

Systematics and biostratigraphy of the ostracoda of the Plio-Pleistocene Monte S. Nicola section (Gela, Sicily)

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ABSTRACT – The ostracod assemblages of the Plio-Pleistocene section of Monte S. Nicola (Gela, Sicily) are studied. The section, sampled at 2 m intervals, yielded 113 species, belonging to 46 genera, ten of which are left in open nomenclature due to scarce or badly preserved material.

The following species: *Bairdoppilata profunda* sp. nov., *Occultocythereis culter* sp. nov. and *Propontocypris dromas* sp. nov. are described as new. Most of the species are treated taxonomically, with data on their stratigraphical distribution and palaeoecology. Some species which were imperfectly described are better illustrated.

The qualitative distribution of the species through the section, shows a high number of appearances and disappearances. First appearances of species are staggered throughout the section; this and the limited stratigraphical ranges of certain species indicate the biostratigraphical potential of the Ostracoda. In particular, the genus *Krithe* is of high diversity and numerous species appear restricted to well defined and frequently short intervals. Many of the *Krithe* species have never been recorded from the Atlantic, suggesting the possibility that the Mediterranean Basin, due to its peculiar character, may have acted as a laboratory of evolution especially of this genus.

RIASSUNTO – [Sistematica e biostratigrafia degli ostracodi della sezione Plio-Pleistocenica di Monte San Nicola (Gela, Sicilia)] – Vengono studiati gli ostracodi della sezione Plio-Pleistocenica di Monte San Nicola (Gela, Sicilia). La sezione, che ha uno spessore totale di circa 170 m, è costituita alla base da circa 34 m della Formazione "Trubi" cui seguono le marne azzurre della Formazione Monte Narbone ed è compresa tra la parte superiore della Biozona M Pl 3 e il Pleistocene basale. La campionatura, effettuata ad intervalli di 2 m circa, ha fornito un'ostracofauna costituita da 113 specie, 10 delle quali lasciate in nomenclatura aperta a causa della scarsità di individui o del loro cattivo stato di conservazione. Tre specie, *Bairdoppilata profunda* sp. nov., *Occultocythereis culter* sp. nov., *Propontocypris dromas* sp. nov., sono descritte come nuove. Un capitolo sulla sistematica riporta le sinonimie considerate valide, la distribuzione stratigrafica e note ecologiche della maggior parte delle specie; parte di esse vengono reillustrate nelle tavole allegate.

La distribuzione delle ostracofaune, studiata sotto un aspetto qualitativo, evidenzia un alto numero di comparse e di estinzioni. Numerose specie mostrano il loro LOD a differenti altezze della sezione ed alcune di esse sembrano limitate a ridotti intervalli stratigrafici. In particolare il genere *Krithe* mostra un'alta diversità e numerose specie, non registrate in Atlantico, risultano limitate ad intervalli ben definiti e spesso di breve durata. Tale constatazione suggerisce la possibilità che il bacino del Mediterraneo per le sue peculiari condizioni abbia agito come laboratorio di evoluzione del genere stesso.

INTRODUCTION

The present paper is a systematic and biostratigraphical study of the entire ostracod fauna of the Monte S. Nicola section (Gela, Sicily), within the framework of a wider project of Mediterranean Pliocene Ostracoda.

The Monte S. Nicola section continuously crops out over a total thickness of some 170 m. The lower 34 m consists of *Globigerina* marls of the "Trubi" Formation, overlain by the blue-marls of the Monte Narbone Formation, with transitional layers (about 8 m) rich in manganese. Text-fig. 1 gives the complete section and the biostratigraphy established by Sprovieri (Bonaduce & Sprovieri, 1985).

The section extends from the upper part of Biozone M Pl 3 to the early Pleistocene. The base of the studied section (samples 1-3) is in the top part of Biozone M Pl 3, characterized by the co-occurrence of *Globorotalia margaritae* and *G. punctulata*.

Biozone M Pl 4 (samples 3-17) is defined by the common occurrence of *Sphaeroidinellopsis subdehiscens*, Biozone M Pl 5 by *Globigerinoides elongatus* (samples 17-50) and Biozone M Pl 6 (samples 50-70) by *Globorotalia inflata*. The Pliocene-Pleistocene boundary corresponds to the FO of *Globigerina cariacensis*. The Selinuntian is represented by about 30 m in thickness (samples 71-83). The same authors consider that the ostracod assemblages correspond to a paleobathymetry of about 1000 m.

The systematics of the ostracod fauna has been previously studied from the same section as well as the qualitative stratigraphical distribution of certain genera by various authors: *Krithe* (Abate et al., 1993), *Parakrithe* (Aiello et al., 1993), *Xestoleberis* (Abate et al., 1994), *Anchistrocheles* (Aiello et al., 1996b), *Cytheropteron* (Aiello et al., 1996a), *Cytherella* (Aiello et al., 1996c) and *Argilloecia* (Barra et al., 1996).

These works have resulted in the erection and description of numerous new species some of whose

distribution in the section is restricted to defined intervals.

The biostratigraphy and cyclostratigraphy of the Monte S. Nicola section is well established through the works of Spaak (1983) and Sprovieri (1992; 1993) on planktonic Foraminifera, Driever, (1988) on calcareous nannofossils and Channel *et al.* (1992) on planktonic Foraminifera and nannofossils.

The upper Pliocene part of the Monte S. Nicola section has been selected as the stratotype of the Gelasian, a new stage for the third, upper, subdivision of the Pliocene (Rio *et al.*, 1994).

MATERIAL AND METHODS

A total of 83 samples, taken at about 2 m intervals, have been used in this study (Text-fig. 1). All ostracods were picked out from samples of about 400 gr, washed over 120 meshes sieves. The ostracod fauna comprises 113 species, belonging to 46 genera; 103 species have been definitively or tentatively identified and the remaining 10 left in open nomenclature because of sparse or poorly preserved material. The species list is given in the systematic appendix and the quantitative stratigraphical distribution of all the species in Tab. 1. Previously poorly illustrated species, those proposed as new and those left in open nomenclature are illustrated in the plates.

SYSTEMATIC SECTION

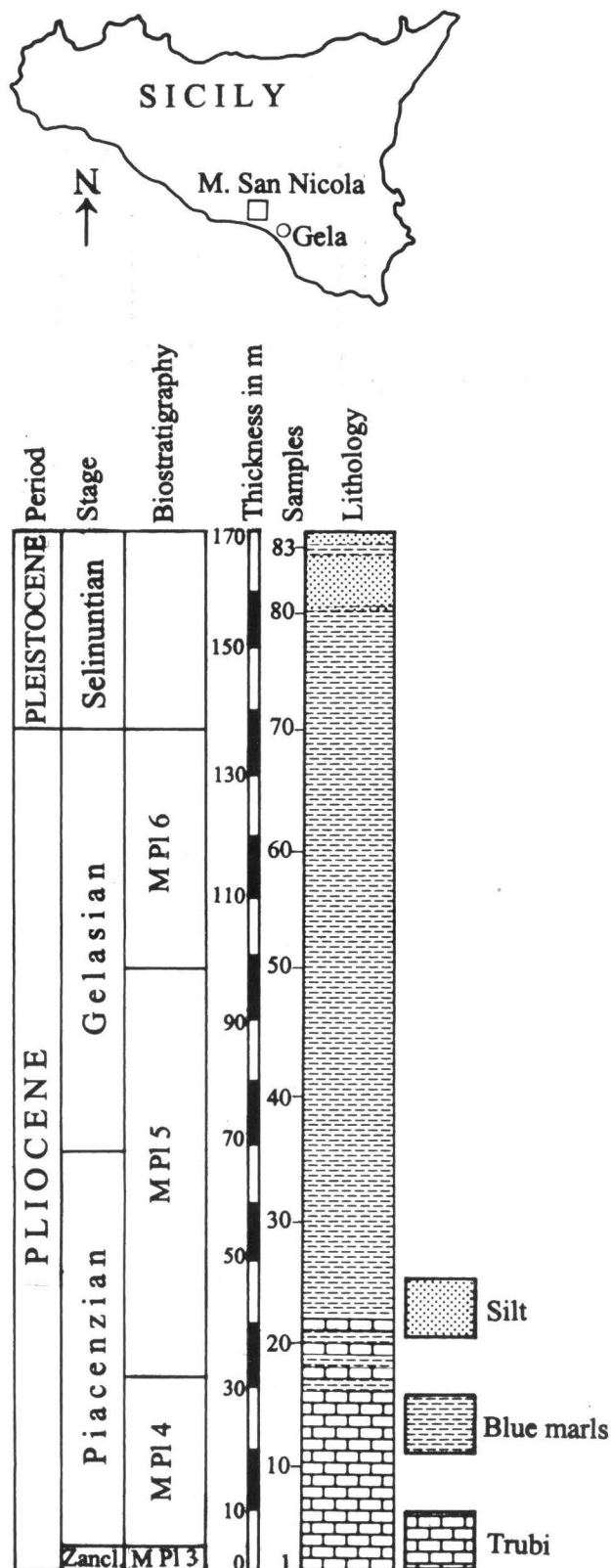
In the following chapter, those species not treated in detail in previous papers (Abate *et al.*, 1993; Aiello *et al.*, 1993; Abate *et al.*, 1994; Aiello *et al.*, 1996a; 1996b; 1996c; Barra *et al.*, 1996), their synonymies, distribution in the section, ecological data and previously known occurrences, with age and location, are reported in systematic order. The systematics follow fundamentally that of Hartmann & Puri (1974) with some modifications due to the contributions of Maddocks (1969; 1976) for Bairdiidae, Maddocks (1990) for Macrocyprididae, Schornikov (1990) for Bythocytheridae, Maddocks & Steineck (1987) for Eucytheruridae, and Sissingh (1975) for Pedicytherinae.

The following 3 species, *Bairdoppilata profunda* sp. nov., *Occultocythereis culter* sp. nov. and *Proponotocypris dromas* sp. nov., are described and illustrated.

Subclass OSTRACODA Latreille, 1806
Order MYODOCOPIDA Sars, 1866
Suborder CLADOCOPA Sars, 1866
Family POLYCOPEIDAE Sars, 1866
Genus POLYCOPE Sars, 1866

POLYCOPE DEMULDERI Sissingh, 1972

1972 *Polycope demulderi* SISSINGH, pp. 66-67, pl. 1, fig. 1.
1972 *Polycope* sp. A UFFENORDE, p. 49, pl. 5, fig. 2.



Text-fig. 1 - Biostratigraphy, lithostratigraphy and samples location of the Monte San Nicola section. The lower boundary of the Gelasian is from Sprovieri (pers. comm.).

- 1976 *Polycope demulderi* Sissingh - BONADUCE *et al.*, p. 10, pl. 3, figs. 1-5.
 1976b *Polycope demulderi* Sissingh - BREMAN, p. 43, pl. 5, fig. 51.
 1980 *Polycope demulderi* Sissingh - COLALONGO & PASINI, p. 66, pl. 26, fig. 4.
 1982 *Polycope demulderi* Sissingh - BONADUCE *et al.*, p. 349, pl. 1, figs. 3-4.

Distribution – Only one valve (sample 77) has been found (early Pleistocene).

Sissingh (1972): Rhodes (Greece), Lower Pleistocene.
 Uffenorde (1972): Limski Kanal, Adriatic Sea (Mediterranean Sea), Recent, 24-34 m.
 Bonaduce *et al.* (1976): Adriatic Sea, Recent, below 71 m.
 Breman (1976b): Adriatic Sea, Recent, below 70 m.
 Colalongo & Pasini (1980): Vrica Section (Calabria, Italy), Lower Pleistocene.
 Bonaduce *et al.* (1982): Gulf of Naples (Mediterranean Sea), Recent, 60 - 300 m.

POLYCOPE ? OVALIS Bonaduce, Ciliberto, Masoli, Minichelli & Pugliese, 1982

- ? 1982 *Polycope ovalis* BONADUCE, CILIBERTO, MASOLI, MINICHELLI & PUGLIESE, pp. 7-8, pl. 2, figs. 1-4; pl. 5, fig. 7.

Remarks and Distribution – The species is doubtfully attributed to the nominate species due to its very rare occurrence (only in sample 6, Biozone M Pl 4) and the badly preserved specimens.

POLYCOPE VASFIENSIS Sissingh, 1972
 Pl. 1, fig. 1

- 1964 *Polycope dentata* Brady 1867 - PURI *et al.*, p. 164, fig. 65.
 1969 *Polycope* cf. *P. dentata* Brady - PURI, BONADUCE & GERVASIO, pl. 2, fig. 2.
 1969 *Polycope dentata* Brady - PURI & DICKAU, pl. 2, fig. 4a.
 1972 *Polycope vasfiensis* Sissingh, p. 68, pl. 1, fig. 6.
 1976 *Polycope vasfiensis* Sissingh - BONADUCE *et al.*, p. 18, pl. 1, figs. 6-8, text-fig. 6.
 1976b *Polycope vasfiensis* Sissingh - BREMAN, p. 45, pl. 5, fig. 60.
 1982 *Polycope vasfiensis* Sissingh - BONADUCE *et al.*, p. 351, pl. 3, figs. 1-4.
 1988 *Polycope vasfiensis* Sissingh - RUAN & HAO, p. 393, pl. 74, figs. 2-5.

Distribution – It occurs, represented by few valves, only into two samples, in Biozones M Pl 5 and M Pl 6.

Puri *et al.* (1964), Puri & Dickau (1969), Bonaduce *et al.* (1982): Gulf of Naples (Mediterranean Sea), Recent, 135- 940 m.
 Puri *et al.* (1969): Mediterranean Sea, Recent, 150 to 4285 m.
 Sissingh (1972): Rhodes (Greece), Lower Pleistocene.
 Bonaduce *et al.* (1976), Breman (1976b): Southern

part of the Adriatic Sea (Mediterranean Sea), Recent, below 71 m.

Ruan & Hao (1988): Okinawa Trough, Quaternary.

Order PODOCOPIDA G.W. Müller, 1894
 Suborder METACOPA Sylvester-Bradley, 1967
 Superfamily HEALDIACEA Harlton, 1933
 Family SAIPANETTIDAE McKenzie, 1968
 Genus CARDOBAIRDIA van den Bold, 1960

CARDOBAIRDIA ? ASYMMETRICA (van den Bold, 1946)
 Pl. 1, figs. 11-12

- ? 1946 *Krausella asymmetrica* BOLD, p. 67, pl. 3, figs. 17a-b.
 ? 1974 *Cardobairdia asymmetrica* (Bold) - BOLD, p. 74, pl. 1, figs. 6-7.
 1969 *Cardobairdia* aff. *asymmetrica* (van den Bold) - RUSSO, p. 46, pl. 7, figs. 2a-c.
 1996 *Cardobairdia asymmetrica* (van den Bold) - COLES *et al.*, pl. 6, fig. 18.

Remarks – The figured specimens correspond perfectly to the drawings of Russo (1969). Van den Bold (1974) considered that Russo's form might differ because "*C. asymmetrica* falls slightly outside the area of the species on the L/H diagram...".

Distribution – Present throughout the section, usually represented by few specimens.

Russo (1969): Montebaranzone (Emilia, Italy), Tortonian.

Coles *et al.* (1996): Porcupine Basin, Eastern Atlantic, Quaternary, 660 m.

Suborder PODOCOPINA Sars, 1866
 Superfamily BAIRDIACEA Sars, 1866
 Family BAIRDIIDAE Sars, 1888
 Subfamily BAIRDIINAE Sars, 1888
 Genus BAIRDOPILATA Coryell, Sample & Jenning, 1935

BAIRDOPILATA CONFORMIS (Terquem, 1878)
 Pl. 1, fig. 2

- 1878 *Bairdia subdeltoidea* var. *conformis* TERQUEM, p. 93, pl. 10, figs. 17 a-c.
 1966 *Bairdia subdeltoidea conformis* Terquem - COLALONGO, pp. 86-87, pl. 10, figs. 2-3.
 1972 *Bairdopilata* (*Bairdopilata*) *supradentata* (Terquem, 1878) - SISSINGH, pp. 75-76, pl. 2, figs. 10-11.
 1976 *Bairdia conformis* (Terquem) - BONADUCE *et al.*, p. 22, pl. 6, figs. 5-10.
 1980 *Bairdia conformis* (Terquem) - COLALONGO & PASINI, p. 52, pl. 1, figs. 5-8.
 1985 *Bairdia conformis* (Terquem) - BONADUCE & MASCELLARO, pl. 1, fig. 11.
 1989 *Bairdia conformis* Terquem - MOSTAFAWI, pp. 124-125, pl. 1, fig. 8.

Remarks – The opinion of Sissingh (1972) who considered the species concept in a wide sense and identifies this species as *B. supradentata* (Terquem), is

not accepted here, because *B. supradentata* has posterior denticulations which do not occur in the present species. Since all our specimens lack this character, we maintain Terquem's *B. subdeltoidea* var. *conformis* as a valid species.

Distribution – This species appears in the section at the end of Biozone M Pl 5 but becomes relatively frequent only at the beginning of the Pleistocene. The first occurrence of *B. conformis* is consequently confirmed to occur in the topmost Mediterranean Pliocene.

Terquem (1878): Rhodes (Greece), Upper Pliocene. Colalongo (1966): Le Castella (Calabria, Italy), Upper Pliocene - Lower Pleistocene.

Sissingh (1972): Crete (Greece), Pliocene; Karpathos (Greece), Upper Pliocene; Rhodes, Upper Pliocene - Lower Pleistocene.

