior concentric ridges are less inclined, the posterior meshes are arranged in gently arched rows and the posterior flattened margin is narrower.

For the posterior meshes arranged in gently arched row, *M. (Sylvestra) tetrafoveolata* nov. sp. resembles *M. (Sylvestra) franzi* (Krstić), and "*Chartocythere*" sp. Krstić (Krstić & McKenzie, 1991) but the outline is different and less elongate.

Mediocytherideisinae species left in open nomenclature

Some other valves referable to *Mediocytherideisinae* species have been found both in Tuscany and in other Italian localities, but the remains are scarce or not well preserved, preventing the possibility to arise other new species. A brief description of each taxon is here provided, together with its age and the locality where it has been recovered.

Mediocytherideis (Mediocytherideis) sp. A (Pl. 1, figs. 1-2): medium-sized *Mediocytherideis* (L = 0.57 mm; h = 0.23-0.25 mm). In lateral outer view dorsal and ventral margins straight and subparallel, anterior margin infracurved with one parallel rib. Posterior border strongly arched. The posterior rib feeble but present. The

whole surface of the valve densely pitted with small rounded pits. Velona Basin, Fosso Casotto section, sample VE 6, Sub-unit B of the Lower Synthem, early Messinian.

Mediocytherideis (Mediocytherideis) sp. B (Pl. 6, figs. 9-10): medium-sized *Mediocytherideis* (L = 0.62 mm; h = 0.27 mm) with elongate carapace sub-rectangular in shape, slightly inflated, particularly in the posterior portion. Feeble ornamentation, with several small pits and three evident anterior and antero-ventral concentric ribs. Velona Basin, Fosso Casotto section, sample VE 8, Sub-unit B of the Lower Synthem, early Messinian.

Mediocytherideis (Sylvestra) sp. C (Pl. 6, fig. 8): elongate A-1 male carapace, characterised by a sinuous ventral margin, underlined by a strongly infracurved anterior margin. Strong reticulated ornamentation, with flattened anterior and posterior areas. Two concentric ribs are visible anteriorly and one posteriorly. In front of the posterior rib, a small node is sometimes developed along the ventral margin. Taranta Peligna cemetery (Majella Mt., central Italy), sample MAJ 144; Trave section (Ancona, central Italy), samples TRA 63, TRA 69, late Messinian.

DISCUSSION

Palaeoecology and age of the Mediocytherideis s.l. new species

The *Mediocytherideis* s.l. species discussed in the present paper have been collected in brackish environments, associated with different species.

In the samples from the Radicondoli and Velona Basins *Mediocytherideis (Mediocytherideis)* spp. and *Mediocytherideis (Sylvestra)* spp. are always associated with *Cyprideis* spp. and sometimes with *Loxoconcha minima* Müller, *Loxoconchissa (Loxocaspia) cosentinoi* Faranda, Ligios & Gliozzi, *Loxoconchissa (Loxocaspia) punctata* Faranda, Ligios & Gliozzi, *Loxoconchissa (Loxocaspia) reticulata* Faranda, Ligios & Gliozzi, *Loxoconchissa (Loxocaspia) velonae* Faranda, Ligios

