

Pliocene ostracod assemblages at the M Pl 3 - M Pl 4 boundary in the Capo Rossello borehole (Agrigento, Sicily)

Giuseppe AIELLO Diana BARRA

Dipartimento di Scienze della Terra
Università di Napoli "Federico II"

KEY WORDS – *Ostracoda*, *Systematics*, *Palaeoecology*, *Pliocene*, *Sicily*.

ABSTRACT – The *Ostracoda* from 15 samples of Pliocene sediments taken at the M Pl 3 – M Pl 4 boundary in the Punta di Maiata borehole (Agrigento, Sicily) have been studied. A quantitative analysis of the *Ostracoda* suggests the persistence of a good bottom water circulation, as was the case in the lower part of the M Pl 3 Biozone. The *Ostracoda* reflect a sedimentation depth of about 1000 m. For some of the species found and previously not reported or illustrated from the Mediterranean Pliocene, an iconographic documentation and palaeoecological-taxonomic notes are given.

RIASSUNTO – [Le ostracofaune plioceniche al limite M Pl 3 - M Pl 4 del carotaggio nell'area di Capo Rossello (Agrigento, Sicilia)] – Sono state studiate le associazioni ad ostracodi di sedimenti pliocenici del pozzo TPM al passaggio tra le Biozone M Pl 3 – M Pl 4. L'analisi quantitativa di 15 campioni ha permesso di evidenziare la continuità di condizioni di buona circolazione al fondo precedentemente individuate nella parte inferiore della zona M Pl 3 e la persistenza di un ambiente di deposizione batiale, con una paleobatimetria stimata intorno a 1000 m. Per alcune delle specie rinvenute, precedentemente non segnalate o figurate dal Pliocene mediterraneo, è fornita documentazione iconografica e note paleoecologiche e sistematiche.

INTRODUCTION

The bathyal Pliocene ostracod assemblages of southern Sicily have been studied from both outcrops and boreholes in some recent papers dealing with their systematics, palaeoecology and stratigraphical distribution (Bonaduce & Sprovieri, 1985; Abate *et al.*, 1993; 1994; Aiello *et al.*, 1993; 1994; 1996a; 1996b; 1996c; 2000; Barra *et al.*, 1996; 1998; Bonaduce *et al.*, 2000).

The Zanclean ostracods have been previously studied from the lowermost Pliocene up to the first part of the M Pl 3 Biozone in the Capo Rossello area; the assemblages from the uppermost M Pl 3 Biozone to the early Pleistocene belong to the sediments of the Monte S. Nicola section.

In the prospect of a review of the bottom palaeoenvironmental events of the whole deep Mediterranean Pliocene based on ostracods, the present paper deals with 15 samples at the M Pl 3 - M Pl 4 boundary, allowing the correlation between the Capo Rossello borehole and the Monte S. Nicola section.

The M Pl 3 - M Pl 4 boundary has been placed by Sgarrella *et al.* (1999), who studied the calcareous plankton biostratigraphy of the Capo Rossello borehole, between 89 and 79 metres below the surface (mbs). The position of the boundary is uncertain due to the ambiguous common presence datum of *Globorotalia margaritae*, probably influenced by the presence of slumps.

MATERIAL AND METHODS

Fifteen samples, generally taken at 1 m intervals, were recovered from the drilling depth interval of 95.96 mbs to 78.58 m in the Capo Rossello borehole. They belong to the sediments of the Trubi Formation, directly overlying the samples studied by Barra *et al.* (1998). All the samples (each of 150 gr dried weight) were washed through 230 and 120 mesh sieves (63 µm and 125 µm respectively). All the



Text-fig. 1 - Location of the Capo Rossello borehole (Agrigento, Sicily).

Ostracoda were picked in the coarsest fraction (>125 mm), the species identified and counted.

The ostracod fauna consists of 71 species, belonging to 35 genera. Sixty-three species have been definitively or tentatively identified and the remaining 8 left in open nomenclature due to the sparse or poorly preserved nature of the material (Tab. 1); SEM illustrations and short taxonomic remarks are provided for some rare or poorly known species. The specimens studied are housed in the Bonaduce Ostracode Collection (B.O.C.), Dipartimento di Scienze della Terra, Università degli Studi di Napoli "Federico II", Naples.

GENERAL RESULTS

Throughout the investigated portion of the Capo Rossello borehole the fluctuations in abundance (total number of adult specimens) and simple species diversity (number of species) show similar trends (Text-fig. 2).