Bonaduce *et al.* (1976): Adriatic Sea (Mediterranean Sea), Recent.

Colalongo & Pasini (1980): Vrica Section (Calabria), Lower Pleistocene.

Bonaduce & Mascellaro (1985): Gulf of Taranto (Ionian Basin), Quaternary (Pleistocene - Holocene).

Mostafawi (1989): Lower Pleistocene, Rhodes.

BAIRDOPPILATA PROFUNDA sp. nov.
Pl. 1, figs. 3-6; Pl. 6, fig. 1

1966 *Bairdia* sp. 2 RUSSO, pp. 235-236, pl. 41, figs. 2a-c.

1981 *Bairdia* sp. 2 CIAMPO, pl. 1, figs. 4-5.

1985 *Bairdia crebra* Deltel, 1963 (misspelling for *creba*) - DUCASSE *et al.*, pl. 72, figs. 11-12.

1985 *Bairdia* sp. 1 BONADUCE & SPROVIERI, pl. 2, fig. 1.

1998 *Bairdia profunda* nomen nudum BARRA *et al.*, p. 75.

Etymology – From Latin *profundus* = deep.

Holotype – A LV (Pl. 1, fig. 3). Stn. 23. B.O.C. 2340.

Paratypes – 4 valves, 1 RV (Pl. 1, fig. 6), B.O.C. 2343 and 1 LV (Pl. 6, fig. 1), B.O.C. 2398.

Hypotypes – 1 complete carapace (Pl. 1, fig. 4), Stn. 9, B.O.C. 2341 and 1 RV (Pl. 1, fig. 5), Stn. 6, B.O.C. 2342.

Other specimens – More than 30 valves from different samples.

Type-level – Biozone M Pl 5.

Diagnosis – A species of *Bairdoppilata* characterized by the particularly convex dorsal margin in the left valve, low L/H ratio (1.3-1.5), the presence in well preserved specimens of long antero-ventral and posterior spines. The posterior extremity is blunt below mid-height. Valve surface finely punctate.

Description – Left valves triangular in lateral view with particularly convex dorsal margin which at mid length forms an evident angle. It slopes abruptly toward the anterior and posterior extremities with feebly arched margins. Ventral margin straight with numerous antero-ventral and postero-ventral relatively long spines (Pl. 1, figs. 3, 5, 6). Caudal process stocky, very low and postero-ventral extremity feebly upturning. The posterior extremity shows a clear angle with the postero-dorsal. Carapaces short in lateral view (L/H ratio 1.3 - 1.5). In dorsal view carapace particularly inflated at about mid-length (Pl. 1, fig. 4). Right valves relatively longer with posterior extremity less truncated, more rounded, and with central part of the dorsal margin straight and almost parallel to the ventral one, slightly converging toward the posterior (Pl. 1, fig. 5).

Size (mm) – Holotype (LV): l = 1.33; h = 0.92.

Affinities – This species is very similar to *Bairdia creba* Deltel, 1963 in the lateral view of the right valve (Deltel, 1963; Pl. 1, fig. 15b) but differs in its more inflated carapace in dorsal view (Deltel, 1963; Pl. 1, fig. 15a), the different shape of the left valve in lateral view, that in the former has a more ventral posterior extremity and is more elongate (Deltel, 1963; Pl. 1, fig. 17, holotype).

EXPLANATION OF PLATE 1

Fig. 1 - *Polycopse vasfiensis* Sissingh, 1972, RV from CC in lateral view, Stn. 40, B.O.C. 2338, (x 138).

Fig. 2 - *Bairdoppilata conformis* (Terquem, 1878) RV, Stn. 80, B.O.C. 2339, (x 51).

Figs. 3-6 - *Bairdoppilata profunda* sp. nov. 3) Holotype, LV, Stn. 23, B.O.C. 2340, (x 45); 4) Hypotype, CC in dorsal view, Stn. 9, B.O.C. 2341, (x 49); 5) Hypotype, RV, Stn. 6, B.O.C. 2342, (x 56); 6) Paratype, RV, detail of the marginal denticulation, B.O.C. 2343, (x 151).

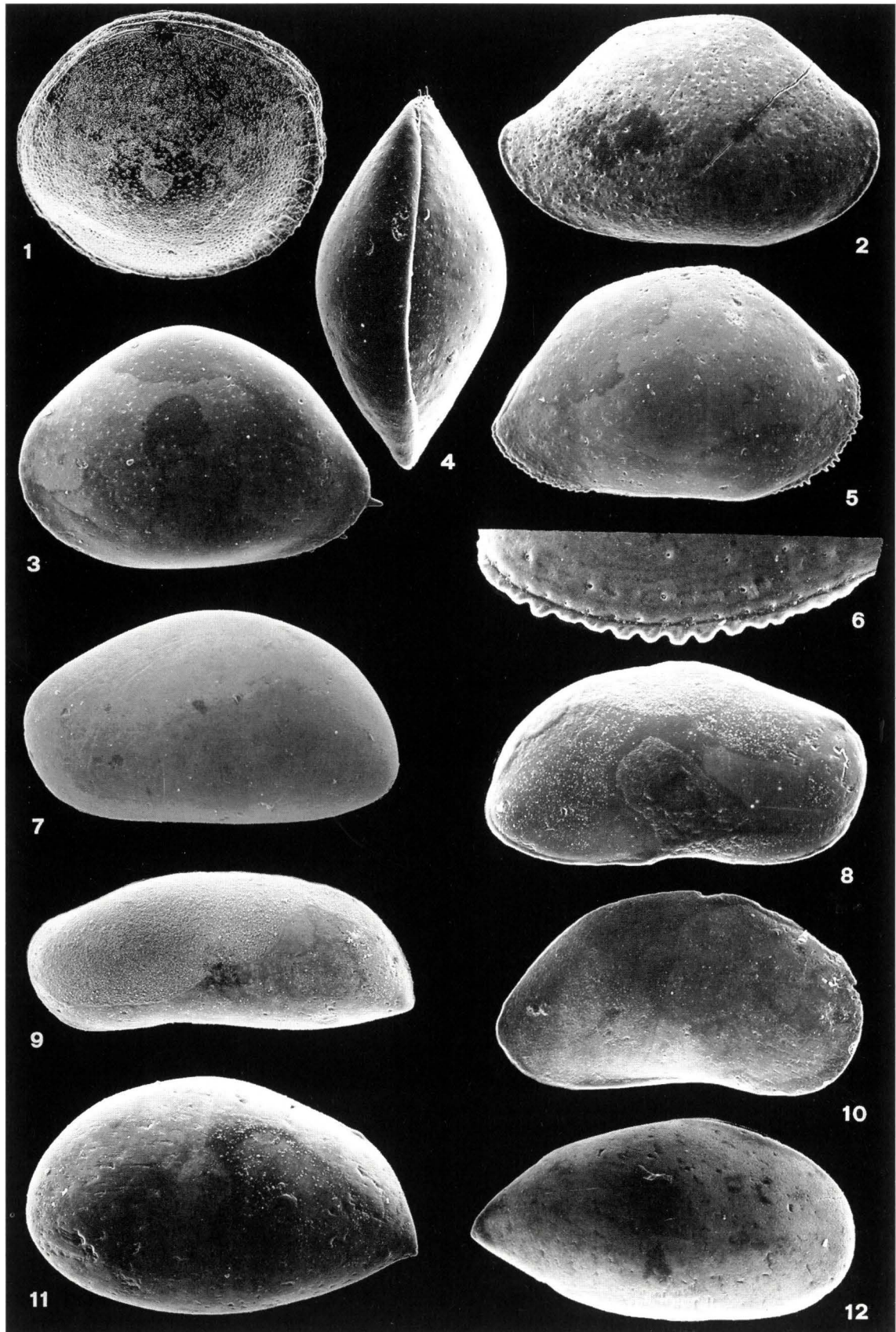
Figs. 7-8 - *Bythocypris obtusata producta* (Seguenza, 1880). 7) LV, Stn. 57, B.O.C. 2344, (x 53); 8) RV, Stn. 53, B.O.C. 2345, (x 69).

Fig. 9 - *Macromckenziea ligustica* (Bonaduce, Masoli & Pugliese, 1977), LV, Stn. 77, B.O.C. 2346, (x 53).

Fig. 10 - *Bythocypris bosquetiana* (Brady, 1866), RV, Stn. 16, B.O.C. 2347, (x 51).

Figs. 11-12 - *Cardobairdia? asymmetrica* (van den Bold, 1946). 11) LV, Stn. 46, B.O.C. 2348, (x 127); 12) RV, Stn. 46, B.O.C. 2349, (x 127).

RV = right valve; LV = left valve; CC = complete carapace.



Distribution – It occurs from the base of the section (Biozone M Pl 3) to the top part of Biozone M Pl 5.

Russo (1966): Langhian of Pescale (Emilia).

Ciampo (1981): Langhian of Monte Cammarata (Sicily, Italy).

Ducasse *et al.* (1985): Southern Aquitanian Basin (France), Middle Eocene, in deep-water assemblages.

Barra *et al.* (1998): Punta di Maiata (Sicily), from Biozone M Pl 2 to M Pl 3.

Bonaduce (unpublished data): Morocco, Tortonian.

Subfamily BYTHOCYPRIDINAE Maddocks, 1969
Genus BYTHOCYPRIS Brady, 1880

BYTHOCYPRIS BOSQUETIANA (Brady, 1866)
Pl. 1, fig. 10; Pl. 6, fig. 2

- 1866 *Bairdia bosquetiana* BRADY, p. 364, pl. 57, fig. 5.
- 1894 *Bythocypris bosquetiana* (Brady) - MÜLLER, p. 275, pl. 13, fig. 38; pl. 14, figs. 16-18, 20, 31; pl. 15, figs. 13-17, 26, 27, 34.
- 1923 *Bythocypris bosquetiana* (Brady) - SARS, pp. 64-65, pl. 29.
- 1969 *Bythocypris bosquetiana* (Brady) - PURI & DICKAU, p. 2, fig. 7.
- 1972 *Bythocypris bosquetiana* (Brady) - SISSINGH, p. 78, pl. 3, fig. 7.
- 1976b *Bythocypris bosquetiana* (Brady) - BREMAN, p. 47, pl. 2, fig. 12.
- 1980 *Bythocypris lucida* (Seguenza, 1880) - COLALONGO & PASINI, p. 52, pl. 2, figs. 7, 8.
- 1988 *Bythocypris lucida* (Seguenza) - VAN HARTEN & DROSTE, pl. 1, figs. 9-10.
- 1996 *Bythocypris bosquetiana* (Brady) - COLES *et al.*, p. 150, pl. 1, figs. 5-6.

Distribution – It occurs rather commonly in Biozones M Pl 3 and M Pl 4 and becomes rare in Biozone M Pl 5, where it disappears.

Brady (1866): Atlantic Ocean, Recent.

Müller (1894): Gulf of Naples (Mediterranean Sea), calcareous algae, Recent.

Sars (1923): Norway Sea (Atlantic Ocean), 230 m, Recent.

Puri & Dickau (1969): Mediterranean Sea between 150 and 3381 m, Recent.

Sissingh (1972): Adriatic Sea (Mediterranean Sea), 929 m, Recent; Crete (Greece), Upper Miocene-Pliocene.

Breman (1976b): Adriatic basin, Pleistocene (reworked in Recent sediments).

Colalongo & Pasini (1980): Vrica Section (Calabria, Italy), Upper Pliocene - Lower Pleistocene.

Van Harten & Droste (1988): Libyan Sea (Mediterranean), between 500 and 1500 m, Holocene - Recent; Balearic Sea (Mediterranean), about 200 m, Recent; Ligurian Sea (Mediterranean), about 150 m, Recent.

Coles *et al.* (1996): Porcupine Basin, Eastern Atlantic, Quaternary, 750 m.

Barra *et al.* (1998): Punta di Maiata (Sicily), from Biozone M Pl 1 to M Pl 3.

BYTHOCYPRIS OBTUSATA (Sars, 1866) PRODUCTA
(Seguenza, 1880)

Pl. 1, figs. 7-8; Pl. 6, fig. 4

- 1880 *Bairdia obtusata* SEGUENZA, pp. 191, 288, 324.
- 1880 *Bairdia obtusata* var. *angulosa* SEGUENZA, p. 224, pl. 17, fig. 21.
- 1880 *Bairdia obtusata* var. *producta* SEGUENZA, pp. 191, 288.
- 1965 *Bythocypris lucida* (Seguenza 1880) - DIECI & RUSSO, p. 56, pl. 14, fig. 7.
- 1966 *Bythocypris obtusata* (Sars 1866) - COLALONGO, p. 88, pl. 10, figs. 4-5.
- 1969 *Bythocypris* gr. *compressa* Brady 1880 - CARBONNEL, p. 22, pl. 11, fig. 19.
- 1969 *Bythocypris lucida* (Seguenza) - RUSSO, pp. 14-15, pl. 7, figs. 6a-c.
- 1972 *Bythocypris lucida* (Seguenza) - SISSINGH, p. 78, pl. 3, fig. 89.
- 1978 *Bythocypris lucida* (Seguenza) - BRESTENSKA & JIRICEK, pl. 2, figs. 1-2.
- 1980 *Bythocypris obtusata* (Sars) - COLALONGO & PASINI, p. 52, pl. 2, figs. 9-10.
- 1981 *Bythocypris obtusata* (Sars) - TSAPRALIS, p. 83, pl. 4, figs. 1-3.
- 1982 *Bythocypris lucida* (Seguenza) - CARBONNEL, pp. 24-25, pl. 4, figs. 20-21.
- 1985 *Bythocypris lucida* (Seguenza) - BONADUCE & RUSSO, p. 428, pl. 1, fig. 6.
- 1989 *Bythocypris obtusata* (Sars) - MOSTAFAWI, p. 125, pl. 1, fig. 9.
- 1991 *Bythocypris lucida* (Seguenza) - JIRICEK & RIHA, pl. 2, fig. 4.
- 1991 *Bythocypris producta* (Seguenza) - RUGGIERI, pp. 56, 58, figs. 1-2.

Remarks – The variety of Seguenza (1880) *B. obtusata* var. *producta* elevated by Ruggieri (1991) to species level, does not seem to us sufficiently different from the main species to be accepted at specific rank.

Distribution – Common throughout the section.

Dieci & Russo (1965): Tortona (Piedmont, Italy, and Montegibbio (Emilia, Italy), Tortonian.

Colalongo (1966): Le Castella (Calabria, Italy), Upper Pliocene - Lower Pleistocene.

Carbonnel (1969): Bassin de Valence (France), Pliocene.

Russo (1969): Montebarezzone (Emilia), Tortonian.

Sissingh (1972): Crete (Greece), Tortonian and Pliocene.

Brestenska & Jiricek (1978): Borac (Moravia), Lower Badenian.

Colalongo & Pasini (1980): Vrica Section (Calabria), Upper Pliocene-Lower Pleistocene.

Tsapralis (1981): Zakynthos (Greece), Pleistocene.

Carbonnel (1982): South-eastern France, Lower Pliocene.

Bonaduce & Russo (1985): Sardinia (Italy), Miocene (NN2 - NN4).

Mostafawi (1989): Rhodos (Greece), Lower Pleistocene.

Jiricek & Riha (1991): Borehole Ceska HV 208 (CSSR), Lower Badenian.

Ruggieri (1991): Sicily (Italy), Pliocene.
Barra *et al.* (1998): Punta di Maiata (Sicily), Biozone M Pl 3.

Subfamily PUSSELLINAE Danielopol, 1976
Genus ANCHISTROCHELES Brady & Norman, 1889

ANCHISTROCHELES INTERRUPTA Aiello, Barra &
Bonaduce, 1996

- 1996b *Anchistrocheles interrupta* AIELLO, BARRA & BONADUCE, pp. 272-274, text-figs. 1a-e 2 A-C (and synonymy).
1996 *Bythocypris tenera* Breman, 1975 - COLES *et al.*, p. 150, pl. 1, figs. 7-8.

Remarks and Distribution – As amply discussed in Aiello *et al.* (1996b), this species has been attributed to the genus *Anchistrocheles* instead than to *Bythocypris*. This species occurs from the base of the section to the early Pleistocene. It, also cited from the Quaternary Eastern Atlantic in the Porcupine Basin at a depth of 700 – 800 m (Coles *et al.*, 1996), seems to indicate a cold, relatively deep environment both in the Mediterranean (Aiello *et al.*, 1996b) and the Atlantic.

Superfamily CYPRIDACEA Baird, 1845
Family MACROCYPRIDIDAE G.W. Müller, 1912
Genus MACROCYPRIS Brady, 1868

MACROCYPRIS ? NIMIA Maddocks, 1990
Pl. 2, figs. 1-2

- 1985 *Macrocypris* sp. 1 BONADUCE & SPROVIERI, p. 134, pl. 2, fig. 5.
? 1990 *Macrocypris nimia* MADDOCKS, p. 47, figs. 2.4, 3.4, 48.5, 49.5; pls. 2.6, 3.6.

Remarks – The nominate species, which occurs in the Recent of the North Atlantic (depth range 1491 to 1500 m) differs from our specimens chiefly in its larger size > 3 mm as compared to 2 mm for the LV figured in Pl. 2, fig. 1; it is here only tentatively included.

Distribution – Ranging from the base of the section to the lower part of Biozone M Pl 5.