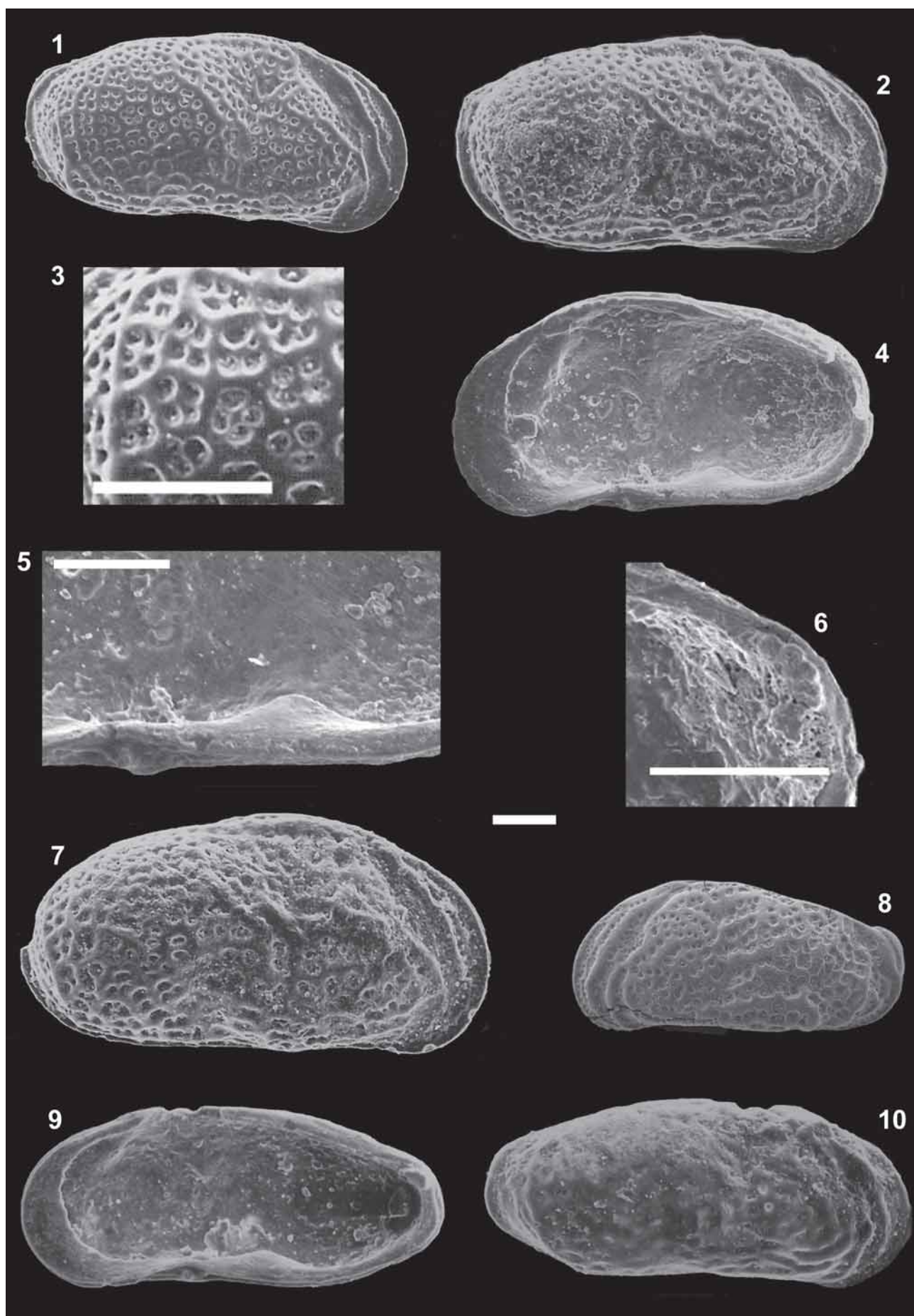
EXPLANATION OF PLATE 6

- figs. 1-7 - *Mediocytherideis (Sylvestra) tetrafoveolata* nov. sp.
1 - Holotype, female RV, lateral external view, sample VE 57.
2 - Paratype, female RV, lateral external view, sample VE 57.
3 - Paratype, particular of the reticulated ornamentation in a right valve, sample VE 57.
4 - Female RV, lateral inner view, sample VE 36.
5 - Particular of the ventral angularity of the inner margin of the female RV illustrated in fig. 4, sample VE 36.
6 - Paratype, particular of the posterior tooth in a female RV, sample VE 57.
7 - Female RV, lateral external view, sample VE 36.

fig. 8 - *Mediocytherideis (Sylvestra)* sp. C, A-1 male LV, lateral external view, sample MAJ 144.

- figs. 9-10 - *Mediocytherideis (Mediocytherideis)* sp. B
9 - Female RV, lateral inner view, sample VE 8.
10 - Female RV, lateral external view, sample VE 8.

Scale bar = 0.1 mm.



& Gliozzi, *Loxoconchissa* (*Loxocaspia*) *tuberculata* Faranda, Ligios & Gliozzi, *Tavanicythere pulchra* Bossio, *Tavanicythere posteroalata* Bossio, Gliozzi & Tassone, *Tavanicythere varieornata* Bossio, Gliozzi & Tassone, *Tavanicythere julianii* Bossio, Gliozzi & Tassone, *Bullocypris robusta* Devoto, *Potamocypris* cf. *P. gracilis* (Sieber), *Ilyocypris* cf. *I. gibba* (Ramdohr), *Ilyocypris* sp., *Candona* sp. and several freshwater-brackish molluscs as *Bithynia leachi* (Sheppard), *Planorbarius* sp., *Planorbis* cf. *P. moquini* (Requien), *Gyraulus crista* (Linnaeus), *Pseudoamnicola* sp., *Orygoceras* sp., *Micromelania* sp., and *Melanopsis fallax* Pantanelli (Ghetti et al., 2002).

At the Trave section *Mediocytherideis* (*Sylvestra*) sp. C is associated with typical late Messinian *Lago-Mare* ostracods such as *Cyprideis agrigentina* Decima, *Loxoconcha eichwaldi* Livental, *Loxoconcha mülleri* (Méhes), *Loxocorniculina djafarovi* (Schneider in Suzin, 1956), *Tyrrhenocythere ruggierii* Devoto, *Amnicythere propinqua* (Livental), *Amnicythere accicularia* (Olteanu) and *Amnicythere* sp. D Miculan in Bassetti et al., 2003, while at the Taranta Peligna cemetery is accompanied by *Tyrrhenocythere pontica* Livental in Agalarova et al., 1961 and *Loxoconcha* sp. juv.

Thus it is possible to conclude that all the *Mediocytherideis* s.l. new species are characteristic of brackish environments, mainly in the mesohaline (or oligo-mesohaline) range.

All these new species have a Messinian stratigraphic distribution (Fig. 2).

Palaeobiogeographic distribution of Mediocytherideis s.l.

The genus *Mediocytherideis* s.l. shows a wide stratigraphical (Middle Miocene-Recent) and (palaeo)-geographical distribution (Mediterranean, Paratethys, Indian and Atlantic oceans). Tab. 1 lists several species referable to *Mediocytherideis* s.s. and *M. (Sylvestra)*, including the new species and those quoted in literature, their provenance and their age. Compiling this table some problems arose with the correlation between the Mediterranean and Paratethyan stages, since, as shown in Fig. 3, it is still uncertain. Using this database, made only by species checked on the basis of the published illustrations, a tentative is made to understand the spreading centre and the distribution pathways of genus *Mediocytherideis*.

The first representative of the genus could be *M. (Sylvestra) inflata* (Schneider, 1939) from the Karaganian (middle Badenian, early Serravallian) of Caucasus. This species is associated with *Leptocythere stabilis* (Schneider), *Leptocythere distincta* (Schneider), *Cythereis declivis* Schneider, *Hirshmannia viridis* (Müller), *Palmoconcha laevata* (Norman), *Loxoconcha truncata* (Schneider) and *Xestoleberis* sp. and with few continental ostracods: *Darwinula stevensoni* (Brady & Robertson) and *Ilyocypris bradyi* (Sars) (Schneider, 1939). This assemblage could point to a littoral marine environment with few continental displaced ostracods or to a marginal marine environment characterised by brackish waters. During late Badenian (middle Serravallian) *M. (Sylvestra)* aff. *M. (S.) posterobursa* Doruk occurs in the Serbian area (Krstić & McKenzie,

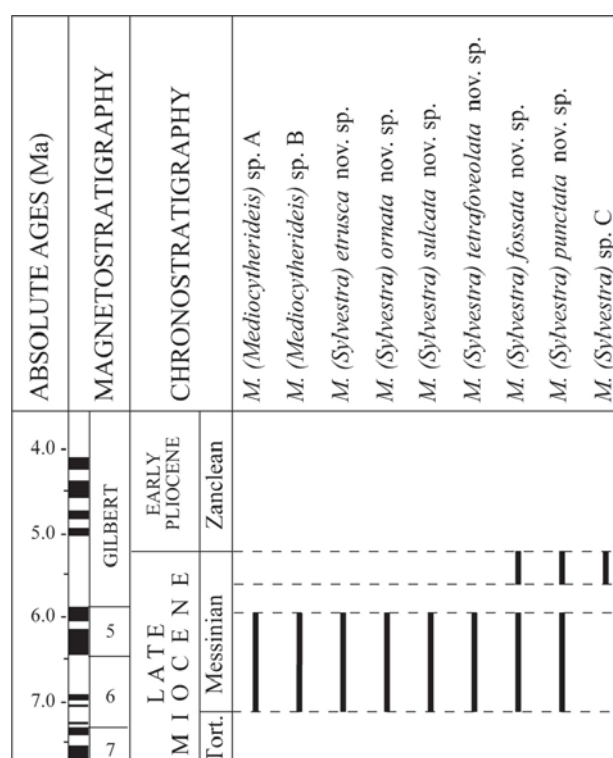


Fig. 2 - Stratigraphic distribution of the *Mediocytherideis* s.l. species described in this paper.