Genus MACROMCKENZIEA Maddocks, 1990

MACROMCKENZIEA LIGUSTICA (Bonaduce, Masoli &
Pugliese, 1977)
Pl. 1, fig. 9

- 1977 *Macrocypris ligustica* BONADUCE, MASOLI & PUGLIESE, pp. 245-246, pl. 1, figs. 1-3, text-fig. 3.
1980 *Macrocypris ligustica* Bonaduce *et al.* - COLALONGO & PASINI, p. 62, pl. 23, figs. 6-9.
1985 *Macrocypris ligustica* Bonaduce *et al.* - BONADUCE & SPROVIERI, p. 134, pl. 2, fig. 7.
1990 *Macromckenziea ligustica* (Bonaduce *et al.*) - MADDOCKS,

pp. 53-54, pl. 6, figs. 11-12; pl. 7, figs. 11-12; pl. 78, figs. 19-20.

Remarks – The form *Macromckenziea* sp. aff. *porcelanica* (Whatley & Downing, 1984) figured by Yassini & Jones (1995; p. 311, figs. 114, 116, 118, 120, 122) from the Recent of Southern Australia is very similar to *M. ligustica* but differs in its higher and more abruptly truncated posterior extremity.

Distribution – It occurs only from Biozone M Pl 6 upwards.

Bonaduce *et al.* (1977): Northern Tyrrhenian Sea (Mediterranean), Recent, below 77 m.
Colalongo & Pasini (1980): Vrica Section (Calabria, Italy), Lower Pleistocene.
Bonaduce & Sprovieri (1985): M. San Nicola (Sicily, Italy), Upper Pliocene-Early Pleistocene.
Maddocks (1990): Bay of Naples (Mediterranean), 95 - 340 m, Recent.

Genus MACROCYPRISSA Triebel, 1960

MACROCYPRISSA ARCUATA (Colalongo & Pasini, 1980)

- 1979 *Macrocypris* (?) n. sp. 2 MADDOCKS, pl. 1, figs. 6-10.
1980 *Paramacrocypris arcuata* COLALONGO & PASINI, p. 106, pl. 25, figs. 1-8.
1990 *Macrocyprissa arcuata* (Colalongo & Pasini) - MADDOCKS, pp. 85-86, pl. 30, figs. 7-10; pl. 31, figs. 7-11; pl. 67, figs. 8, 9; pl. 68, figs. 6-14; pl. 69, fig. 1; pl. 70, figs. 1-4; pl. 80, fig. 7; pl. 91, figs. 10-14; pl. 104, figs. 1-5; pl. 111, fig. 6; text-figs. 12.17-18; 13.17-18; 21.24; 23.24; 24.34; 28.29-30; 29.9; 35.19; 44.5; 47.6-7; 50.15-19, 51.9-13; 56.10, 24, 27; 57.11, 32; 58.18; 59.26, 33; 60.4; 63.3, 17; 64.23, 40, 51; 68.5; 72.1-3; 76.3; 78.9-10.
1996 *Macrocyprissa arcuata* (Colalongo & Pasini) - COLES *et al.*, pl. 1, figs. 10-11.

Distribution – Always very rare, the species occurs in scattered Pliocene samples.

Colalongo & Pasini (1980): Vrica (Calabria, Italy), Pleistocene.
Maddocks (1979; 1990): Northeastern Atlantic Ocean, Recent, 1491-1500 m.
Coles *et al.* (1996): Porcupine Basin, Eastern Atlantic, Quaternary, 700-750 m.

Genus MACROSARISA Maddocks, 1990

"MACROSARISA" sp.1
Pl. 2, fig. 4

Remarks – This species shows some similarity in outline with some species of *Macrosarisa* Maddocks (1990) such as *Macrosarisa simplex* (Chapman, 1898; *vide* Maddocks, 1990), but is probably an undescribed genus of Macrocyprididae. The scarce and badly preserved material at our disposal does not allow the description of either a new genus or new species.

This species anyway shows a very elongate valve in lateral view with anterior extremity obtusely rounded and posterior subacuminate. The dorsal margin is slightly arched and the ventral one almost straight.

Distribution – Confined to the basal sample.

Family PONTOCYPRIDIDAE G.W. Müller, 1894
Genus PONTOCYPRIA G.W. Müller, 1894

PONTOCYPRIA aff. *P. SPINOSA* G.W. Müller, 1894
Pl. 2, figs. 7-8

Remarks – This species differs from *P. spinosa* G.W. Müller, 1894 as its maximum height being located more anteriorly and the anterior margin being more acutely rounded. The scarceness of material at our disposal did not allow a more detailed study of this taxon, which is probably new.

Distribution – Represented by few valves in scattered Pliocene samples.

Genus PONTOCYPRIS Sars, 1866

PONTOCYPRIS aff. *P. ACUTA* Bonaduce, Ciampo & Masoli, 1976
Pl. 2, fig. 6

Remarks – This species differs from *P. acuminata* G.W. Müller, 1894 due to the absence of the anterodorsal angle and to the posterior extremity being more acuminate. It differs from *P. acuta* Bonaduce, Ciampo & Masoli, 1976 in its regularly arched dorsal margin.

Distribution – It occurs, always very rare, in some samples in Biozones M Pl 4 and M Pl 5.

Genus PROPONTOCYPRIS Sylvester-Bradley, 1947

PROPONTOCYPRIS DROMAS sp. nov.
Pl. 2, fig. 5; Text-fig. 2 a-d

? 1978 *Propontocypris* sp. ROSENFELD & BEIN, pl. 1, fig. 12.

Etymology – From Greek δρομας = racer.

Holotype – A LV (Pl. 2, fig. 5), Stn. 1, B.O.C. 2354.

Hypotypes – 1 LV (Text-fig. 2a), Stn. 11, B.O.C. 2383 and 1 complete carapace (Text-fig. 2b), Stn. 11, B.O.C. 2384.

Other specimens – 1 LV instar (Text-fig. 2c), Stn. 11, B.O.C. 2385; 1 RV instar (Text-fig. 2d), Stn. 11, B.O.C. 2386; 1 LV, Stn. 12; 1 RV, Stn. 14.

Type-level – Biozone M Pl 3.

Diagnosis – A species of *Propontocypris* characterized by its triangular shape in lateral view, its obtusely rounded anterior margin, concave antero-dorsal slope, strongly umbonate dorsal margin, very long slightly concave postero-dorsal slope, narrowly rounded subventral posterior apex and straight ventral margin.

Description – A relatively small species of *Propontocypris* characterized by a triangular shape in lateral view. Anterior margin regularly rounded, posterior extremity acutely rounded, ventral straight, dorsal margin strongly umbonate and laterally protruding, antero-dorsal clearly concave and postero-dorsal feebly convex near the apex and feebly concave posteriorly (Pl. 2, fig. 5; Text-figs. 2a-b). Right valve strongly overlapping the left valve. Surface of the valves completely smooth. The instars show the same characters of the adults (Text-figs. 2c-d).

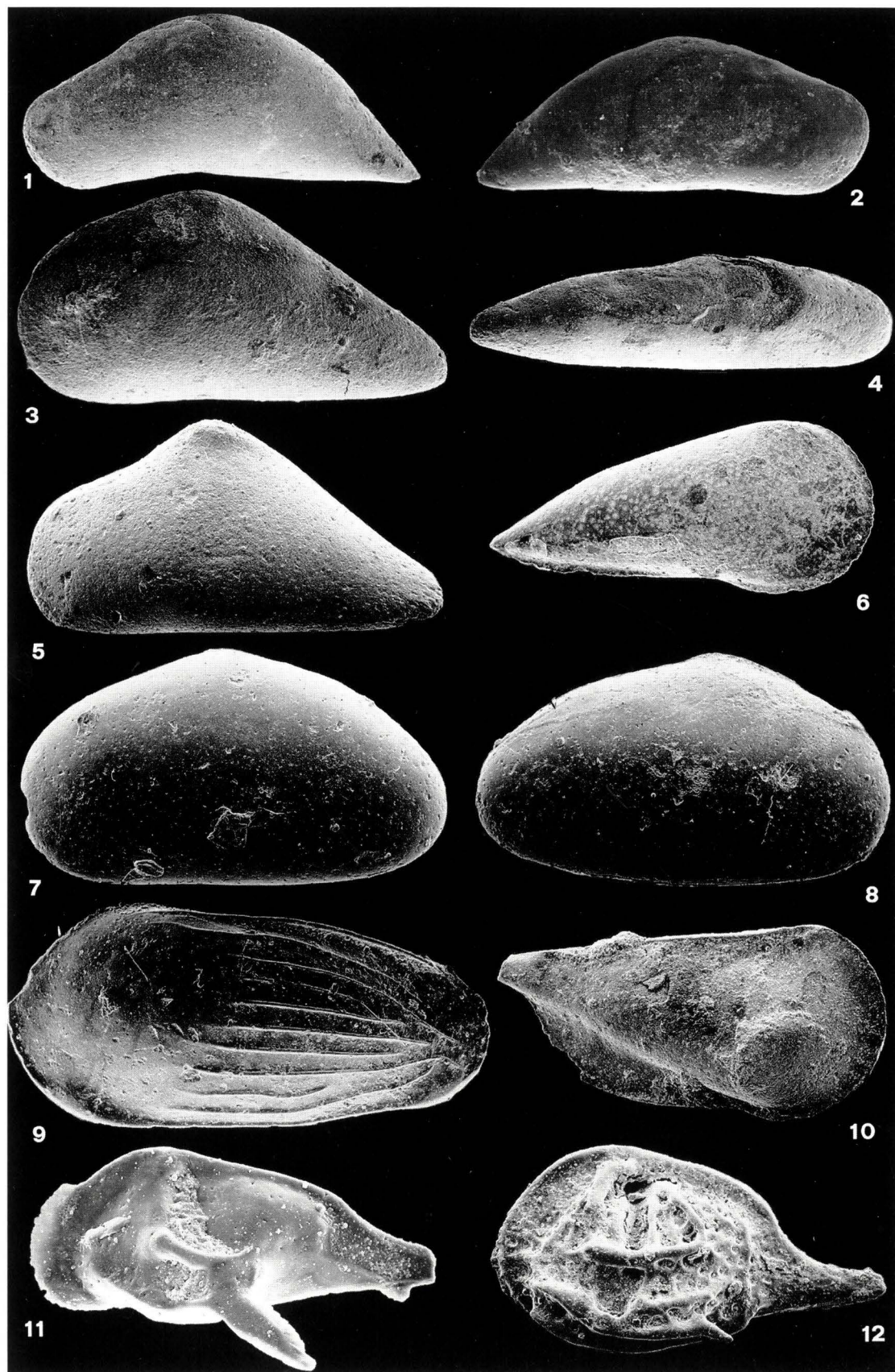
Size (mm) – Holotype (LV): l = 0.68; h = 0.35.

Affinities – This species can be compared with *Propontocypris* sp. Rosenfeld & Bein (1978), which shows the same type of dorsal shape but slightly differs in the outline.

Distribution – Present in Biozones M Pl 3 and M Pl 4, always very rare.

EXPLANATION OF PLATE 2

- Figs. 1-2 – *Macrocypris* ? *nimia* Maddocks, 1990. 1) LV, Stn. 3, B.O.C. 2350, (x 30); 2) RV, instar, Stn. 5, B.O.C. 2351, (x 36).
Fig. 3 – *Propontocypris* sp. 1, LV, Stn. 1, B.O.C. 2352, (x 119).
Fig. 4 – “*Macrosarisa*” sp. 1, RV, Stn. 1, B.O.C. 2353, (x 60).
Fig. 5 – *Propontocypris dromas* sp. nov., Holotype, LV, Stn. 1, B.O.C. 2354, (x 100).
Fig. 6 – *Pontocypris* aff. *P. acuta* Bonaduce, Ciampo & Masoli, 1976, RV from CC in lateral view, Stn. 38, B.O.C. 2355, (x 124).
Figs. 7-8 – *Pontocypris* aff. *P. spinosa* G.W. Müller, 1894. 7) LV, Stn. 32, B.O.C. 2356, (x 189); 8) RV, Stn. 20, B.O.C. 2357, (x 189).
Fig. 9 – *Ruggeriella decemcostata* Colalongo & Pasini, 1980, LV, Stn. 72, B.O.C. 2358, (x 214).
Fig. 10 – *Pseudocythere (Dopseucythere) mediterranea* Bonaduce, Masoli, Pugliese & Mc Kenzie, 1980, RV, Stn. 6, B.O.C. 2359, (x 109).
Fig. 11 – *Paijenborchella iocosa* Kingma, 1948, LV, Stn. 21, B.O.C. 2360, (x 138).
Fig. 12 – *Paijenborchella malaiensis cymbula* Ruggieri, 1950, LV, Stn. 35, B.O.C. 2361, (x 125).





Text-fig. 2 - *Propontocypris dromas* sp. nov., Hypotypes, Stn. 11.

a) LV, B.O.C. 2383, (x 79); b) RV from complete carapace, B.O.C. 2384, (x 69); c) LV instar, B.O.C. 2385, (x 79); d) RV instar, B.O.C. 2386, (x 79).

Propontocypris sp. of Rosenfeld & Bein (1978) has been found along the northwestern African coast (470-660 m depth) in Recent sediments. The main species has been found in Moroccan Mio-Pliocene sections near Rabat (Bonaduce, unpublished data).

PROPONTOCYPRIS sp. 1
Pl. 2, fig. 3

Distribution – It occurs from the base of the section to the first part of Biozone M Pl 5.

Superfamily CYTHERACEA Baird, 1850
Family BYTHOCYTHERIDAE Sars, 1866
Genus PROFUNDOBYTHERE Coles & Whatley, 1989

PROFUNDOBYTHERE sp. 1
Pl. 3, fig. 5; Pl. 6, fig. 7

Remarks and Distribution – This species has been found, always rarely, in a few samples from Biozone M Pl 3 to M Pl 5. Although probably new, the material at our disposal is insufficient to erect a new species.

Subfamily BYTHOCYTHERINAE Sars, 1866
Genus RETIBYTHERE Schornikov, 1981
Subgenus BATHYBYTHERE Schornikov, 1987

RETIBYTHERE (BATHYBYTHERE) SCABERRIMA (Brady, 1886) MEDITERRANEA (Colalongo & Pasini, 1980)

1966 *Bythoceratina vandenboldi* Ruggieri, 1960 - COLALONGO, p. 133, pl. 12, fig. 8.

- 1971 *Bythoceratina scaberrima* ? (Brady, 1887) - BENSON & SYLVESTER-BRADLEY, pl. 1, fig. 7.
1972 *Bythoceratina vandenboldi* Ruggieri - CIAMPO, pl. 6, fig. 4.
1972b *Bythoceratina scaberrima* (Brady) - BENSON, fig. 3.3.
1973 *Bythoceratina scaberrima* (Brady) - BENSON, fig. 2.B.
1974 *Bythoceratina vandenboldi* Ruggieri - BENSON & RUGGIERI, fig. 1c.
1980 *Bythoceratina scaberrima mediterranea* COLALONGO & PASINI, pp. 72, 74, pl. 1, fig. 9; pl. 4, figs. 9-10.
1987 *Retibythere (Bathybythere) scaberrima mediterranea* Colalongo & Pasini - SCHORNIKOV, p. 1003.

Distribution – It ranges from Biozone M Pl 5 to the early Pleistocene.

Colalongo (1966); Benson (1972b); Benson & Sylvester Bradley (1971): Le Castella (Calabria, Italy), early Pleistocene.
Ciampo (1972): Mar Piccolo (Apulia, Italy), early Pleistocene.
Benson (1973): DSDP Site 132, Western Mediterranean, Pleistocene.
Colalongo & Pasini (1980): Vrica Section (Calabria), Upper Pliocene - Lower Pleistocene.

Subfamily KEIJCYTHERINAE Kozur, 1985
Genus RUGGERIELLA Colalongo & Pasini, 1980

RUGGERIELLA DECEMCOSTATA Colalongo & Pasini, 1980
Pl. 2, fig. 9

- 1980 *Ruggieriella decemcostata* COLALONGO & PASINI, pp. 110, 112, pl. 32, figs. 3-6.
1983 *Ruggieriella ? decemcostata* Colalongo & Pasini - BONADUCE *et al.*, pl. 2, figs. 10-11.

Remarks – A degree of intraspecific variability is expressed in that the typical 10 longitudinal costae may or may not be joined posteriorly.

Distribution – It occurs only in two early Pleistocene samples; very rare.

Colalongo & Pasini (1980): Vrica Section, Calabria (Italy), early Pleistocene.

Bonaduce *et al.* (1983): Atlantic, 1245 m, Recent; Western Mediterranean, 2613 m, Recent.

Aiello (1998): Calabria (Italy), Tortonian.

Subfamily PSEUDOCYTHERINAE Schneider, 1960

Genus PSEUDOCYTHERE Sars, 1866

Subgenus DOPSEUCYTHERE Malz & Jellinek, 1994

PSEUDOCYTHERE (DOPSEUCYTHERE) MEDITERRANEA

Bonaduce, Masoli, Pugliese & McKenzie, 1980

Pl. 2, fig. 10

1894 *Pseudocythere caudata* Sars, 1866 - G.W. MÜLLER, p. 284, pl. 16, figs. 5, 10, 30-36.

1976b *Pseudocythere caudata* Sars - BREMAN, pl. 4, fig. 42.

1980 *Pseudocythere caudata mediterranea* BONADUCE *et al.*, pp. 136-138, pl. 1, fig. 1; pl. 2, figs. 1-2, 6.

1994 *Dopseucythere mediterranea* Bonaduce *et al.* - MALZ & JELLINEK, pl. 5, figs. 1-2.