1991), but its palaeoenvironment is unfortunately unknown. During Sarmatian (late Serravallian) several *Mediocytherideis* occur: *M. (Mediocytherideis) cejcensis* Zelenka in the foredeep Carpathian basin of the Jamnica S-119 borehole (southern Poland) in a stressed shallow marine environment (Szczechura, 2000), in the Styrian Basin and in the Vienna Basin in shallow brackish water environments (Gross et al., 2007; Zelenka, 1990; Fordinal & Zlinska, 1998); *M. (Sylvestra)* sp. in the foredeep Carpathian basin of the Jamnica S-119 borehole (southern Poland) in a stressed shallow marine environment (Szczechura, 2000); *M. (Mediocytherideis) inflata sensu* Stancheva, 1963 (not *M. inflata* Schneider, 1939), in Bulgaria (Stancheva, 1963); *M. (Sylvestra)* spp. in the Atapuerca Basin (Spain) in a brackish water environment (Gliozzi et al., 2005). Although all these species seem adapted to shallow stressed marine environment or brackish water environments a further species, *M. (Mediocytherideis) tripartita* (Carbonnel), occurs in the Rhône Basin during the Serravallian in fully marine environment; this taxon is found associated with *Cytheretta orthezensis* Moyes, *Bythocythere neerlandica vedenei* Carbonnel, *Cytheridea expansa* Carbonnel, *Cytheridea acuminata caumontensis* Carbonnel, *Costa batei batei* (Brady), *Falunia* gr. *F. plicatula* (Reuss), *Falunia sphaerulolineata* (Jones), *Callistocythere propecornuta* Oertli, *Loxoconcha grignanensis* Carbonnel, *Cytherelloidea* sp., *Pseudoxammocythere kollmanni* Carbonnel, *Cytheropteron ascolii* Carbonnel, *Leptocythere pentagonalis* Carbonnel, *Parakrithe*

SPECIES	REFERENCES	AGE		LOCALITY AND ENVIRONMENT	
		PARATETHYS	MEDITERRANEAN		
<i>M. (Mediocytherideis) tripartita</i> (Carbonnel)	Carbonnel, 1969			Rhône Basin (France), marine environment	
<i>M. (Sylvestra) inflata</i> (Schneider)	Schneider, 1939	Karaganian	Serravallian (early Serravallian)	Caucasian region, stressed marine environment	
<i>M. (Sylvestra) aff. M. (S.) postorbursa</i> (Doruk)	Krsić & McKenzie, 1991	Late Badenian	(middle Serravallian)	Serbia, brackish environment	
<i>M. (Sylvestra) sp. Rodriguez-Lazaro et al.</i>	Glozzi et al., 2005; (= <i>M. apatoica</i>) Otleanu, 1990		Late Serravallian	Ataquera (Northern Spain), brackish environment	
<i>M. (Sylvestra) sp. 1 Rodriguez-Lazaro et al.</i>	Glozzi et al., 2005		Late Serravallian	Ataquera (Northern Spain), brackish environment	
<i>M. (Mediocytherideis) celcensis</i> (Zelenka)	Szczuchura, 2000	Sarmatian	(late Serravallian-early Tortonian)	Poland, brackish environment	
<i>M. (Mediocytherideis) celcensis</i> (Zelenka)	Gross et al., 2007	late Sarmatian	(late Serravallian-early Tortonian)	Syrian basin, brackish environment	
<i>M. (Mediocytherideis) celcensis</i> (Zelenka)	Zelenka, 1990	late Sarmatian	(late Serravallian-early Tortonian)	Vienna Basin, brackish environment	
<i>M. (Sylvestra) sp. (Szczuchura)</i>	Szczuchura, 2000	Sarmatian	(late Serravallian-early Tortonian)	Poland, brackish environment	
<i>M. (Sylvestra) postorbursa</i> (Doruk)	Doruk, 1973		Late Miocene	Turkey, littoral marine environment	
<i>M. (Mediocytherideis) tripartita</i> (Carbonnel)	Grekoff in Cravatte et al., 1974		Late Miocene	Gulf of Lyon (France)	
<i>M. (Sylvestra) bismuthi</i> Bonaduce, Russo & Barra	Bonaduce et al., 1990		Tortonian	Gulf of Gabes (Tunisia), marine euphotic zone	
<i>M. (Sylvestra) sp. Mostafawi</i>	Mostafawi, 1990		early Tortonian	Kythira island (Greece), marine environment	
<i>M. (Sylvestra) chersonica</i> Krsić	Krsić & McKenzie, 1991	Kersonian	(middle-late Tortonian)	Serbia, brackish environment	
<i>M. (Sylvestra) aff. M. (S.) chersonica</i> Krsić	Krsić & McKenzie, 1991	Kersonian	(middle-late Tortonian)	Serbia, brackish environment	
<i>M. (Sylvestra) franzi</i> (Krsić)	Krsić & McKenzie, 1991	Kersonian	(middle-late Tortonian)	Strymon Basin (Greece), brackish environment	
<i>M. (Sylvestra) postorbursa</i> (Doruk)	Unpublished data		late Tortonian	Cessaniti basin (Calabria), marginal marine environment	
<i>M. (Mediocytherideis) macrostigma</i> (Jiríček)	Jiríček, 1985	late Pannonian	(late Tortonian)	Vienna Basin, brackish environment	
<i>M. (Sylvestra) postorbursa</i> (Doruk)	Clampo, 1993		late Tortonian-early Messinian	Rio Mazzapiedi (Piedmont)	
<i>M. (Sylvestra) sp. Sarti & Testa</i>	(= <i>Leptocythere</i> sp.) Sarti & Testa, 1994		Messinian	Volterra Basin (Tuscany)	
<i>M. (Sylvestra) maximus</i> Otleanu	Otleanu, 1990	middle Pontian	(Messinian)	Pannonian basin (Romania), brackish environment	
<i>M. (Mediocytherideis) kleiniae</i> (Markova)	Nagy-Bodor & Szurmi-Korecz, 1989	Pontian	(Messinian)	Pannonian basin, oligo-mesohaline environment	
<i>M. (Mediocytherideis) velonae</i> nov. sp.	This paper		early Messinian	Velona Basin (Tuscany), brackish environment	
<i>M. (Mediocytherideis) sp. A</i>	This paper		early Messinian	Velona Basin (Tuscany), brackish environment	
<i>M. (Sylvestra) etrusca</i> nov. sp.	This paper		early Messinian	Volterra-Radicondoli Basin (Tuscany) brackish environment	
<i>M. (Sylvestra) ornata</i> nov. sp.	This paper		early Messinian	Velona Basin (Tuscany), brackish environment	
<i>M. (Sylvestra) sulcata</i> nov. sp.	This paper		early Messinian	Velona Basin (Tuscany), brackish environment	
<i>M. (Sylvestra) tetralofoletta</i> nov. sp.	This paper		early Messinian	Velona Basin (Tuscany), brackish environment	
<i>M. (Sylvestra) fossata</i> nov. sp.	This paper		early – late Messinian	Volterra-Radicondoli Basin (Tuscany) brackish environment	
<i>M. (Sylvestra) punctata</i> nov. sp.	This paper		early – late Messinian	Volterra-Radicondoli Basin (Tuscany) brackish environment	
<i>M. (Sylvestra) postorbursa</i> (Doruk)	Miculan, 1992		early Messinian	Vigoleno area (Emilia) marine environment	
<i>M. (Sylvestra) sp. Krsić & McKenzie</i>	(= <i>C. tenuipunctata</i>) Devoto, 1968		early Messinian	Belforte (Tuscany), brackish environment	
<i>M. (Sylvestra) bismuthi</i> Bonaduce, Russo & Barra	Dall'Antonia & Bossio, 2001		early Messinian	Lampedusa island (Sicily channel)	
<i>M. (Sylvestra) gravida</i> Bonaduce, Russo & Barra	Bonaduce et al., 1990		early Messinian	Gulf of Gabes (Tunisia), marine euphotic zone	
<i>M. (Sylvestra) gravida</i> Bonaduce, Russo & Barra	Dall'Antonia & Bossio, 2001		early Messinian	Lampedusa island (Sicily channel)	
<i>M. (Sylvestra) ruggieri</i> Bonaduce, Russo & Barra	Bonaduce et al., 1990		early Messinian	Abbadia area (Sicily), marine environment	
<i>M. (Sylvestra) franzi</i> (Krsić)	Mostafawi, 1996	Portaferrian	(early Messinian)	Thessaloniki (Greece), brackish environment	
<i>M. (Mediocytherideis) brancisi</i> Krsić	Krsić & McKenzie, 1991	Portaferrian	(early Messinian)	Serbia, brackish environment	
<i>M. (Sylvestra) sp. B</i>	This paper		late Messinian	Tarantia Peligna (Abruzzo), Trave section (Marche), brackish lagoon-mare	
<i>M. (Sylvestra) sp. A Nachite</i>	Glozzi et al., 2005		late Messinian	Sorbas Basin, brackish lagoon-mare	
<i>M. (Sylvestra) sp. B Nachite</i>	Glozzi et al., 2005		late Messinian	Sorbas Basin, brackish lagoon-mare	
<i>M. (Sylvestra) sp. C Nachite</i>	Glozzi et al., 2005		late Messinian	Sorbas Basin, brackish lagoon-mare	
<i>M. (Sylvestra) delicatula</i> Bonaduce, Russo & Barra	Bonaduce et al., 1990		Pliocene	Atlantic Morocco, marine environment	
<i>M. (Sylvestra) moncharmonti</i> Bonaduce, Russo & Barra	Bonaduce et al., 1990		Pliocene	Atlantic Morocco, marine environment	
<i>M. (Mediocytherideis) sp. Carbonnel & Ballesio</i>	Carbonnel & Ballesio, 1982		Pliocene	South eastern France, marine environment	
<i>M. (Mediocytherideis) sp. 3 Clampo</i>	Clampo, 1992		Zandean	Calabria, marine environment	
<i>7M. (Mediocytherideis) apatoica</i> (Schweyer)	Vekua, 1975	Kuyanichian	(late Pliocene)	Caucasian region (Georgia), brackish environment	
<i>7M. (Mediocytherideis) apatoica</i> (Schweyer)	Popova-Livova, 1972 in Krsić & McKenzie, 1991	Akchagylia	(late Pliocene)	South Caucasian region, brackish environment	
<i>M. (Mediocytherideis) apatoica</i> (Schweyer)	Schweyer, 1949	Apscheronian	(Pleistocene)	Astrakhan region (Uzbekistan)	
<i>M. (Mediocytherideis) kleiniae</i> (Markova)	Markova, 1960	Apscheronian	(Pleistocene)	Turkmenistan, brackish environment	
<i>M. (Mediocytherideis) apatoica</i> (Schweyer)	Agalarova et al., 1961	Apscheronian	(Pleistocene)	Azerbaijan, brackish environment	
<i>M. (Sylvestra) virgula</i> Bonaduce, Russo & Barra	Bonaduce et al., 1990		Sarmatian	S. Maria del Belice (Sicily), littoral marine environment	
<i>M. (Sylvestra) virgula</i> Bonaduce, Russo & Barra	Faranda et al., 2007		Sarmatian	M. Mario (Rome), littoral marine environment	
<i>M. (Sylvestra) seminis</i> Bonaduce, Russo & Barra	Bonaduce et al., 1976; Barra et al., 1991		Tyrrenian (OIS 5e)	Sarno (Campania), shallow water marine	
<i>M. (Sylvestra) sp. 1 Pugliese & Stanley</i>	Pugliese & Stanley, 1991		late Quaternary	Egypt, shallow marine environment	
<i>M. (Sylvestra) arenicola</i> (Hartmann)	Hartmann, 1964		Recent	Red Sea (Coast of Egypt), coral reefs	
<i>M. (Sylvestra) arenicola</i> (Hartmann)	(= <i>S. tramontano</i>) Bonaduce et al., 1990		Recent	Gulf of Aqab (Red Sea), coral reefs	
<i>M. (Sylvestra) intermedia</i> Bonaduce, Russo & Barra	Bonaduce et al., 1990		Recent	Gulf of Aqab (Red Sea), coral reefs	
<i>M. (Sylvestra) patriziae</i> Bonaduce, Russo & Barra	Bonaduce et al., 1990		Recent	Gulf of Aqab (Red Sea), coral reefs	
<i>M. (Sylvestra) seminis</i> (Bonaduce, Masoli & Pugliese)	Bonaduce et al., 1990		Recent	Red Sea and Indian Ocean, shallow marine environment	
<i>7M. (Sylvestra) seminis</i> (Bonaduce, Masoli & Pugliese)	Dias-Brito et al., 1988		Recent	Brazil, marine environment	