Remarks – Some valves (e.g., Pl. 2, fig. 10) seem to show characters intermediate between *P. (D.) mediterranea* and *P. (D.) kraspedon* (Malz & Jellinek, 1994). In fact the two species differ each other because of the different shape of the antero-dorsal margin which in *P. (D.) kraspedon* upturns more evidently than in *P. (D.) mediterranea* which shows a more rectilinear antero-dorsal margin.

We prefer to attribute our specimens to *P. (D.) mediterranea* suggesting that *P. (D.) kraspedon* can be only a morphotype of the former species.

Distribution – It has been found, always represented by few specimens, in some samples from Biozone M Pl 4 to the end of the section.

G.W. Müller (1894): Bay of Naples (Tyrrhenian Sea, Mediterranean), among calcareous algae.

Breman (1976b): Adriatic Sea (Mediterranean), 60-1207 m, Recent.

Bonaduce *et al.* (1980); Malz & Jellinek (1994): Bay of Naples (Mediterranean Sea), 30-700 m, Recent.

Barra *et al.* (1998): Punta di Maiata (Sicily), from Biozone M Pl 2 to M Pl 3.

Family CYTHERIDAE Baird, 1850

Subfamily CYTHERINAE Baird, 1850

Genus PAIJENBORCHELLA Kingma, 1948

PAIJENBORCHELLA IOCOSA Kingma, 1948

Pl. 2, fig. 11

1948 *Paijenborchella iocosa* KINGMA, pp. 86-87, pl. 5, fig. 2; pl. 8, fig. 12.

1966 *Paijenborchella iocosa* Kingma - KEIJ, pp. 347-348, pl. 1, figs. 1-16; pl. 2, figs. 4-10.

? 1978 *Paijenborchella (Paijenborchella) iocosa* Kingma - BRESTENKA & JIRICEK, pl. 9, fig. 5.

1985 *Paijenborchella solitaria* Ruggieri, 1962 - BONADUCE & SPROVIERI, pl. 1, fig. 6.

1991 *Paijenborchella (Paijenborchella) cf. iocosa* Kingma - AHMAD *et al.*, pp. 191-192, pl. 5, fig. 4.

Remarks – Keij (1966) illustrated forms which seem rather different each other; the present material resembles figures 13 and 14 of Pl. 1 of Keij. This form is reported by Keij as occurring in deep water (deeper than 500 m) and is the most slender with a high L/H ratio. Eventually, after more detailed investigations, it maybe necessary to create a new specific or subspecific taxon from this material.

Distribution – It occurs only in Biozones M Pl 4 and M Pl 5.

Keij (1966): South China Sea, deep water, Recent.

Bonaduce & Sprovieri (1985): M. San Nicola (Gela, Sicily), Biozones M Pl 4 - M Pl 5.

Ahmad *et al.* (1991): Mongo Stream (Lindi Area, Tanzania), Lower Miocene.

Aiello (1998): Calabria (Italy), Tortonian and early Pliocene.

Barra *et al.* (1998): Punta di Maiata (Sicily), from Biozone M Pl 1 to the base of Biozone M Pl 2.

PAIJENBORCHELLA MALAIENSIS Kingma, 1948

CYMBULA Ruggieri, 1950

Pl. 2, fig. 12

1950 *Paijenborchella cymbula* RUGGIERI, pp. 60-63, 2 text-figs.

1953 *Paijenborchella (Paijenborchella) malaiensis* Kingma, 1948 - RUGGIERI, pl. 2, fig. 14.

1955 *Paijenborchella malaiensis* Kingma - PUCCI, pl. 1, fig. 8.

1966 *Paijenborchella (Eopaijenborchella) malaiensis* Kingma - KEIJ, pl. 3, figs. 13-15.

1971 *Paijenborchella cymbula* Ruggieri - BENSON & SYLVESTER-BRADLEY, pl. 1, fig. 9.

1972 *Paijenborchella (Eopaijenborchella) malaiensis* Kingma - SISSINGH, p. 152, pl. 12, fig. 15.

1973 *Paijenborchella (Eopaijenborchella) malaiensis cymbula* Ruggieri - DORUK, pp. 161 - 164.

1978 *Paijenborchella* sp. BENSON, pl. 1, fig. 1.

1980 *Paijenborchella malaiensis cymbula* Ruggieri - COLALONGO & PASINI, p. 64, pl. 24, fig. 6.

1981 *Paijenborchella malaiensis* Kingma - TSAPRALIS, p. 85, pl. 17, figs. 1, 1a, 2, 2a.

? 1988 *Paijenborchella cymbula* Ruggieri - RUAN & HAO, p. 353, pl. 63, figs. 19-23.

1989 *Paijenborchella (Eopaijenborchella) cymbula* Ruggieri - MOSTAFAWI, p. 130, pl. 3, figs. 53-54.

Remarks – The form reported by Ruan & Hao (1988) as *P. cymbula* from the Quaternary of the

Okinawa Trough differs moderately from *P. cymbula* s.s. by the presence of two additional ribs posterocentrally. We consider this form a geographical variety or a new subspecies.

Distribution – It occurs from Biozone M Pl 3 to the end of the Pliocene and disappears at the top of the section.

Ruggieri (1950): Crotona (Calabria, Italy), Pliocene.
Pucci (1955): Valle del Tronto (Marche, Italy), Pleistocene.

Benson & Sylvester-Bradley (1971): Rimini (Italy), Plaisancian (Pliocene).

Sissingh (1972): Crete (Greece), Pliocene.

Doruk (1973): Cyprus (Greece), Pliocene.

Benson (1978): DSDP Leg 42 A, Site 376, Florence Rise (Mediterranean Basin), Piacenzian; DSDP Leg 42 A, Site 378, Aegean Basin (Mediterranean), Piacenzian.

Colalongo & Pasini (1980): Vrica Section (Calabria), Upper Pliocene - Lower Pleistocene.

Tsapralis (1981): Zakynthos (Greece), Pleistocene.

Mostafawi (1989): Rodhos (Greece), Lower Pleistocene.

Barra *et al.* (1998): Punta di Maiata (Sicily), from Biozones M Pl 2 to M Pl 3.

Family CYTHERURIDAE G.W. Müller, 1894
Subfamily CYTHERURINAE G.W. Müller, 1894
Genus PARAHemingwayella Dingle, 1984

PARAHemingwayella tetrapterum (Bonaduce,
Ciampo & Masoli, 1976)
Pl. 3, fig. 9

1976 ?*Cytheropteron tetrapterum* BONADUCE, CIAMPO & MASOLI, pp. 99-100, pl. 47, figs. 1-7.

1978 *Bythocythere* sp. BENSON, pl. 1, fig. 2.

1980 *Cytheropteron* ? *tetrapterum* Bonaduce, Ciampo & Masoli - CIAMPO, p. 19, pl. 3, fig. 5.

1980 *Tuberculoocythere tetrapterum* (Bonaduce, Ciampo & Masoli) - COLALONGO & PASINI, p. 68, pl. 34, fig. 2.

1981 "*Cytheropteron*" *tetrapterum* Bonaduce, Ciampo & Masoli - TSAPRALIS, p. 112, pl. 12, figs. 2-4.

1985 *Tuberculoocythere tetrapterum* (Bonaduce, Ciampo & Masoli) - BONADUCE & MASCELLARO, pl. 1, fig. 1.

1988 Gen. et sp. 3 RUAN & HAO, p. 389, pl. 45, fig. 22.

1989 Gen. 1 et sp. RUAN, p. 131, pl. 24, figs. 15-16.

1994 *Parahemingwayella tetrapterum* (Bonaduce, Ciampo & Masoli) - MALZ & JELLINEK, p. 28, pl. 7, figs. 37-40

Remarks – We do not agree with the opinion of Ayress *et al.* (1995) who suggest that *Parahemingwayella* Dingle (1984) is a junior synonym of *Eucytherura* G. W. Müller (1894). Apart from the absence of an eye-tubercle, *Parahemingwayella* shows an elongated subtriangular shape in lateral view, with posterior convergence of the dorsal and ventral margins, the presence of 2 well developed interiorly mirrored, carapace swellings, characters, which we evaluate sufficient to separate *Parahemingwayella* from *Eucytherura*, which is subrectangular, without subventral tubercles and also characterized by subhorizontal ridges, characters which do not occur in the former genus.

Distribution – It occurs only in sample 37, Biozone M Pl 5.

Bonaduce *et al.* (1976): Adriatic Sea (Mediterranean), Recent, below 117 m.

Benson (1978): Ionian Basin (Mediterranean), Pleistocene.

Ciampo (1980): Ragusa (Sicily, Italy), Upper Tortonian - Lower Messinian.

Colalongo & Pasini (1980): Vrica Section (Calabria, Italy), early Pleistocene.

Tsapralis (1981): Zakynthos (Western Greece), Pleistocene.

Bonaduce & Mascellaro (1985): Gulf of Taranto (Ionian Basin, Mediterranean), Upper Pleistocene.

Ruan & Hao (1988): Okinawa Trough, Quaternary.

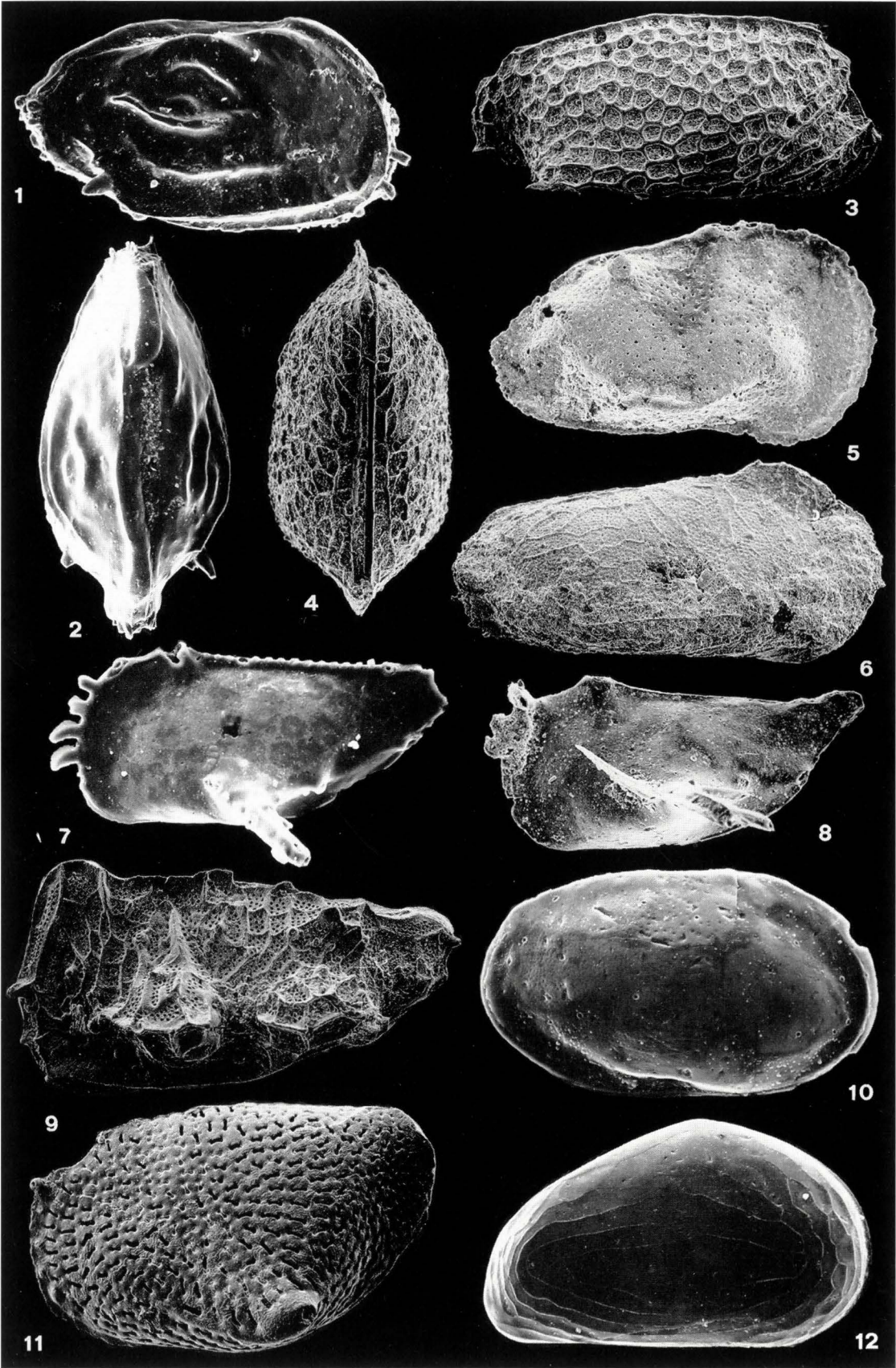
Ruan (1989): South China Sea, Quaternary.

Malz & Jellinek (1994): Ionian and Levantine Basins, Subrecent, from 984 to 2967 m.

Barra *et al.* (1998): Punta di Maiata (Sicily), from Biozone M Pl 2 to M Pl 3.

EXPLANATION OF PLATE 3

- Figs. 1-2 - *Ruggeria tetraptera palpebralis* Ruggieri, 1960. 1) RV from CC in lateral view, Stn. 20, B.O.C. 2362, (x 58); 2) CC in dorsal view, Stn. 46, B.O.C. 2363, (x 63).
Figs. 3-4 - *Xylocythere* ? *producta* 3) RV, Stn. 80, B.O.C. 2364, (x 166); 4) CC in dorsal view, Stn. 21, B.O.C. 2365, (x 189).
Fig. 5 - *Profundocythere* sp. 1, RV, Stn. 3, B.O.C. 2366, (x 187.5).
Fig. 6 - *Microceratina polygonia* (Colalongo & Pasini, 1980), RV, Stn. 1, B.O.C. 2367, (x 189).
Fig. 7 - *Pedicythere* ? *polita* Colalongo & Pasini, 1980, LV, Stn. 37, B.O.C. 2368, (x 164).
Fig. 8 - *Pedicythere phryne* Bonaduce, Ciampo & Masoli, 1976, LV, Stn. 38, B.O.C. 2369, (x 206).
Fig. 9 - *Parahemingwayella tetrapterum* (Bonaduce, Ciampo & Masoli, 1976), LV, Stn. 37, B.O.C. 2370, (x 250).
Fig. 10 - *Loxoconchidea minima* Bonaduce, Ciampo & Masoli, 1976, RV, Stn. 78, B.O.C. 2371, (x 179).
Fig. 11 - *Rimacytheropteron longipunctatum* (Bremner, 1976), RV, Stn. 71, B.O.C. 2372, (x 202).
Fig. 12 - *Eucythere pubera* Bonaduce, Ciampo & Masoli, 1976, RV, Stn. 58, B.O.C. 2373, (x 151).



Subfamily EUCYOTHERURINAE Puri, 1974
Genus TYPHLOEUCYOTHERURA Colalongo
& Pasini, 1980

TYPHLOEUCYOTHERURA CALABRA Colalongo
& Pasini, 1980

- 1980 *Typhloeucytherura calabra* COLALONGO & PASINI, p. 122, pl. 20, figs. 1-8, pl. 21, figs. 1-2.
1987 *Eucytherura calabra* (Colalongo & Pasini) – WHATLEY & COLES, pl. 3, figs. 14-16.
1988 *Eucytherura calabra* (Colalongo & Pasini) – WHATLEY & AYRESS, pl. 1, figs. 9a-b.
1995 *Eucytherura calabra* (Colalongo & Pasini) – AYRESS *et al.*, figs. 3a-d.
1996 *Eucytherura calabra* (Colalongo & Pasini) – COLES *et al.*, pl. 3, fig. 18.

Remarks – Ayress *et al.* (1995) consider *Typhloeucytherura* Colalongo & Pasini (1980) a synonym of *Eucytherura* G. W. Müller (1894) evaluating the absence of an eye tubercle in the former genus as insufficient grounds for separating the two taxa. This opinion is not accepted here because of the other numerous differences between the two genera pointed out by Maddocks & Steinek (1987) among which are different shape, absence in *Typhloeucytherura* of the subcentral muscle-scar tubercle and the absence of dorsal, posterolateral and ventrolateral ridges.

Ayress *et al.* (1987) doubtfully synonymize *Eucytherura ? hirsuta* Ciampo (1980) and *E. calabra*. Even if the identity of the two species could be demonstrated, now impossible on the basis of the literature, Colalongo & Pasini's species would become a junior synonym of Ciampo's species because the latter paper, even if published in the same year and accepted for publication in the same day, has been received for publication some months before.

Distribution – Found only in sample 21, Biozone M Pl 5.

Colalongo & Pasini (1980): Vrica Section (Calabria, Italy), Lower Pleistocene.
Whatley & Coles (1987); Whatley & Ayress (1988); Ayress *et al.* (1995): widespread in deep-sea sediments, late Oligocene to Quaternary.
Coles *et al.* (1996): Porcupine Basin, Eastern Atlantic, Quaternary, 700 m.
Barra *et al.* (1998): Punta di Maiata (Sicily), from Biozone M Pl 1 to M Pl 3.

Genus XYLOCY THERE Maddocks & Steinek, 1987

XYLOCY THERE ? PRODUCTA (Colalongo
& Pasini, 1980)
Pl. 3, figs. 3-4

- ?1980 "*Typhlocythere*" *producta* COLALONGO & PASINI, pp. 121-122, pl. 3, figs. 6-9.
1986 "*Typhlocythere*" *producta* Colalongo & Pasini - CIAMPO, pl. 9, fig. 11; pl. 10, fig. 1.