Tab. 1 - List of the known *Mediocytherideis* s.l. species. Legend: normal character - Mediterranean fossil species; bold character - Paratethyan fossil species; grey background - recent Atlantic and Red Sea species.

dactylomorpha Ruggieri, *Elofsonella amberii* Carbonnel and *Sclerophilus* aff. *S. contortus* (Norman) (Carbonnel, 1969). Since it is unknown to which part of the Serravallian the Rhône species must be referred, it is impossible to establish whether the origin of the genus

is to be located in the Mediterranean or in the Paratethyan domain, but what is rather clear is that the adaptation to both the marine and brackish environment occurred in its early evolutive phases. Anyway, up to the end of middle Serravallian, several connections

Nevevskaya et al., 1984

Ages Ma	Forams (Blow, 1979)	Nannos (Martini, 1978)	Epoch	Subepoch	Mediterranean	Western Paratethys	Eastern Paratethys
1	N23	NN21-20	QUATERNARY	QUATERNARY	QUATERNARY	QUATERNARY	QUATERNARY
2	N22	NN19					
3	N21	NN17-18	PLIOCENE	Upper	PIACENZIAN	ROMANIAN	AKCHAGILIAN
4	N20	NN16			ZANCLEAN	DACIAN	KIMMERIAN
5	N19	NN15		Lower	MESSINIAN	PONTIAN	PONTIAN
6	N18	NN14			TORTONIAN	PANNONIAN	MAEOTIAN
7	N17	NN13	MIOCENE	Upper	TORTONIAN	PANNONIAN	MAEOTIAN
8	N16	NN12					
9	N15	NN11					
10	N14	NN10					
11	N13	NN9		Middle	SERRAVALLIAN	SARMATIAN s.s.	SARMATIAN
12	N12	NN8					
13	N11	NN7					
14	N10	NN6					
15	N9	NN5		Lower	LANGHIAN	BADENIAN	KARAGANIAN
16	N8	NN4					

Meulenkamp & Sissingh, 2000

Ma	EPOCHS	AGES	REGIONAL STAGES		STANDARD ZONES		
			CENTRAL PARATETHYS	EASTERN PARATETHYS	CALCAREOUS NANNOS	PLANKTONIC FORAMINIFERA	MAMMAL ZONES
1							
3	PLIOCENE	GELASIAN			NN17-18	PL3-5	MN17-MN15
4		PIACENZIAN	ROMANIAN	AKCHAGILIAN	NN16	PL2	
5		ZANCLEAN	DACIAN	KIMMERIAN	NN15	PL1	MN14
7	LATE MIOCENE	MESSINIAN	PONTIAN	PONTIAN	NN14		MN13
9		TORTONIAN	PANNONIAN	MAEOTIAN	NN13		MN12-MN10
11			SARMATIAN	SARMATIAN	NN12		MN9
13	MIDDLE MIOCENE	SERRAVALLIAN	BADENIAN	KONKIAN KARAGANIAN TSCHOKRAKIAN	NN11	M13	MN9-MN7
15		LANGHIAN			NN10		MN6-MN5
17		BURDIGALIAN	KARPATIAN	KOTSCHUKHIAN	NN9		

Popov et al., 2006

CHRONS	POLARITY	Times (Ma)	EPOCHS	Mediterranean Stages	Paratethys Stages and Biozones				Planktonic Foraminifera Zones	Nanno-plankton Zones	Mammal Zones (Steininger, 1999)
					Central	Dacic	Euxinian	Caspian			
					Rogl, 1998	Snel et al., 2001	Nevevskaya et al., 1986; Trubikhin, 1989; Popov et al., 2006		Berggren et al., 1995		
C1n		0	Q	IONIAN					PT1	NN20-21	MQ1-4
C1n		1.8		CALABRIAN						NN19	MN18
C2			PLIOCENE	GELASIAN	ROMANIAN	ROMANIAN	KUJALNICIAN	AKCHAGILIAN	PL6	NN18	MN17
C2An				PIACENZIAN					PL5	NN16b-17	MN16
C2Ar									PL3-4	NN16a	MN15
C3n		5		ZANCLEAN	DACIAN	DACIAN	KIMMERIAN	BALAKHANIAN	PL2	NN14-15	MN14
C3r									PL1	NN13	MN13
C3An			LATE MIOCENE	MESSINIAN	PONTIAN	PONTIAN	Bosporian + Portafemian	Babadzhanian	M14	NN12	MN12
C3Ar							Akmanaian	Novorossian			MN11
C3Br							Bagerovian				MN10
C4n											MN10
C4r											MN9
C4An											MN8-7
C4Ar											
C5n		10									
C5r			M. MIOCENE	TORTONIAN	PANNONIAN	SARMATIAN s.l.	Khersonian	Bessarabian	M13	NN11	MN9
C5An										NN10	MN8-7
C5Ar										NN9b	MN6
C5ACn										NN9a/b	
C5ADn		15								NN7-8	
										NN6	
										NN5	

Fig. 3 - Different chronostratigraphic schemes of correlation between the Mediterranean and Paratethyan stages.

between the two domains are documented (Meulenkamp & Sissingh, 2003) and only during the late Serravallian the emersion of both the Carpathian and the Alpine foreland domains isolated the two areas, which, from this moment developed into two different bioprovinces (Marinescu & Papaianopol, 1990; Meulenkamp & Sissingh, 2003). From this moment, in the Paratethyan domain, both *Mediocytherideis* s.s. and *M. (Sylvestra)* spread with different species (Tab. 1) all adapted to brackish environments up to the Apsheronian (Quaternary) of the Caspian Basin (Turkmenistan, Uzbekistan, and Azerbaijan, Schweyer, 1949; Markova, 1960; Agalarova et al., 1961). On the contrary, in the Mediterranean, *Mediocytherideis* s.l. underwent an important adaptive radiation in the marine realm from the late Tortonian (*M. (Sylvestra) bismuthi* Bonaduce, Russo & Barra in the Ashtart 1 well, Gulf of Gabes, Tunisia, Bonaduce et al., 1990, 1992) to the Late Pleistocene (OIS 5e, *M. (Sylvestra) seminis* Bonaduce, Masoli & Pugliese, Sarno Plain, southern Italy, Pugliese & Stanley, 1991). Only during Messinian several brackish species occurred in the Mediterranean: during the pre-evaporitic Messinian they were limited to the Tuscan basins with nine endemic species (Tab. 1), while, in the late Messinian *Lago-Mare* biofacies, *Mediocytherideis* s.l. seems widespread in a large portion of the Mediterranean, from Italy to Spain, associated with Paratethyan ostracods of the *L. djaffarovi* Zone (*sensu* Carbonnel, 1979).