1987 *Xylocythere producta* (Colalongo & Pasini) - MADDOCKS & STEINECK, p. 323.

Remarks – The form found by us corresponds perfectly to the Miocene material figured by Ciampo (1986), while the RV figured by Colalongo & Pasini (1980) from the Calabrian Pleistocene is more elongate and has smaller foveolae. More material is needed to verify the intraspecific variability.

Distribution – Found only in two samples of Biozone M Pl 5.

Ciampo (1986): Piedmont (Italy), Upper Tortonian-Lower Messinian; Falconara (Sicily, Italy), Upper Tortonian; Cropalati (Calabria, Italy), Upper Tortonian.

Subfamily PEDICYTHERINAE Sissingh, 1975
Genus PEDICYTHERE Eagar, 1965

PEDICYTHERE PHRYNE Bonaduce, Ciampo
& Masoli, 1976
Pl. 3, fig. 8

- 1976 *Pedicythere phryne* BONADUCE, CIAMPO & MASOLI, pp. 86-88, pl. 58, figs. 1-9, text-figs. 33-34.
1976b *Pedicythere phryne* Bonaduce, Ciampo & Masoli - BREMAN, p. 73, pl. 10, fig. 148.
1985 *Pedicythere phryne* Bonaduce, Ciampo & Masoli - BONADUCE & MASCELLARO, pl. 1, fig. 8.
1988 *Pedicythere phryne* Bonaduce, Ciampo & Masoli - WHATLEY & AYRESS, pl. 2, figs. 5a - 5b.
1994 *Pedicythere phryne* Bonaduce, Ciampo & Masoli - MALZ & JELLINEK, p. 26, pl. 6, figs. 34-35.

Distribution – It occurs only in sample 38.

Bonaduce *et al.* (1976): Adriatic Sea (Mediterranean), Recent, below 133 m.
Bremar (1976b): Adriatic Sea, Recent, 135 - 500 m.
Bonaduce & Mascellaro (1985): Ionian Basin (Mediterranean), late Pleistocene.
Whatley & Ayress (1988): North Atlantic, Indian Ocean and Pacific Ocean, Quaternary in deep sea sediments.
Malz & Jellinek (1994): Eastern Mediterranean, from 987 to 4617 m, Subrecent.
Aiello (1998): Vallone Salina (Calabria, Italy), Tortonian.

PEDICYTHERE ? POLITA Colalongo & Pasini, 1980
Pl. 3, fig. 7; Pl. 6, fig. 5

- ?1980 *Pedicythere polita* COLALONGO & PASINI, p. 108, pl. 24, figs. 7-10.

Remarks – One only badly preserved valve of this species has been found. Because of this a better defined identification has not been possible. The species, described from the Calabrian of the Vrica Section (Co-

lalongo & Pasini, 1980) has been also cited from the Quaternary of the Atlantic (Whatley & Coles, 1987).

Family CYTHERIDEIDAE Sars, 1925
Subfamily CYTHEROPTERINAE Hanai, 1957
Genus CYTHEROPTERON Sars, 1866

CYTHEROPTERON OMEGA Aiello, Barra & Bonaduce, 1996

- 1996a *Cytheropteron omega* AIELLO, BARRA & BONADUCE, p. 170, pl. 2, figs. 7-9 (and synonymy).
1996 *Cytheropteron garganicum* Bonaduce, Ciampo & Masoli 1976 - COLES *et al.*, pl. 2, fig. 12.

Distribution – The species, found in Monte San Nicola section from the base of Biozone MPI 4 to the top of Biozone MPI 5 and from the Upper Pliocene of the Atlantic (see in Aiello *et al.*, 1996a), has been recently figured as *Cytheropteron garganicum* by Coles *et al.* (1996) from the Quaternary of the Porcupine Basin (Eastern Atlantic).

Genus RIMACYTHEROPTERON Whatley & Coles, 1987

RIMACYTHEROPTERON LONGIPUNCTATUM (Bremán, 1976)
Pl. 3, fig. 11

- 1975 *Monoceratina*? sp. BREMAN, p. 216.
1976a *Monoceratina longipunctata* BREMAN, pp. 15-16, pl. 1, figs. 4a-b; pl. 2, figs. 4c-i.
1976 "*Pedicythere*" *tessellata* BONADUCE, CIAMPO & MASOLI, p. 88, pl. 36, figs. 12-15.
1976b *Monoceratina longipunctata* Bremán - BREMAN, p. 77, pl. 12, fig. 183.
1980 "*Pedicythere*" *tessellata* Bonaduce, Ciampo & Masoli - COLALONGO & PASINI, p. 66, pl. 26, fig. 3.
1981 "*Pedicythere*" *tessellata* Bonaduce, Ciampo & Masoli - TSAPRALIS, p. 111, pl. 11, figs. 1-2.
1985 "*Pedicythere*" *tessellata* Bonaduce, Ciampo & Masoli - BONADUCE & MASCELLARO, pl. 1, fig. 5.
1987 *Rimacytheropteron longipunctata* (Bremán) - WHATLEY & COLES, p. 70, pl. 3, figs. 12-13.
1988 Gen. nov. *A. longipunctata* (Bremán) - WHATLEY & AYRESS, pl. 1, figs. 10 a-c.
1989 Gen. 3 et sp. RUAN, p. 132, figs. 17-18.

Distribution – *R. longipunctatum* occurs only in two samples of early Pleistocene age.

- Bremán (1975; 1976a; 1976b); Bonaduce *et al.* (1976): Adriatic Sea (Mediterranean), subfossil and Recent, below 85 m.
Colalongo & Pasini (1980): Vrica Section (Calabria, Italy), Upper Pliocene-Lower Pleistocene; Marche (Italy) Pleistocene.
Tsapralis (1981): Zakynthos (Greece), Pleistocene.
Bonaduce & Mascellaro (1985): Gulf of Taranto (Ionian Basin, Mediterranean Sea), Upper Pleistocene-Holocene.
Whatley & Coles (1987); Whatley & Ayress (1988): Pliocene-Quaternary of the South-Western

Pacific; Quaternary of the Indo-Pacific and Atlantic.

Ruan (1989): South China Sea, Quaternary.

Family EUCYTHERIDAE Puri, 1954
Genus EUCYTHERE Brady, 1868

EUCYTHERE PUBERA Bonaduce, Ciampo & Masoli, 1976
Pl. 3, fig. 12

- 1976 *Eucythere pubera* BONADUCE, CIAMPO & MASOLI, pp. 64-65, pl. 37, figs. 1-8; text-fig. 28.
1980 *Eucythere pubera* Bonaduce *et al.* - COLALONGO & PASINI, p. 58, pl. 21, figs. 7-8.
1987 *Eucythere pubera* Bonaduce *et al.* - WHATLEY & COLES, pl. 4, fig. 15.
1988 *Eucythere parapubera* Whatley & Downing 1984 - WHATLEY & AYRESS, pl. 1, figs. 4a, b.

Remarks – The forms figured in the literature exhibit a certain degree of variability. Particularly, Colalongo & Pasini (1980) illustrate 2 LV notably elongate (? males), with the posterior margin more rounded (Pl. 21, fig. 7) or more markedly truncated (Pl. 21, fig. 8). In our opinion the forms attributed by Whatley & Ayress (1988) to *E. parapubera* Whatley & Downing, 1984 should be considered within the limits of the species variability.

Distribution – From mid Biozone M Pl 4 to mid M Pl 6; always very rare.

- Bonaduce *et al.* (1976): Bay of Naples and Adriatic Sea (Mediterranean), Recent.
Colalongo & Pasini (1980): Vrica Section (Calabria, Italy), Lower Pleistocene.
Whatley & Coles (1987): DSDP Leg 94, Sites 607 and 610 (Atlantic Ocean), Pliocene (NN 16).
Whatley & Ayress (1988): DSDP Sites 259/1/5 (Indian Ocean), Quaternary.
Barra *et al.* (1998): Punta di Maiata (Sicily), from Biozone M Pl 1 to M Pl 2.

Family LOXOCONCHIDAE Sars, 1925
Genus LOXOCONCHIDEA Bonaduce, Ciampo & Masoli, 1976

LOXOCONCHIDEA MINIMA Bonaduce, Ciampo & Masoli, 1976
Pl. 3, fig. 10

- 1976 *Loxoconchidea minima* BONADUCE, CIAMPO & MASOLI, pp. 112-113, pl. 59, figs. 1-7; text-fig. 43.
1985 *Loxoconchidea minima* Bonaduce *et al.* - BONADUCE & MASCELLARO, pl. 1, fig. 12.

Distribution – Found in only 2 samples of Biozone M Pl 5 and in the early Pleistocene.

Bonaduce *et al.* (1976): Adriatic Sea (Mediterranean)

below 56 m, Recent; Bay of Naples (Mediterranean Sea), Recent.

Bonaduce & Mascellaro (1985): Gulf of Taranto (Ionian Basin, Mediterranean Sea), late Pleistocene-Holocene.

Family TRACHYLEBERIDIDAE Sylvester-Bradley, 1948
Subfamily BRACHYCYTHERINAE Puri, 1954
Genus BOSQUETINA Keij, 1957

BOSQUETINA RHODIENSIS Sissingh, 1972
Pl. 5, fig. 6; Pl. 6, fig. 3

- 1966 *Bosquetina carinella* (Reuss, 1850) - COLALONGO, pp. 91-92, pl. 11, fig. 2.
1972 *Bosquetina rhodiensis* Sissingh, pp. 93-94, pl. 6, figs. 1-3.
1980 *Bosquetina rhodiensis* Sissingh - COLALONGO & PASINI, p. 52, pl. 2, figs. 1-4.
1989 *Bosquetina rhodiensis* Sissingh - MOSTAFAWI, p. 139, pl. 5, fig. 115.

Distribution – This species occurs from the uppermost part of Biozone M Pl 6 up to the top of the section.

Colalongo (1966): Le Castella (Calabria, Italy), Lower Pleistocene.
Sissingh (1972): Karpathos (Greece), Upper Pliocene, Rhodes (Greece), Lower Pleistocene.
Colalongo & Pasini (1980): Vrica Section (Calabria), Upper Pliocene - Lower Pleistocene.
Mostafawi (1989): Rhodes, Lower Pleistocene.

Subfamily BUNTONINAE Apostolescu, 1961
Genus BUNTONIA Howe, 1935

BUNTONIA DERTONENSIS Ruggieri, 1954
Pl. 4, figs. 1-3, 5

- 1954 *Buntonia sublatissima dertonensis* RUGGIERI, pp. 565, 568, figs. 25, 25a, 26, 32-33.
1965 *Buntonia sublatissima dertonensis* Ruggieri - DIECI & RUSSO, p. 75, pl. 12, fig. 12.
1972 *Buntonia (Buntonia) sublatissima dertonensis* Ruggieri - Sissingh, p. 95, pl. 6, fig. 6.
1980 *Buntonia dertonensis* Ruggieri - CIAMPO, p. 10, pl. 1, figs. 5-6.

1981 *Buntonia (Buntonia) sublatissima dertonensis* Ruggieri - UFFENORDE, p. 149, pl. 10, fig. 12.

1985 *Buntonia* aff. *B. dertonensis* Ruggieri - BONADUCE & SPROVIERI, pl. 2, fig. 3.

Remarks – There is some variability in the size of the foveolae.

Distribution – Relatively common from the base of the section to the top part of Biozone M Pl 5.

Ruggieri (1954): Rimini (Romagna, Italy), Tortonian.
Dieci & Russo (1965): Montegibbio (Emilia, Italy), Tortonian.

Sissingh (1972): Gavdos (Greece), mid-Upper Tortonian; Crete (Greece), Tortonian.

Ciampo (1980): Ragusa (Sicily, Italy), Tortonian.

Uffenorde (1981): Lower Elbe Region (NW Germany), Upper Miocene.

Bonaduce & Sprovieri (1985): Monte San Nicola, Biozones M Pl 4 - M Pl 5.

BUNTONIA OBESA Ciampo, 1986
Pl. 4, figs. 4, 13; Pl. 6, fig. 6

1986 *Buntonia obesa* CIAMPO, p. 52, pl. 6, fig. 3.

Distribution – Biozones M Pl 4 and M Pl 5 of M. San Nicola section.

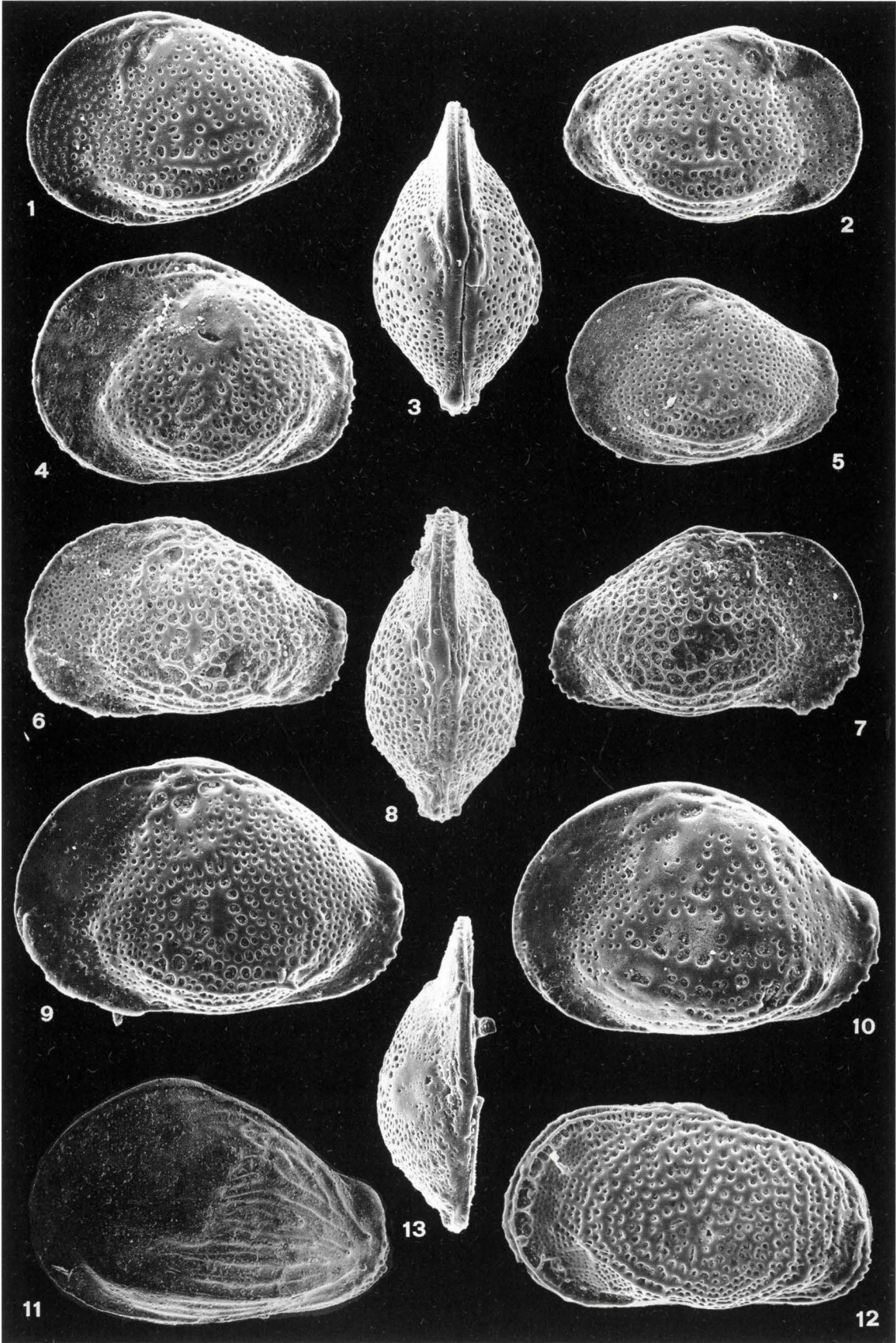
Ciampo (1986): Piedmont (Italy), Upper Tortonian - Lower Messinian.

BUNTONIA SUBLATISSIMA (Neviani, 1906)
Pl. 4, fig. 10

- 1906 *Cythere sublatissima* NEVIANI, p. 198, fig. 8.
1954 *Buntonia sublatissima* (Neviani) - RUGGIERI, pp. 564-565, figs. 22, 24, 27, 29, 31.
1964 *Buntonia sublatissima* (Neviani) - PURI *et al.*, fig. 23.
1972 *Buntonia sublatissima sublatissima* (Neviani) - Sissingh, p. 95, pl. 6, fig. 7.
1976 *Buntonia sublatissima* (Neviani) - BONADUCE *et al.*, p. 55, pl. 33, figs. 6, 11.
1976b *Buntonia sublatissima* (Neviani) - BREMAN, p. 61, pl. 8, fig. 117.
1979 *Buntonia sublatissima* (Neviani) - YASSINI, p. 381, pl. 4, figs. 13-14.