The origin of these Messinian brackish taxa is unknown. Both the hypotheses of their derivation from the Tortonian Mediterranean marine *Mediocytherideis* s.l. species or from the Paratethyan brackish forms, eventually migrated westwards *via* passive dispersal, are not supported by data. Similarly, the morphologies of the Messinian brackish Tuscan species do not suggest their origin from a common ancestor, thus, for the moment, it is not possible to suppose a Tuscan brackish adaptive radiation.

ACKNOWLEDGEMENTS

We wish to thank J. Rodriguez-Lazaro and S. Trenkwalder who read the manuscript and helped us to improve it with their valuable suggestions, and Valentina Reveha, who, very kindly, helped us to read the Russian papers.

REFERENCES

- Agalarova D.A., Kadyrova Z.K. & Kulieva S.A. (1961). Ostrakody pliotzenovykh i postpliotzenovykh otlozheniy Azerbaydzhana, Baku, 420 pp. [in Russian].
- Barra D., Cinque A., Gedwelt M. & Hurtgen C. (1991). L'ospite caldo *Sylvestra seminis* (Bonaduce, Masoli & Pugliese, 1976) (Crustacea, Ostracoda): un possibile marker dell'ultimo interglaciale dell'area mediterranea. *Il Quaternario*, 4 (2): 327-332.
- Bassetti M.A., Miculan P. & Ricci Lucchi F. (2003). Ostracod faunas and brackish-water environments of the late Messinian Sapigno section (northern Apennines, Italy). *Palaeogeography, Palaeoclimatology, Palaeoecology*, 198: 335-352.
- Bonaduce G., Masoli M. & Pugliese N. (1976). Ostracoda from the Gulf of Aqaba (Red Sea). *Pubblicazioni della Stazione Zoologica di Napoli*, 40: 372-428.
- Bonaduce G., Ruggieri G., Russo A. & Bismuth H. (1992). Late Miocene ostracods from the Ashtart 1 well (Gulf of Gabès, Tunisia). *Bollettino della Società Paleontologica Italiana*, 31 (1): 3-92.
- Bonaduce G., Russo A. & Barra D. (1990). The ostracod genus *Sylvestra* Doruk, 1973: systematics, ecology and distribution. *Bollettino della Società Paleontologica Italiana*, 29 (3): 279-288.
- Bossio A., Cerri R., Mazzei R., Salvatorini G. & Sandrelli F. (1994a). The neoautochthonous succession of the Spicchiaiola-Pignano area, east of Volterra (Southern Tuscany, Italy). *Memorie della Società Geologica Italiana*, 48: 425-430.
- Bossio A., Cerri R., Mazzei R., Salvatorini G. & Sandrelli F. (1996). Geologia dell'area Spicchiaiola-Pignano (Settore orientale del Bacino di Volterra). *Bollettino della Società Geologica Italiana*, 115: 393-422.
- Bossio A., Costantini A., Foresi L.M., Gandin A., Mazzanti R., Mazzei R. & Salvatorini G. (1994b). Su alcuni affioramenti miocenici della Val di Cornia (Provincia di Grosseto e Pisa). *Atti Società Toscana di Scienze Naturali*, A, 101: 167-185.
- Bossio A., Esteban M., Giannelli L., Longinelli A., Mazzanti R., Mazzei R., Ricci Lucchi F. & Salvatorini G. (1978). Some aspects of the Upper Miocene in Tuscany. Messinian Seminar N° 4, Field Trip Guidebook, 88 pp., Pacini, Pisa.
- Bossio A., Giannelli L., Mazzanti R., Mazzei R. & Salvatorini G. (1981). Il passaggio dalla facies lacustre alla evaporitica e le "Argille a Pycnodonta" presso Radicondoli (Siena). IX Convegno della Società Paleontologica Italiana 3-8 ottobre 1981: 161-174, Pacini, Pisa.
- Buryndina L.V. (1969). Sarmatian Ostracods from the Transcarpathians. Fam. Policopidae, Cytheridae. *Paleontologicheskii Sbornik*, 6: 62-67 [in Russian].
- Carbonnel G. (1969). Les Ostracodes du Miocene Rhodanien. *Documents des Laboratoires de Géologie et la Faculté des Sciences de Lyon*, 32 (1): 1-228; 32 (2): 229-469.
- Carbonnel G. (1979). La zone à *Loxoconcha djaffarovi* Schneider (Ostracoda, Miocene supérieur) ou le Messinien de la vallée du Rhône. *Revue de Micropaléontologie*, 21: 106-118.
- Carbonnel G. & Ballesio R. (1982). Les Ostracodes pliocènes du sud-est de la France. *Documents des Laboratoires de Géologie et la Faculté des Sciences de Lyon*, 85: 1-113.
- Ciampo G. (1983). Alcuni ostracodi del Miocene superiore piemontese. *Bollettino della Società Paleontologica Italiana*, 22 (3): 247-262.
- Ciampo G. (1992). Ostracofauna Plioceniche della Calabria ionica. *Bollettino della Società Paleontologica Italiana*, 31 (2): 223-240.
- Cipollari P., Cosentino D., Di Bella L., Gliozzi E. & Pipponzi G. (2002). Inizio della sedimentazione d'avansfossa nella Majella meridionale: la sezione di Fonte dei Pulcini (Taranta Peligna). In Cosentino D. & Cipollari P. (eds.), *Evoluzione cinematica del sistema orogenico dell'Appennino centro-meridionale: caratterizzazione stratigrafico-strutturale dei bacini sintettonici. Studi Geologici Camerti*, vol. spec. 23 (1): 63-71.
- Cosentino D., Cipollari P., Lo Mastro S. & Giampaolo C. (2005). High-frequency cyclicity in the latest Messinian Adriatic foreland basin: Insight into palaeoclimate and palaeoenvironments of the Mediterranean Lago-Mare episode. *Sedimentary Geology*, 178: 31-53.
- Cravatte J., Dufaure P., Prim M. & Rouaix S. (1974). Les sondages du Golfe du Lyon: stratigraphie, sédimentologie. *Cie Française des Pétroles. Notes et Mémoires*, 11: 209-274.
- Dall'Antonia B. & Bossio A. (2001). Ostracoda from the lower Messinian of Lampedusa island: systematics and chronostratigraphical significance. *Bollettino della Società Paleontologica Italiana*, 40 (1): 81-96.
- Devoto G. (1968). *Bullocypris robusta*, nuovo genere e nuova specie del Messiniano ipoalino dell'Italia centrale. *Geologica Romana*, 7: 399-404.
- Dias-Brito D., Moura J.A. & Wurdig N. (1988). Relationships between ecological models based on ostracodes and foraminifers from Sepetiba Bay (Rio de Janeiro, Brazil). In Hanai T., Ikeya N. & Ishizaki K. (eds.), *Evolutionary biology*