EXPLANATION OF PLATE 4

- Figs. 1-3, 5 - *Buntonia dertonensis* Ruggieri, 1954. 1) LV, Stn. 32, B.O.C. 2374, (x 127); 2) RV, Stn. 32, B.O.C. 2375, (x 127); 3) CC in dorsal view, Stn. 32, B.O.C. 2376, (x 127); 5) LV, Stn. 21, B.O.C. 2377, (x 116).
Figs. 4, 13 - *Buntonia obesa* Ciampo, 1986. 4) LV, Stn. 38, B.O.C. 2378, (x 127); 13) LV in dorsal view, Stn. 38, B.O.C. 2379, (x 127).
Figs. 6-9 - *Buntonia textilis* Bonaduce, Ciampo & Masoli, 1976. 6) LV, Stn. 21, B.O.C. 2380, (x 116); 7) RV, Stn. 21, B.O.C. 2381, (x 116); 8) CC in dorsal view, Stn. 21, B.O.C. 2382, (x 116); 9) LV, Stn. 77, B.O.C. 2383, (x 127).
Fig. 10 - *Buntonia sublatissima* (Neviani, 1906), LV, Stn. 25, B.O.C. 2384, (x 127).
Fig. 11 - *Quasibuntonia radiatopora radiatopora* (Seguenza, 1880), LV, Stn. 9, B.O.C. 2385, (x 74).
Fig. 12 - *Rectobuntonia inflata* (Colalongo & Pasini, 1980), LV, Stn. 35, B.O.C. 2386, (x 127).



- 1980 *Buntonia sublatissima* (Neviani) - YASSINI, p. 106, pl. 2, figs. 16, 23-24.
 1985 *Buntonia sublatissima sublatissima* (Neviani) - CARBONEL, pl. 95, figs. 10-11.
 1988 *Buntonia sublatissima* (Neviani) - BONADUCE *et al.*, pl. 1, fig. 14.
 1989 *Buntonia sublatissima* (Neviani) - LACHENAL, p. 167, pl. 4, fig. 2.
 1990 *Buntonia sublatissima* (Neviani) - MOSTAFAWI, pl. 2, fig. 30.
 1993 *Buntonia sublatissima* (Neviani) - NACHITE *et al.*, pl. 4, fig. 11.

Distribution – Present in Biozone M Pl 5, always very rare.

- Neviani (1906): Carrubare (Calabria, Italy), Pleistocene.
 Ruggieri (1954): Crotone (Calabria), Recent (probably reworked) and Plio-Pleistocene of some Italian sections.
 Puri *et al.* (1964): Bay of Naples (Mediterranean Sea), between 70 and 123 m, Recent.
 Sissingh (1972): Crete (Greece), Lower-mid Pliocene; Rhodes (Greece), late Pliocene.
 Bonaduce *et al.* (1976): Adriatic Sea (Mediterranean), between 71 and 125 m, Recent.
 Breman (1976b): Adriatic Sea.
 Yassini (1979): Alger (Algeria), Pliocene.
 Yassini (1980): Bay of Bou Ismail (Mediterranean Sea), between 10 and 180 m, Recent.
 Carbonel (1985): Forage Froues (Landes, France), Upper Miocene.
 Bonaduce *et al.* (1988): Tunisian Shelf (Mediterranean Sea), below 75 m, Recent.
 Lachenal (1989): Gulf of Gabès (Mediterranean Basin), Quaternary.
 Mostafawi (1990): Krytika (Greece), Pliocene.
 Nachite *et al.* (1993): Tetuàn (Morocco), Lower Pliocene.

BUNTONIA TEXTILIS Bonaduce, Ciampo & Masoli,
 1976
 Pl. 4, figs. 6-9; Pl. 6, fig. 8

- 1966 *Buntonia* (*Buntonia*) cf. *sublatissima* (Neviani, 1906) - COLALONGO, pp. 97-99, pl. 12, fig. 1.
 1972 *Buntonia dertonensis* Ruggieri, 1954 - CIAMPO, p. 29, pl. 3, figs. 2-5; pl. 7, figs. 3-4.
 1975 *Buntonia dertonensis* Ruggieri - BREMAN, fig. 2
 1976 *Buntonia textilis* BONADUCE, CIAMPO & MASOLI, pp. 55-56, pl. 33, figs. 1-5.
 1976b *Buntonia dertonensis* Ruggieri - BREMAN, pp. 213-214, pl. 4, fig. 18.
 1980 *Buntonia textilis* Bonaduce *et al.* - COLALONGO & PASINI, p. 52, pl. 2, figs. 5-6.
 ? 1983 *Quasibuntonia* sp. CRONIN, pl. 9, fig. G.
 ? 1984 *Buntonia* aff. *B. textilis* Bonaduce *et al.* - CIAMPO, p. 56, pl. 3, fig. 10.
 ? 1987 *Buntonia textilis* Bonaduce *et al.* - WHATLEY & COLES, p. 81, pl. 5, fig. 5.
 1987 *Buntonia textilis* Bonaduce *et al.* - WHATLEY & COLES, p. 81, pl. 5, fig. 6.
 1996 *Buntonia textilis* Bonaduce *et al.* - COLES *et al.*, p. 150, pl. 5.

- ? 1996 *Buntonia textilis* Bonaduce *et al.* - RUIZ & GONZALEZ-REGALADO, pl. 2, fig. 5.

Remarks – This species shows some variability in the foveolae which sometimes are smaller than normal and well separated from each other (Pl. 4, fig. 9) and in the larger size of those specimens with less regular reticulation (Pl. 4, figs. 6, 8).

In some cases, shape variability allows doubts in identification; Whatley & Coles (1987; Pl. 5, fig. 5) who correctly synonymize *Quasibuntonia* sp. of Cronin (1983; Pl. 9, fig. G) interpret the species in a rather wide sense, and attribute to *B. textilis* specimens inflated at mid-height instead of ventrally as in *B. textilis* s.s. We include only doubtfully such specimens in synonymy.

Distribution – It appears as a rare species at the base of Biozone M Pl 5 but becomes relatively common from the top of Biozone M Pl 6 upwards.

- Colalongo (1966): Le Castella (Calabria, Italy), Upper Pliocene - Lower Pleistocene.
 Ciampo (1972): Mar Piccolo, Taranto (Apulia, Italy), Pleistocene.
 Breman (1975): Adriatic Basin (Mediterranean), Upper Pleistocene.
 Bonaduce *et al.* (1976): Adriatic Sea, Recent, below 110 m.
 Breman (1976b): Adriatic Sea, Recent, below 120 m.
 Colalongo & Pasini (1980): Vrica (Calabria), Lower Pleistocene.
 Coles *et al.* (1996): Porcupine Basin, Eastern Atlantic, Quaternary, 610-800 m.
 Whatley & Coles (1987): North Atlantic, Quaternary and Recent.

Genus QUASIBUNTONIA Ruggieri, 1958

QUASIBUNTONIA RADIATOPORA RADIATOPORA
 (Seguenza, 1880)
 Pl. 4, fig. 11

- 1880 *Cythere radiatopora* SEGUENZA, p. 289, pl. 16, figs. 48-48a.
 1954 *Buntonia radiatopora* Seguenza - RUGGIERI, p. 561, figs. 18-19, 21.
 1958 *Quasibuntonia radiatopora radiatopora* Seguenza - RUGGIERI, text-figs. 23-24.
 1966 *Buntonia* (*Quasibuntonia*) *radiatopora radiatopora* Seguenza - COLALONGO, p. 99, pl. 12, fig. 2.
 1980 *Quasibuntonia radiatopora* Seguenza - COLALONGO & PASINI, p. 64, pl. 27, fig. 2.

Remarks – The synonymy and distribution of the specimens figured relate only to the nominate subspecies as defined by Ruggieri (1958). This Author stresses the co-existence of transitional forms between *Q. radiatopora radiatopora* and *Q. radiatopora sculpta* (see Benson & Sylvester-Bradley, 1971; Mostafawi, 1989) even in sediments of the same age. Con-

sequently, the possibility exists that the two sub-species are actually only morphotypes of the same species.

Distribution – It occurs only in Biozone M Pl 4, with the exception of two valves found in sample 78 (early Pleistocene).

Seguenza (1880): Vito, Riace (Calabria, Italy), Upper Pliocene.

Ruggieri (1954; 1958): Squillace, Bianconuovo (Calabria), Lower Pliocene.

Colalongo (1966): Le Castella (Calabria), Upper Pliocene.

Colalongo & Pasini (1980): Vrica Section (Calabria, Italy), Upper Pliocene – Lower Pleistocene.

Bonaduce & Sprovieri (1985): M. San Nicola (Sicily, Italy), Biozone M Pl 4.

Barra *et al.* (1998): Punta di Maiata (Sicily), Biozone M Pl 3.

Genus RECTOBUNTONIA Sissingh, 1972

RECTOBUNTONIA INFLATA Colalongo & Pasini, 1980
Pl. 4, fig. 12

1980 *Rectobuntonia inflata* COLALONGO & PASINI, pp. 108, 110,
pl. 26, figs. 8-10; pl. 27, fig. 1.

1985 *Rectobuntonia inflata* Colalongo & Pasini - BONADUCE &
SPROVIERI, pl. 2, figs. 4, 6.

Distribution – It occurs only in Biozone M Pl 5.

Colalongo & Pasini (1980): Vrica Section (Calabria, Italy), Upper Pliocene – Lower Pleistocene.

Bonaduce & Sprovieri (1985): M. San Nicola (Sicily, Italy), Pliocene, Biozone M Pl 5.

Subfamily CAMPYLOCYOTHERINAE Puri, 1960

Genus RUGGERIA Keij, 1957

RUGGERIA TETRAPTERA (Seguenza, 1880)

PALPEBRALIS Ruggieri, 1960

Pl. 3, figs. 1-2

1960 *Ruggieria palpebralis* RUGGIERI, pp. 4-5, pl. 1, figs. 3-5; pl.
2, fig. 13.

1962 *Ruggieria tetraptera angustata* (Seguenza) - RUGGIERI, pp.
47-48, pl. 5, figs. 10, 10 a-b.

1965 *Ruggieria tetraptera angustata* (Seguenza) - DIECI & RUSSO,
p. 68, pl. 11, fig. 5.

1988 *Ruggieria tetraptera angustata* (Seguenza) - CIAMPO, pl. 4,
fig. 10.

1992 *Ruggieria* sp. cf. *angustata* (Seguenza) - RUGGIERI, p. 186.

1992 *Ruggieria angustata* (Seguenza) - CIAMPO, p. 236.

Remarks – *R. palpebralis*, described and illustrated by Ruggieri (1960), was later considered (Ruggieri, 1962) a junior synonym of *R. tetraptera angustata* (Seguenza, 1880). The species variability caused Ruggieri (1992) to refer to this form as *R.* sp. cf.

angustata because (*in litteris*) “la variabilità delle *Ruggieria* nel Miocene superiore e nel Pliocene italiani è molto elevata, e si potrà arrivare a determinazioni soddisfacenti solo dopo una revisione completa del gruppo”. Due to these observations, rather than exhumate the “variety” *angustata* of Seguenza, who in any case did not figure this form and whose original material is lost, in our opinion it is more correct to restore to use *R. palpebralis*. Because of the observations of Ruggieri (1962), that there is continuous transition between *R. tetraptera tetraptera* and *R. t. angustata*, we prefer to consider the present form as a subspecies of *R. tetraptera*.

Distribution – It ranges from the base of the section to the first half of Biozone M Pl 5.

Ruggieri (1960; 1962); Dieci & Russo (1965): Sicily and Emilia (Italy), Tortonian; Marche and Emilia (Italy), Lower Pliocene.

Ciampo (1988; 1992): Calabria (Italy), Pliocene, Biozones M Pl 3 and M Pl 4.

Subfamily TRACHYLEBERIDINAE Sylvester-Bradley, 1948

Genus AGRENOCY THERE Benson, 1972

AGRENOCY THERE PLIOCENICA (Seguenza, 1880)

Pl. 5, fig. 4

1880 *Cythereis pliocenica* SEGUENZA, p. 192.

1953 *Cythereis dictyon pliocenica* (Seguenza) - RUGGIERI, p. 78,
pl. 2, figs. 10-11.

1966 *Bradleya pliocenica* (Seguenza) - COLALONGO, p. 91, pl.
11, fig. 1.

1971 *Bradleya ? pliocenica* (Seguenza) - BENSON & SYLVESTER-
BRADLEY, pl. 1, figs. 4, 6.

1972a *Agrenocythere pliocenica* (Seguenza) - BENSON, pp. 77-78,
figs. 44-50; pl. 3, figs. 3-4; pl. 5, figs. 3-4.

1973 *Agrenocythere pliocenica* (Seguenza) - BENSON, fig. 2.A.

1980 *Agrenocythere pliocenica* (Seguenza) - COLALONGO &
PASINI, pp. 51-52, pl. 1, fig. 1.

1985 *Agrenocythere pliocenica* (Seguenza) - BONADUCE &
SPROVIERI, pl. 1, figs. 2, 4.

1985 *Agrenocythere pliocenica* (Seguenza) - PETERS *et al.*, fig. 5.

1991 *Agrenocythere pliocenica* (Seguenza) - RUGGIERI, p. 56.

Distribution – This species occurs, generally common, from the base of the section to Biozone M Pl 6. Its occurrence is cited from all the deep-water Pliocene facies of Central and Southern Italy, although for the Pleistocene citations are rather rare. It has been found in deep-sea drillings of the Thyrrenian Sea (Benson, 1972a; 1973; Colalongo & Pasini, 1988) but outside the Italian area, it has been found only in the early Pliocene of Crete (Peters *et al.*, 1985). Its FO in the Mediterranean Basin has been defined at the M Pl 1 / M Pl 2 boundary (Barra *et al.*, 1998). In Atlantic sections, the species is restricted to the first part of the Messinian and it disappears before its end (Benson *et al.*, 1991).

- Seguenza (1880): Calabria (Italy), Zanclean.
 Ruggieri (1953): Squillace (Calabria) and S. Arcangelo (Romagna, Italy), Lower Pliocene; Catanzaro Marina (Calabria), Lower Pleistocene.
 Colalongo (1966): Le Castella (Calabria), Upper Pliocene.
 Benson & Sylvester-Bradley (1971): San Ruffillo (Emilia, Italy), Pliocene.
 Benson (1972a): Licata (Sicily, Italy), Pliocene.
 Benson (1972a; 1973): DSDP Leg. 13, Sites 132 and 134 (Tyrrhenian Basin), Pliocene.
 Colalongo & Pasini (1980): Vrica Section (Calabria), Upper Pliocene; Crotone (Calabria), Lower Pleistocene.
 Peters *et al.* (1985): Eastern Crete (Greece), early Pliocene.
 Colalongo & Pasini (1988): ODP Leg 107, Hole 654A (Tyrrhenian Basin), from Biozone M Pl 2 to the Lower Pleistocene.
 Ciampo (1992): Ionian Calabria, Biozones M Pl 2 and M Pl 3.
 Barra *et al.* (1998): Punta di Maiata (Sicily), from Biozone M Pl 2 to M Pl 3.

Genus COSTA Neviani, 1928
 Subgenus CUNEOCOSTA Ruggieri, 1992

COSTA (CUNEOCOSTA) TRICOSTATA (Reuss, 1850)
 PLIOCENICA Ruggieri, 1992
 Pl. 5, fig. 2

- 1992 *Costa (Cuneocosta) tricostata pliocenica* RUGGIERI, pp. 177-178, fig. 8.

Distribution – It occurs in a few scattered samples and is always very rare.

Ruggieri (1992): Filozingaro (Sicily), early Pliocene.

Genus HENRYHOWELLA Puri, 1957

HENRYHOWELLA SARSII (G.W. Müller, 1894) PROFUNDA Bonaduce, Barra & Aiello, 1999

- 1999 *Henryhowella sarsii* (G. W. Müller) *profunda* BONADUCE,

BARRA & AIELLO, pp. 68-70, pl. 1, figs. 5-12; pl. 4, figs. 1-8 (and synonymies).

Distribution – The present subspecies, rather common in the Miocene and Pliocene of the Atlantic and Mediterranean, is one of the most abundant taxa throughout the section.

Genus OBLITACYTHEREIS Benson, 1977

OBLITACYTHEREIS MEDITERRANEA Benson, 1977
 Pl. 5, fig. 3

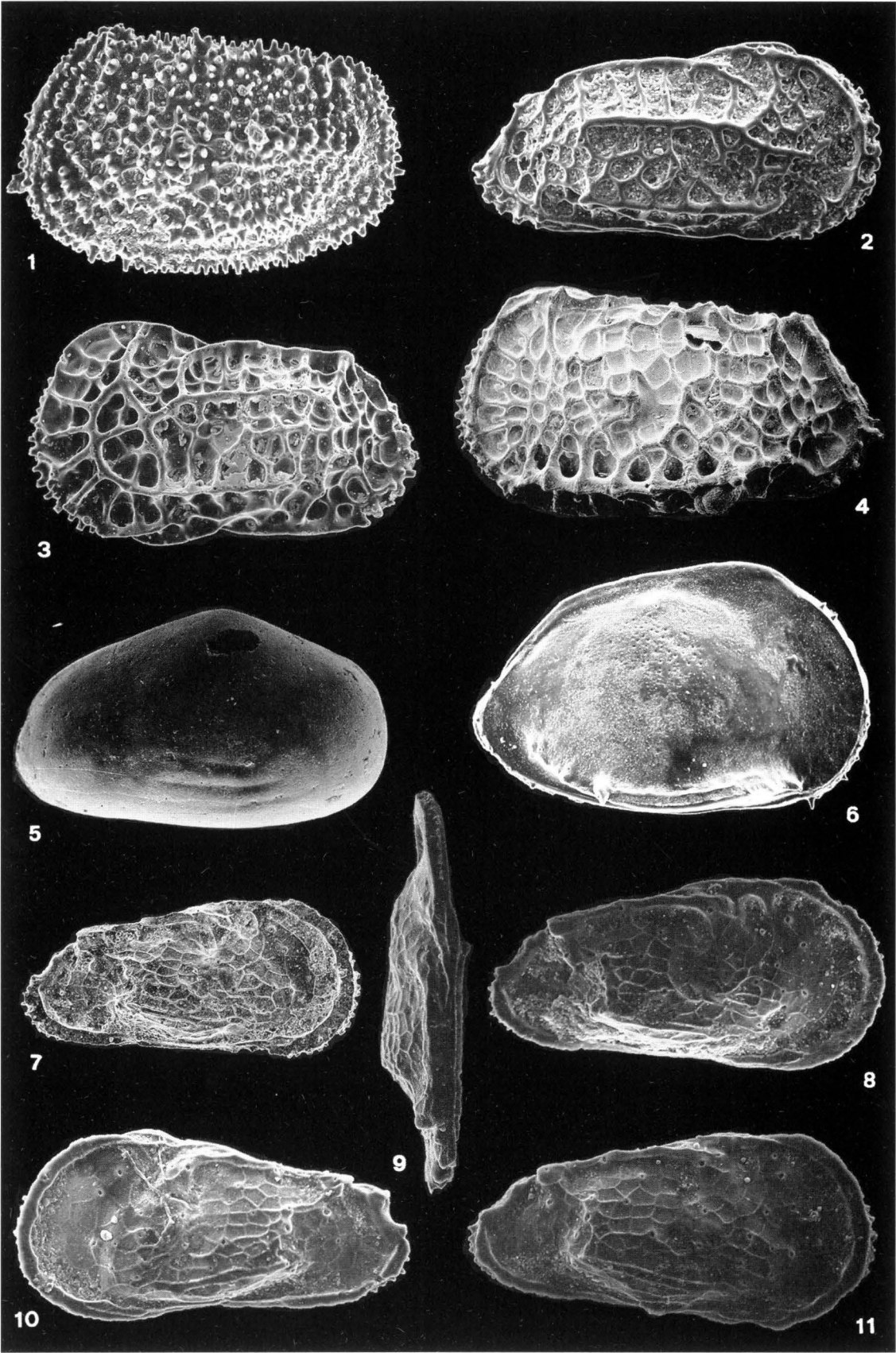
- 1972 *Bradleya*? sp. SISSINGH, p. 122, pl. 9, fig. 13.
 1977 *Oblitacythereis (Oblitacythereis) mediterranea* BENSON, p. 33, pl. 1, figs. 1-4; pl. 3, fig. 1, text-figs. 3, 4A, 5B
 1978 *Oblitacythereis mediterranea* Benson - BENSON, pl. 1, figs. 5-6.
 1980 *Oblitacythereis mediterranea* Benson - CITA *et al.*, pl. 20, fig. 9.
 1982 *Oblitacythereis mediterranea* Benson - CARBONNEL, p. 45, pl. 4, fig. 12.
 1985 *Oblitacythereis mediterranea* Benson - BONADUCE & SPROVIERI, pl. 1, fig. 3.
 1985 *Oblitacythereis mediterranea* Benson - PETERS *et al.*, fig. 5.

Distribution – It occurs in the first part of the section, Biozones M Pl 3 and M Pl 4.

- Sissingh (1972): Crete (Greece), Pliocene.
 Benson (1977): Atlantic coast of Morocco; Chateau Vaugrenier (Antibe, France), Pliocene; Balestrate (Sicily, Italy), Lower Pliocene; Cyprus (Greece), Zanclean; Buonfornello (Sicily), Zanclean.
 Benson (1978): DSDP Leg 42A, Site 372 (Algero-Provençal Basin, Mediterranean Basin), Zanclean; Site 376 (Florence Rise, Mediterranean Basin), Piacenzian, ? Zanclean.
 Cita *et al.* (1980): Cuevas del Almanzora (Vera Basin, Spain), early Pliocene.
 Carbonnel (1982): Bassins du Var et de la Siagne (Sud - Est de la France), Pliocene.
 Bonaduce & Sprovieri (1985): M. San Nicola (Gela, Sicily), Biozones M Pl 3 - M Pl 4.
 Peters *et al.* (1985): Crete, Pliocene.
 Barra *et al.* (1998): Punta di Maiata (Sicily), from Biozone M Pl 2 to M Pl 3.

EXPLANATION OF PLATE 5

- Fig. 1 - *Henryhowella sarsii profunda* Bonaduce, Barra & Aiello, 1999, LV, Stn. 70, B.O.C. 2387, (x 66).
 Fig. 2 - *Costa (Cuneocosta) tricostata pliocenica* Ruggieri, 1992, RV, Stn. 22, B.O.C. 2388, (x 69).
 Fig. 3 - *Oblitacythereis mediterranea* Benson, 1977, LV, Stn. 4, B.O.C. 2388, (x 69).
 Fig. 4 - *Agrenocythere pliocenica* (Seguenza, 1880) LV, Stn. 3, B.O.C. 2390, (x 60).
 Fig. 5 - *Xestoleberis profundis* Whatley & Coles, 1987, LV, Stn. 52, B.O.C. 2391, (x 187.5).
 Fig. 6 - *Bosquetina rhodiensis* Sissingh, 1972, LV, Stn. 77, B.O.C. 2392, (x 51).
 Figs. 7-11 - *Occultocythereis culter* sp. nov. 7) Holotype, RV, Stn. 21, B.O.C. 2393, (x 110); 8) Hypotype, RV, Stn. 1, B.O.C. 2394, (x 111); 9) Hypotype, RV in dorsal view, Punta di Maiata, Stn. 82, B.O.C. 2395, (x 111); 10) Hypotype, LV, Punta di Maiata, Stn. 48.85, B.O.C. 2396, (x 111); 11) Hypotype, RV, Punta di Maiata, Stn. 55, B.O.C. 2397, (x 111).



Genus OCCULTOCYHEREIS Howe, 1951

OCCULTOCYHEREIS CULTER sp. nov.

Pl. 5, figs. 7-11

?1982 *Occultocythereis dohrni*? Puri, 1963 - CARBONNEL, pp. 45-46, pl. 1, fig. 14.1991 *Occultocythereis culter* nomen nudum BENSON *et al.*, fig. 5.1998 *Occultocythereis culter* nomen nudum BARRA *et al.*, p. 75.*Etymology* – From Latin *culter* = knife.*Holotype* – A RV (Pl. 5, fig. 7), Stn. 21, B.O.C. 2393.*Hypotypes* – 1 RV (Pl. 5, fig. 8), Monte S. Nicola section, Stn. 1, B.O.C. 2394; 1 RV (Pl. 5, fig. 9), Punta di Maiata (Sicily), Stn. 82, B.O.C. 2395; 1 LV (Pl. 5, fig. 10), Punta di Maiata, Stn. 48.85, B.O.C. 2396; 1 RV (Pl. 5, fig. 11), Punta di Maiata, Stn. 55, B.O.C. 2397.*Type-level* – Biozone M Pl 5.*Diagnosis* – A species of the genus *Occultocythereis* characterized by its small size, very laterally compressed appearance in dorsal view, short, prominent latero-ventral ridge which protrudes at its posterior extremity. Valves delicately reticulated. Normal pore-canals very large and antero marginal ridge relatively narrow for the genus. Dorsal ridge well-defined ending posteriorly with a relatively small but protruding tubercle.*Description* – Valves in lateral view subrectangular with dorsal and ventral margins feebly converging toward the posterior with maximum height anteriorly; in dorsal view very compressed with anterior and posterior extremities very depressed (Pl. 5, fig. 9) inside the marginal-ridges. Valves thin. Ornamentation constituted mostly by a very constant delicate reticulation especially in the central part while the anterior and posterior areas appear so delicately ornamented that this character can be detected only by SEM micrographs (Pl. 5, figs. 7-8, 10-11). The anterior marginal ridge is relatively narrow for the genus and is surrounded by numerous marginal denticulation (Pl. 5, fig. 7). The posterior caudal process is fur-

nished by numerous marginal small spines. At about mid height, above the spiny margin a large tubercle overlaps the margin itself (Pl. 5, figs. 8, 10-11). The dorsal ridge ends anteriorly before mid length descending at its anterior extremity toward the interior of the valve while posteriorly it ends with a well developed protruding tubercle. Two or three thin ridges almost parallel each other run subparallel to the ventral margin, one of which ending posteriorly with a tubercle bearing a normal pore-canal.

Numerous tubercles bearing large normal pore-canals are distributed on the reticulation muri mostly at their crossing.

Size (mm) – Holotype (RV): l = 0.59; h = 0.28.*Affinities* – *Occultocythereis culter* sp. nov. differs from *O. dohrni* Puri, 1963 in its narrower anterior marginal ridge, more prominent and better defined latero-ventral keel, more triangular shape in lateral view and less massive dorsal ridge which terminates posteriorly in a single bilobed tubercle. The size is different (*O. dohrni*: l = 0.65 mm).*Distribution* – It occurs from the base of the section up to the first part of Biozone M Pl 5. It is rather common in the Tortonian - Pliocene of Morocco near Rabat (Benson *et al.*, 1991; Bonaduce, unpublished data).Barra *et al.* (1998): Punta di Maiata (Sicily), from Biozone M Pl 2 to M Pl 3.

Family XESTOLEBERIDIDAE Sars, 1866

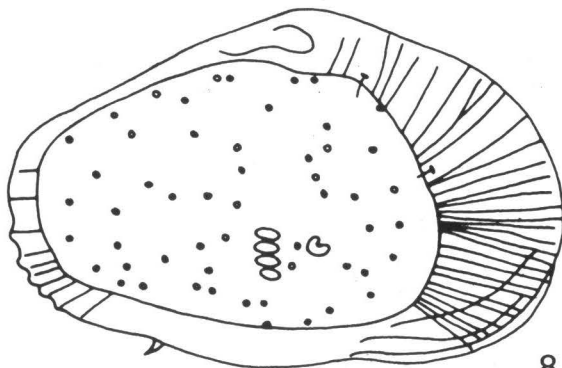
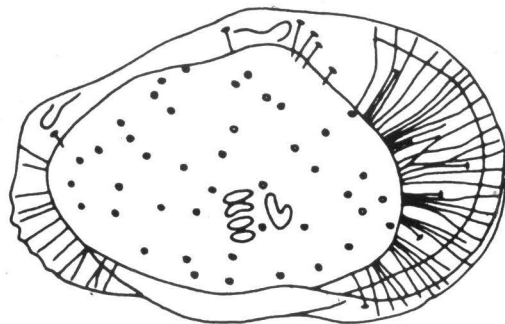
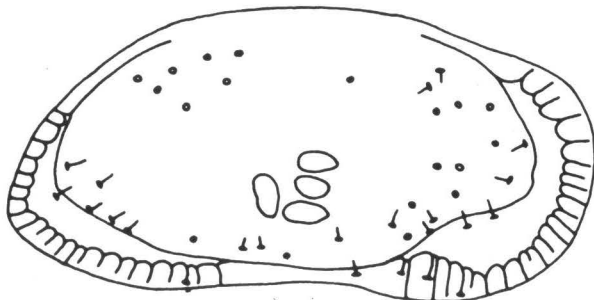
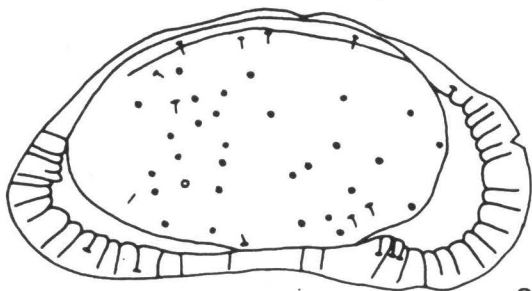
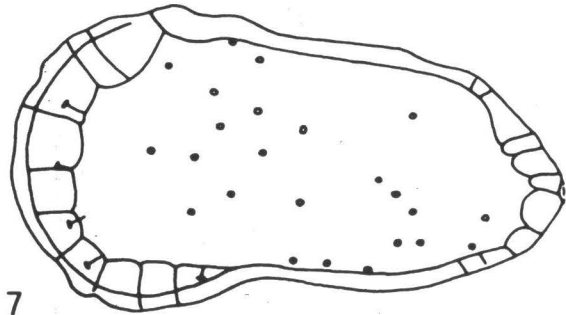
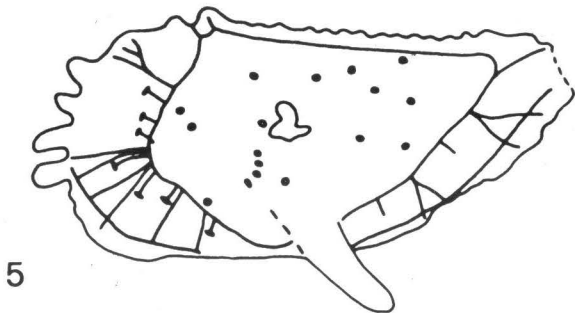
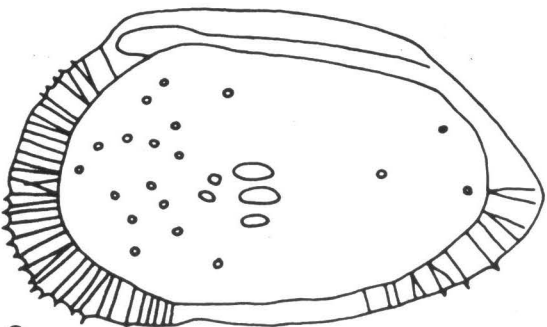
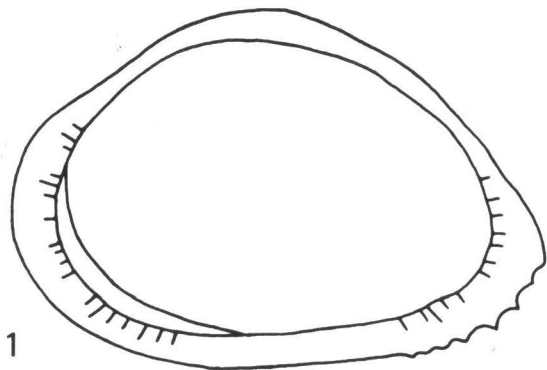
Genus XESTOLEBERIS Sars, 1866

XESTOLEBERIS PROFUNDIS Whatley & Coles, 1987
Pl. 5, fig. 51987 *Xestoleberis profundis* WHATLEY & COLES, p. 79, pl. 6, figs. 26-30.1988 *Xestoleberis* sp. 1 WHATLEY & AYRESS, pl. 2, figs. 9a-b.*Distribution* – Found only in sample 52 of Biozone M Pl 6.

Whatley & Coles (1987); Whatley & Ayress (1988): widespread in the deep sea, Pliocene-Quaternary

EXPLANATION OF PLATE 6

- Fig. 1 - *Bairdoppilata profunda* sp. nov., LV, Paratype, Stn. 23, B.O.C. 2398, (x 60).
 Fig. 2 - *Bythocypris bosquetiana* (Brady, 1866), RV, Stn. 18, B.O.C. 2399, (x 56).
 Fig. 3 - *Bosquetina rhodiensis* Sissingh, 1972, LV, same specimen figured in Pl. 5, fig. 6, B.O.C. 2392, (x 56).
 Fig. 4 - *Bythocypris obtusata producta* (Seguenza, 1880), RV, Stn. 23, B.O.C. 2400, (x 75).
 Fig. 5 - *Pedicythere? polita* Colalongo & Pasini, 1980, LV, same specimen figured in Pl. 3, fig. 7, B.O.C. 2368, (x 192).
 Fig. 6 - *Buntonia obesa* Ciampo, 1986, LV, internal view, Stn. 38, B.O.C. 2401, (x 143).
 Fig. 7 - *Profundobythere* sp. 1, LV, Stn. 21, B.O.C. 2402, (x 171).
 Fig. 8 - *Buntonia textilis* Bonaduce, Ciampo & Masoli, 1976, LV, internal view, Stn. 77, B.O.C. 2403, (x 143).



of Atlantic, Middle Miocene-Quaternary of the South-West Pacific and Indian oceans.

Incertae sedis

Genus MICRO CERATINA Swanson, 1980

MICRO CERATINA POLIGONIA (Colalongo & Pasini, 1980)

Pl. 3, fig. 6

1980 "*Bythoceratina*" *poligonia* COLALONGO & PASINI, p. 72, pl. 3, figs. 1-4.

1986 "*Bythoceratina*" *poligonia* Colalongo & Pasini - CIAMPO, pl. 14, figs. 8-9.

1996 *Microceratina poligonia* (Colalongo & Pasini) - COLES *et al.*, pl. 5, figs. 4-5.

Distribution – It occurs in a single early Pleistocene sample.

Colalongo & Pasini (1980): Vrica (Calabria, Italy), Lower Pleistocene.

Ciampo (1986): Falconara (Sicily, Italy), Tortonian; Mussotto (Piedmont, Italy), Tortonian.

Coles *et al.* (1996): Porcupine Basin, Eastern Atlantic, Quaternary.