- of ostracoda: its fundamentals applications. Proceedings of the 9th International Symposium on Ostracoda. *Developments in Palaeontology and Stratigraphy*, 11: 467-485.
- Doruk N. (1973). On *Sylvestra posterobursa* Doruk gen. et sp. nov. In Sylvester-Bradley P.C. & Sieveter D.J. (eds.), *A Stereo Atlas of Ostracod Shells*, 1 (2): 153-160.
- Faranda C., Gliozzi E. & Mazzini I. (2007). Palaeoenvironmental evolution of the Plio-Pleistocene Monte Mario Succession (Rome, Italy) inferred from Ostracod assemblages. *Rivista Italiana di Paleontologia e Stratigrafia*, 113 (3): 473-485.
- Fordinal K. & Zlinska A. (1998). Fauna vrchnej časti holičského súvrstvia (sarmat) v Skalici (viedenská panva). *Mineralia Slovaca*, 30: 137-146.
- Ghetti P., Anadón P., Bertini A., Esu D., Gliozzi E., Rook L. & Soulié-Märsche I. (2002). The Early Messinian Velona basin (Siena, central Italy): paleoenvironmental and paleobiogeographical reconstructions. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 187: 1-33.
- Gliozzi E., Rodriguez-Lazaro J., Nachite D., Martin-Rubio M. & Bekkali R. (2005). An overview on Neogene leptocytherids from Italy and Spain: Biochronological and Palaeogeographical implications. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 225: 283-301.
- Gross M., Harzhauser M., Mandic O., Piller W.E. & Rögl F. (2007). A stratigraphic enigma: the Age of the Neogene Deposits of Graz (Styrian basin, Austria). *Joannea Geologie und Paläontologie*, 9: 195-220.
- Hartmann G. (1964). Zur kenntnis der ostracoden des Roten Meeres. *Kieler Meeresforschungen*, 20: 35-127.
- Iaccarino S.M., Bertini A., Di Stefano A., Ferraro L., Gennari R., Grossi F., Lirer, F., Manzi V., Ricci Lucchi M., Taviani M., Sturiale G., Angeletti L. & Sprovieri M. (in press). The Trave section (Monte dei Corvi, Ancona, Central Italy): an integrated paleontological study of the Messinian deposits. *Stratigraphy*.
- ICZN (1961). International Code of Zoological Nomenclature. 176 pp. International Trust for Zoological Nomenclature, London.
- ICZN (1985). International Code of Zoological Nomenclature. 335 pp. International Trust for Zoological Nomenclature & University of California Press, Berkeley & Los Angeles.
- ICZN (1999). International Code of Zoological Nomenclature. 4th edition. International Trust Zoological Nomenclature ISBN: 0853010064. Version on line: www.iczn.org/iczn/index.jsp.
- Jiříček R. (1985). Die Ostracoden des Pannonien. In Papp A., Jambor Á. & Steininger F.F. (eds.), *Chronostratigraphie und Neostatotypen*. Miozän der Zentralen Paratethys. Bd VII. Pannonien, 378-425.
- Krstić N. & Bossio A. (1992). Some New Ostracode species from Upper Meotian. *Proceedings of Geoinstitute Belgrade*, 26: 175-199.
- Krstić N. & McKenzie K.G. (1991). *Mediocytherideis* Mandelstam, 1956: diagnosis and relationships. *Annales Géologiques de la Péninsule Balkanique*, 55 (1): 175-205.
- Lazarotto A., Sandrelli F., Foresi L.M., Mazzei R., Salvatorini G., Cornamusini G. & Pascucci V. (eds.) (2002). Note illustrative della Carta Geologica d'Italia alla scala 1:50.000. Foglio 295 Pomarance, 14 pp., L.A.C., Firenze.
- Livental V.E. (1956). Stratigraficheskoe znachenie rakushkovykh rachkov (Ostracoda) v neogene zakarpatya. *Nauchniezapski Iovskogo Politekhnikeskogo Instituta*, 46, Serya Geologorazvedochnaya, 1: 21-38 [in Russian].
- Luebimova P.S., Mandelstam M.I. & Schneider G.F. (1960). Ostracoda: nadseneystvo Cypracea. In Orlov Y.A. (ed.), *Trilobitomorpha and Crustacea. Osnovy Paleontologii*, 8: 347-365 [in Russian].
- Marinescu F. & Papaianopol I. (1990). Le Pontien du Bassin Dacique en Roumanie. In Stevanović P., Nevesskaja L.A., Marinescu F., Sokač A. & Jambor Á. (eds.), *Chronostratigraphie und Neostatotypen*. Neogen der Westlichen ("Zentrale") Paratethys. Bd. VIII. Pontien" (1989): 300-312.
- Markova L.P. (1960). Novye vidi ostrakod iz semeys. *Trudy Institut geologii Akademii Nauk Turkmeniskoi SSR*, 2: 276-297 [in Russian].
- Martini P.I. & Sagri M. (1993). Tectono-sedimentary characteristic of Late Miocene-Quaternary extensional basins of the Northern Apennines, Italy. *Earth Science Reviews*, 34: 197-233.
- Martini P.I. & Sagri M. (1994). The late Miocene-Pleistocene extensional basins of the Northern Apennines: facies distribution and basin fill architecture. *Memorie della Società Geologica Italiana*, 48: 375-380.
- Meulenkamp J.E. & Sissingh W. (2003). Tertiary palaeogeography and tectonostratigraphic evolution of the Northern and Southern Peri-Tethys platforms and the intermediate domains of the African-Eurasian convergent plate boundary zone. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 196: 209-228.
- Miculan P. (1992). Gli ostracodi del Miocene superiore di Vigoleno (subappennino piacentino). *Bollettino della Società Paleontologica Italiana*, 31 (1): 105-132.
- Moore R.C. (ed.) (1961). Treatise on Invertebrate Paleontology. Part Q. Arthropoda 3, Crustacea, Ostracoda, 442 pp., Geology Society of America and University of Kansas Press, Lawrence.
- Mostafawi N. (1990). Neogene Ostracoden von Kythira, Griechenland. *Courier Forschungsinstitut Senckenberg*, 123: 161-179.
- Mostafawi N. (1996). Neogene Ostracodenfaunen im Gebiet von Thessaloniki (Nordgriechenland). *Senckenbergiana Lethaea*, 76 (1/2): 159-173.
- Nagy-Bodor E. & Szuromi-Korecz A. (1989). An evaluation of Sporomorphs and Ostracods of the fehérpart exposure at Tihany, Lake Balaton. *Magyar Allami Földtani Févi Jelentése*, 2: 203-225.
- Nevesskaya L.A., Goncharova I.A., Ilina L.B., Paramonova N.P., Popov S.V., Bogdanovich A.K., Gabuniya L.K. & Nosovskiy M.F. (1984). Regionalnaya stratigraficheskaya shkala neogena Vostochnogo Paratetisa. *Soviet Geology*, 9: 37-49 [in Russian].
- Olteanu R. (1989). New ostracodes in upper Neogene from Romania. *Memoires de l'Institut Géologique et Géophysique de Bucarest*, 34: 123-184.
- Olteanu R. (1990). La Faune d'Ostracodes ponties du Bassin Dacique. In Stevanović P., Nevesskaja L. A., Marinescu F., Sokač A. & Jambor Á. (eds.), *Chronostratigraphie und Neostatotypen*. Neogen der Westlichen (Zentralen) Paratethys. Bd VIII. Pontien: 722-752.
- Popov S.V., Shcherba I.G., Ilyina L.B., Nevesskaya L.A., Paramonova N.P., Khondkarian S.O. & Magyar I. (2006). Late Miocene to Pliocene palaeogeography of the Paratethys and its relation to the Mediterranean. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 238: 91-106.
- Pugliese N. & Stanley D.J. (1991). Ostracoda, depositional environments and late Quaternary evolution of eastern Nile Delta, Egypt. *Il Quaternario*, 4 (2): 275- 302.
- Reuss A.E. (1850). Die fossilen Entomostraceen des österreichischen Tertiärbeckens. *Naturwissenschaften Abhandlungen*, 3 (1): 41-92.
- Rook L. & Ghetti P. (1997). Il bacino neogenico della Velona (Toscana, Italia): stratigrafia e primi ritrovamenti di vertebrati fossili. *Bollettino della Società Geologica Italiana*, 116: 335-346.
- Roveri M., Lugli S., Manzi V., Gennari R., Iaccarino S.M., Grossi F. & Taviani M. (2006). The record of Messinian events in the Northern Apennines foreland basins. R.C.M.N.S. Interim Colloquium 2006 "The Messinian salinity crisis revisited II", Pre-Congress Field Trip Guide. *Acta Naturalia de "L'Ateneo Parmense"*, 42 (3): 47-125.
- Sarti G. & Testa G. (1994). Studio geologico-stratigrafico della successione tortoniana superiore-pliocenica del margine occidentale del bacino di Volterra (Pisa). *Memorie Descrittive della Carta Geologica d'Italia*, 49: 189-228.
- Schneider G.F. (1939). Miocene Ostracoda of the Crimea-Caucasian region. *Problemy Paleontologii*, 5: 177-208.
- Schweier A.V. (1949). On the Pliocene ostracoda of the northern Caucasus and lower Volga region with some new data on the systematics of fossil ostracods. *Trudy Vsesoyuznogo Neftyanogo*