BIOSTRATIGRAPHY

The stratigraphical distribution in the sediments of the Mediterranean area of some species characterizing the bathyal environment during the late Miocene-Recent interval are given in Text-fig. 3. For all the listed species, the first appearance and last occurrence data in the Mediterranean Basin are reported in appearance order. The distributive data of the genera *Anchistrocheles*, *Argilloecia*, *Cytherella*, *Cytheropteron*, *Krithe*, *Parakrithe*, *Xestoleberis* are from: Ciampo, 1992, 1998; Aiello *et al.*, 1993; Abate *et al.*, 1993; Abate *et al.*, 1994; Aiello *et al.*, 1996a; Aiello *et al.*, 1996b; Aiello *et al.*, 1996c; Barra *et al.* 1996; Aiello, 1998; Barra *et al.*, 1998; the presence in the Upper Pleistocene of the Gulf of Taranto of *K. compressa* is an unpublished datum of G. Bonaduce; the presence of *A. kissamovensis* in the Pleistocene of Zakynthos, probably reworked, is reported (as *A. robusta*) by Tsapralis, 1981 (pl. 12, fig. 9).

A number of species are of potential biostratigraphical importance, particularly with respect to their local extinctions.

Bairdoppilata profunda (Langhian – Biozone M Pl 5)

Cytherella russoi (Miocene – Biozone M Pl 5)

Krithe compressa (Tortonian – base Holocene)

Argilloecia bensoni, *Cardobairdia* ? *asymmetrica*, *Cytheropteron bifidum*, *Krithe monosteracensis*, *K. pernoides*, *K. undecimradiata*, *Parakrithe rotundata* (Tortonian – early Pleistocene).

Argilloecia kissamovensis, *Buntonia dertonensis*, *Cytheropteron* (A.) *pinarense gillesi*, *Paijenborchella iocosa*, *Parakrithe ariminensis* (Tortonian – Biozone M Pl 5).

A large number of species seem to be restricted to the Plio – Pleistocene:

Krithe iniqua (Pliocene, Biozones M Pl 1- M Pl 6)

Anchistrocheles interrupta (Biozone M Pl 1 – early Pleistocene)

Cytheropteron (A.) *denticulatum* (Biozones M Pl 1 – M Pl 5)

Agrenocythere pliocenica, *K. frutex* (Biozone M Pl 2 – early Pleistocene)

Occultocythereis culter (Biozones M Pl 2 – M Pl 5)

Oblitacythereis mediterranea (Biozones M Pl 2 – M Pl 4)

Cytherella gibba, *Paijenborchella malaiensis cymbula* (Biozone M Pl 3 – early Pleistocene)

Xestoleberis pasta (Biozones M Pl 3 – M Pl 5)

Cytheropteron testudo (Biozone M Pl 5 – Pleistocene)

Cytheropteron vanharteni, *Retibythere* (B.) *s. mediterranea* (Biozone M Pl 5 – early Pleistocene)

Krithe marialuisae (last part of Biozone M Pl 5 – early Pleistocene)

Only four species are extant of those which first appeared in the late Pliocene or early Pleistocene:

Buntonia sublatissima, *Polycope vasfiensis* (Biozone M Pl 5 – Recent)

Bairdoppilata conformis (top of Biozone M Pl 5 – Recent)

Rimacytheropteron longipunctatum (early Pleistocene – Recent)

It is worth of note that many of the species listed in Tab. 1 have only been described in recent years and, consequently, their stratigraphical distribution must be considered with care and subject to modification when other sections will be studied.

DISCUSSION

In the sediments of the M. S. Nicola Section, and generally in deep-water Pliocene ostracod assemblages of the Mediterranean, the genus *Krithe* is particularly important in both species diversity and percentage dominance. Its importance in the Mediterranean decreases during the Quaternary down to the presence in the Recent of only two species, *Krithe praetexta* and *Krithe keyi*, with occurrence percentages of 5-10% in the Adriatic Sea in the depth range of 60 to 80 m depth (Bremen, 1976b, tab. 3).

Coles *et al.* (1994) studied the genus *Krithe* from the Tertiary and Quaternary of the North Atlantic and found 36 species or subspecies, and described 5 species and 2 subspecies as new. Nineteen species were left in open nomenclature, 10 of which differently distributed from Pliocene to Quaternary. Most of the previous species seem to differ from those described by Abate *et al.* (1993) in the present section. This support the hypothesis of rapid differentiated speciation of the genus in both the Mediterranean Pliocene and the Pliocene - Quaternary of the Atlantic, which seems to have occurred independently in the two basins during the Pliocene.

SPECIES	L.	S.	T.	Mess.	Pliocene						Pleistocene	H.	R.
					M PI 1	M PI 2	M PI 3	M PI 4	M PI 5	M PI 6			
<i>B. profunda</i>													
<i>C. russoi</i>													
<i>K. compressa</i>													
<i>A. bensoni</i>													
<i>C. ? asymmetrica</i>													
<i>C. bifidum</i>													
<i>K. monosteracensis</i>													
<i>K. pernoides</i>													
<i>K. undecimradiata</i>													
<i>P. rotundata</i>													
<i>X. prognata</i>													
<i>A. kissamovens</i>													
<i>B. obesa</i>													
<i>B. dertonensis</i>													
<i>C. (A.) p. gillesi</i>													
<i>P. iocosa</i>													
<i>P. ariminensis</i>													
<i>A. spissa</i>													
<i>K. iniqua</i>													
<i>A. interrupta</i>													
<i>C. (A.) denticulatum</i>													
<i>A. micra</i>													
<i>A. pliocenica</i>													
<i>A. fatua</i>													
<i>K. frutex</i>													
<i>A. trapezium</i>													
<i>P. acuta</i>													
<i>A. subtilis</i>													
<i>O. culter</i>													
<i>O. mediterranea</i>													
<i>K. praetexta</i>													
<i>C. gibba</i>													
<i>P. m. cymbula</i>													
<i>Q. r. radiatopora</i>													
<i>X. pasta</i>													
<i>C. omega</i>													
<i>C. scalprum</i>													
<i>K. exigua</i>													
<i>K. parvipora</i>													
<i>K. keyi</i>													
<i>B. sublatissima</i>													
<i>A. pseudoreticulata</i>													
<i>C. sulcifer</i>													
<i>K. perpulchra</i>													
<i>R. inflata</i>													
<i>L. minima</i>													
<i>P. vasfiensis</i>													
<i>C. testudo</i>													
<i>C. fraudulentum</i>													
<i>C. vanharteni</i>													
<i>R. s. mediterranea</i>													
<i>B. conformis</i>													
<i>K. marialuisae</i>													
<i>M. ligustica</i>													
<i>B. rhodiensis</i>													
<i>C. trapezium</i>													
<i>P. iuliani</i>													
<i>P. oertliana</i>													
<i>A. gonzalezi</i>													
<i>R. longipunctatum</i>													
<i>P. semilunaris</i>													
<i>P. sicana</i>													

Text-fig. 3 - Stratigraphical distribution in the sediments of the Mediterranean area of some species characterizing the bathyal environment during the late Miocene-Recent. L: Langhian, S: Serravallian, T: Tortonian; Mess.: Messinian; H.: Holocene; R: Recent.

The same seems to occur in the genus *Parakrithe*, especially as far as species numbers is concerned. The genus is represented in the section by 11 species. Seven species occur in the range M Pl 3 – M Pl 5; the genus disappears completely between the top part of Biozone M Pl 5 and basal part of Biozone M Pl 6. Three species, *P. acuta*, *P. erecta* and *P. ariminensis* do not survive the early Pleistocene while between Biozone M Pl 6 and the early Pleistocene, the first appearance of *P. oertliana*, *P. semilunaris*, *P. sicana* and *P. iuliani* is registered. None of the previous species occur in Recent sediments, in which only *P. dimorpha* and *P. ambigua* have been cited. Unfortunately, the genus has not been yet studied in great detail in the Recent of the Atlantic but it does not seem that species now extinct in the Mediterranean are still living in the Atlantic (Peypouquet, 1977).

Among other taxa, the subgenus *Aversovalva* no longer occurs in the Mediterranean and in our section it disappears at the top of Biozone M Pl 5.

A certain number of species found in the section occurs also in the Atlantic Tortonian (Benson *et al.*, 1991 and unpublished data of G. Bonaduce). Some of them (group A) occurred in both basins; after their temporary disappearance from the Mediterranean during the Messinian salinity crisis, they gradually recolonized the Mediterranean during the Pliocene. Another group of species (group B) did not occur in the Paleomediterranean Miocene and entered the Mediterranean for the first time during the Plio-Pleistocene.

Group A:

Argilloecia bensoni
Argilloecia kissamovens
Buntonia obesa
Cytheropteron bifidum
Cytheropteron (A.) pinarense gillesi
Krithe compressa
Krithe undecimradiata
Paijenborchella iocosa
Parakrithe ariminensis
Platyleberis profunda
Xestoleberis pasta
Xestoleberis prognata

Group B:

Agrenocythere pliocenica
Anchistrocheles interrupta
Cytherella gibba
Cytherella robusta
Cytheropteron monoceros
Cytheropteron pseudoalatum
Cytheropteron sulcifer
Éucythere pubera
Krithe keyi
Occultocythereis culter
Paijenborchella malaiensis cymbula

The immigration (or reimmigration) of Atlantic species during the Pliocene suggests that some species were able to live in a very wide range of chemico-physical conditions, e.g. *A. kissamovens*, *C. (A.) pinarense gillesi*, *K. compressa*, *X. prognata*, because these species, occurring from the base of Pliocene, were opportunistic and able to tolerate unfavorable conditions, while others (*A. pliocenica*, *O. mediterranea*) seem related strictly to particular Atlantic water masses (Barra *et al.*, 1998).

A large number of the reported species became extinct or appeared in the Mediterranean in the range Biozone M Pl 5 – end of Pliocene, that is in the interval during which the Mediterranean circulation is thought to have changed from estuarine to antiestuarine at about 2.4 Ma (Van Harten, 1984; Loubere, 1987; Rio *et al.*, 1990), a change that resulted in an evident species turnover.

The very few species of the section (*P. profunda*, *E. pubera*, *K. keyi*, *C. latum* and *C. monoceros*) still living in the Mediterranean, probably can do so because of their large tolerance or adaptation to the paleoceanographic and climatic changes which occurred from Pliocene to Recent.

The occurrence of a number of short-living species, especially of the genera *Krithe*, *Parakrithe*, *Cytheropteron* and *Argilloecia*, may be the consequence of speciation due to the peculiar environmental conditions of the Mediterranean which may have acted in some cases as a laboratory of evolution as suggested for the genus *Krithe* by van Harten (1995). At the present state of our knowledge, the interpretation of the Mediterranean as an evolutionary laboratory is simply an idea, because the possible future discovery of these species in the Atlantic would destroy it completely and would support a simpler migration phenomenon.

CONCLUSIONS

The ostracod fauna of the Pliocene – early Pleistocene section at Monte San Nicola is studied both qualitatively and quantitatively.

The section yielded 113 species, 3 of which are described as new.

A notable number of species is restricted to the first part of the section, while the FOD of others occurs only in the second part and most of them have very short vertical distributions. Of particular stratigraphical interest is the LOD of *Agrenocythere pliocenica* which disappears completely in the basal part of Biozone M Pl 6. Some common species, such as *Argilloecia kissamovens*, *Bairdoppilata profunda* n. sp., *Cytheropteron (A.) pinarense gillesi* and *Parakrithe ariminensis*, with their LAD, seem to be of potential stratigraphical importance.

Cytherella gibba, *Occultocythereis culter* n. sp., *Oblitocythereis mediterranea*, *Paijenborchella malaiensis cymbula*, *Xestoleberis pasta* show a very reduced stratigraphical distribution.

Tab. 1 - Stratigraphical percent distribution of all the species recorded in the section following the Biozones of Sprovieri (Bonaduce & Sprovieri, 1985). The species are ordered following their appearance order

BIOZONES		M PI 3			M PI 4													M PI 5																				
Nº	SPECIES / SAMPLES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
	meters	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	70	72
1	<i>Argilloecia acuminata</i>	1	1	x	4	x	3	*				1	x		2			x	x	1		3	1	1	*		x			x	j		1		3		4	
2	<i>Argilloecia bensoni</i>	x		2						3							2	5	2	1	x	3	1		*		x				x	j						
3	<i>Cytherella robusta</i>	1 j	3 j	3 j	2 j	j	x j	* j	* j	1 j	5 j	1 j	2 j	*	j	5	2 j	3 j	2 j	1	2 j	2	1 j	x j		j	3 j	*		1	x j	2	1	1	x j	x	2 j	
4	<i>Henryhowella sarsii profunda</i>	6 j	3 j	3 j	11 j	8 j	x j	*	*	16 j	1 j	4 j	2 j	* j	14	23 j	37 j	6	11 j	11	12	9 j	23	22 j	*	j	29 j	*	35 j	23	9 j	11	5	4	13 j	10 j	3 j	x
5	<i>Krithe compressa</i>	7 j	3	10 j	8	11	13 j	* j	*	9 j	15 j	x j	17 j		21 j	8	6 j	7 j	8	10 j	4	5	5	3			*		1	x		11 j	5	x		14 j		
6	<i>Parakrithe rotundata</i>	2	6 j							2					2 j	1	x	2	3 j	23	11 j	5	1 j	5 j						7 j		15						
7	<i>Xestoleberis prognata</i>	x		2 j	x	4	3			3	2		x	*	9	2	10 j	4	10	12	10	7	13	17 j	*	24	9	*	19 j	21	26	2	8	17	12 j	11	8 j	
8	<i>Bythocypris obtusata producta</i>	14 j	5 j	11 j	11 j	18 j	12 j	*		3	4	9 j	3 j		1 j	3	1 j	4 j	3 j	2	3	3	7 j	1	*	7	1	* j	2	x j								
9	<i>Cardobairdia ? asymmetrica</i>	1				x												x	x		x		x	2		2	1							4	x	2	x	
10	<i>Anchistrocheles interrupta</i>	3	6	x j	2 j	x	7 j	* j	* j		1	5	5		4 j			1		1	3	1	3	x		2	1						x	2	x	x	2	
11	<i>Pajenborchella m. cymbula</i>		1							3				*			3	x	3	2	3	2	2	x	*		1		2	5	x	8	2	5	8	2	3	1
12	<i>Krithe iniqua</i>	17 j	22 j	14	14	11	12 j	*	* j	5 j	25 j	21	26 j	*	6 j	21	3 j	24 j	13 j	x	1	13		4	* j		x	*	11	21	14		32 j	13	28 j	19	6	27
13	<i>Agrenocythere plicenica</i>	12 j	8 j	13 j	4 j	2 j	2 j	*		2 j	8 j	1 j	7 j	* j	1 j	3 j	3 j	2 j	1 j	4	5 j	3 j	x j	2 j	* j	2	x j	*	j		2 j	j	x	x j	2 j			
14	<i>Argilloecia trapezium</i>	1			2	2	x					1					1																					
15	<i>Argilloecia kissamovensis</i>	4	7	16	2	3	5 j	*	*	14	12 j	6	12	*	11 j	9	2	5	9		11	2	13	3	*	20	9	*	10	17	16	22	12	15	6	9	16	14
16	<i>Bairdoppilata profunda</i> sp. nov.	5 j	5 j	4 j	8 j	15 j	15 j	*	* j	5 j	8 j	9 j	5 j	*	1 j	3	15 j	8	6 j	5 j	6 j	4 j	6 j	13 j	*	2	8 j		j				x		x			
17	<i>Propontocypris</i> sp. 1	1	3		x	x		*	*			2						1																				
18	<i>Xestoleberis pasta</i>	2		2 j			x	*		5	4	1					2	x	x	x	2	x		2	*		2		x j		9		3					
19	<i>Bythocypris bosquetiana</i>	1	6 j		2 j	4	7	*			1	4 j	x j					1	2	1	2	x		x	*	3	x	* j										
20	<i>Parakrithe ariminensis</i>	x		3	11 j	7	4 j	*		12 j	5	8	9 j	*	13 j	3	3	3 j	4			11 j			*	3	x											
21	<i>Cytherella russoi</i>	9 j	7 j	3 j														x			1 j			4 j														
22	<i>Macrocypris ? nimia</i>	3	3	4	x	4	2 j				1	1	2					1	1	2		x		x														
23	<i>Occultocythereis culter</i> sp. nov.	2	1	1							1																											
24	<i>Propontocypris dromas</i> sp. nov.	2										1	x		1																							
25	<i>Macrocypris arcuata</i>	x	1																																			
26	<i>Oblitacythereis mediterranea</i>	1	1	x	2 j	x	1 j																															
27	" <i>Macrosarisa</i> " sp. 1	3																																				
28	<i>Cytherella gibba</i>		2	x			x			2	1	2 j	2 j	*	1 j			x	1 j	x	2 j	x	3	x j	*	3	3 j	*	x		x	2	4 j			j		
29	<i>Cytheropteron bifidum</i>		1	2	5		j			1	2	x		*	1	2	x	2	1	2	2	2	3	4		2	1	*	6	2	4	2	4	1	2		x	
30	<i>Argilloecia fatua</i>		1	1		x													3	x	x	x																
31	<i>Pontocypris</i> aff. <i>P. spinosa</i>		1				x																															
32	<i>Buntonia dertonensis</i>		1		6		x	*				x				2	x	x	2	2	2	2 j	1	x	*	8	1			7	2	x	2			6	1	
33	<i>Cytheropteron (A.) denticulatum</i>		1	1		x				1				*				x	x	x	x	x		x	*													
34	<i>Parakrithe dimorpha</i>			1		x			*	3	1		x	*		2	2	2	x	1	1				*	3	</											

Symbols: j = juveniles; x = values <0.5 %; * = % values not calculated because of the extremely low number of total specimens.

[illegible]