- Nauchno-Issledovatels Kogo Geologo-Razvedochnogo Instituta (VNGRI)*, nov. ser., 30: 7-68 [in Russian].
- Servizio Geologico d'Italia (2002). Carta geologica d'Italia alla scala 1:50.000. Foglio 285 - "Volterra". L.A.C., Firenze.
- Servizio Geologico d'Italia (2002). Carta geologica d'Italia alla scala 1:50.000. Foglio 295 - "Pomarance". L.A.C., Firenze.
- Servizio Geologico d'Italia (in press). Carta geologica d'Italia alla scala 1:50.000. Foglio 296 - "Siena". L.A.C., Firenze.
- Stancheva M. (1963). Ostracoda from the Neogene in Northwestern Bulgaria: 2. Sarmatian Ostracoda. *Travaux Geologie Bulgarie, Paléontologie*, 5: 5-73.
- Suzin A. V. (1956). Ostracody Tretichnykh otlozheniy severnogo predkavkazya. Moskva: 1-191 [in Russian].
- Szczuchura J. (2000). Age and evolution of depositional environments of the supra-evaporitic deposits in the Northern, marginal part of the Carpathian Foredeep: micropaleontological evidence. *Geological Quarterly*, 44 (1): 88-10.
- Testa G. (1995). Upper Miocene extensional tectonics and syn-rift sedimentation in the western sector of the Volterra Basin (Tuscany, Italy). *Studi Geologici Camerti*, vol. spec. 1: 617-630.
- Vekua M.L. (1975). The ostracods of the Kimmerian and Kuyalnikian deposits of Abkhazia and their stratigraphic significance. Tblisi (Akademia Nauk Gruzinskoy SSR), 137 pp.
- Zelenka J. (1989). A.E. Reuss importance for research on Neogene Ostracoda from Vienna Basin and the taxonomic of his determinations. *Courier Forschungsinstitut Senckenberg*, 113: 251-254.
- Zelenka J. (1990). A review of the Sarmatian Ostracoda of the Vienna Basin. In Whatley R. & Maybury C. (eds.), *Ostracoda and global events*. Chapman and Hall: 263-271.

Manuscript received 11 January 2008

Revised manuscript accepted 23 May 2008