The average values of abundance and simple diversity are 93 individuals and 26 species per sample respectively. The highest values of abundance and diversity are recorded in sample 88.77-88.72 (297 individuals, 48 species), and the lowest in sample 82.87-82.82 (14 individuals, 9 species).

The ostracod assemblages are dominated by the genera *Agrenocythere* Benson, 1972, *Argilloecia* Sars, 1866, *Cytherella* Jones, 1849, *Cytheropteron* Sars, 1866, *Krithe* Brady, Crosskey & Robertson, 1874, *Parakrithe* van den Bold, 1958. The commonest species are *Krithe compressa* Seguenza, 1880 and

Krithe iniqua Abate *et al.*, 1993; *Agrenocythere pliocenica* Benson, 1972, *Argilloecia kissamovens* Sissingh, 1972, *Bairdoppilata profunda* Aiello *et al.*, 2000, *Parakrithe ariminensis* Ruggieri, 1967 and *Xestoleberis prognata* Bonaduce & Danielopol, 1988 are co-dominant species.

A small number of mainly juvenile specimens pertaining to the genera *Aurila* Pokorny, 1955, *Callistocythere* Ruggieri, 1953, *Loxoconcha* Sars, 1866, *Paracytheridea* G. W. Müller, 1894 and *Semicytherura* Wagner, 1957 have been found in samples 81.84-81.79, 83.87-83.82, 88.77-88.72, 93.95-93.90, 95.02-94.97. These shallow-water taxa are considered allochthonous and are consequently not included in the studied assemblages.

The common occurrences of *A. pliocenica*, pertaining to the psychrospheric (Benson, 1972) genus *Agrenocythere* and of *A. kissamovens*, *Cytheropteron* (*A.*) *pinarense gillesi* Aiello *et al.*, 1996a, *K. compressa*, *K. iniqua*, *Parakrithe dimorpha* Bonaduce *et al.*, 1976 and *X. prognata*, species previously found in the older part of the core, confirm the palaeodepth of about 1000 m estimated by Barra *et al.* (1998).

Throughout the studied sequence the ostracod assemblages show generally good abundance and simple species diversity. Twenty-one species, not found in the lower part of the borehole have been recorded.

The high values of abundance and diversity point to the continuation of the Step 6, which Barra *et al.* (1998) located in the Capo Rossello borehole between 118.22 and 99.94 mbs. The assemblages belonging to this interval show the maximum abundance and diversity of the entire section, being indicative of a good bottom circulation. The first occurrences of 21 ostracod species testify the continuing re-colonization of the Pliocene Mediterranean Basin after the extinction of the marine fauna during the Messinian Salinity Crisis. The data from the Monte San Nicola section demonstrates, that in the upper part of the Pliocene the abundance and diversity of the Ostracoda increases further, reaching maximum values near the Piacenzian-Gelasian boundary (Bonaduce *et al.*, 2000).

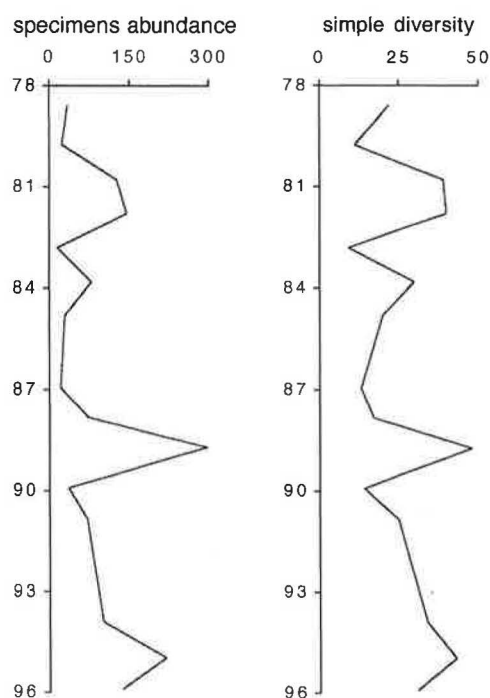
SYSTEMATICS

Order PODOCOPIDA G.W. Müller, 1894
Suborder PODOCOPINA Sars, 1866
Superfamily CYPRIDACEA Baird, 1845
Family MACROCYPRIDAE G.W. Müller, 1912
Genus MACROCYPRIS Brady, 1868
MACROCYPRIS NIMIA Maddocks, 1990

1990 *Macrocypris nimia* MADDOCKS, p. 47, figs. 2.4, 3.4, 48.5, 49.5; pls. 2.6, 3.6.

2000 *Macrocypris* ? *nimia* Maddocks – AIELLO, BARRA & BONADUCE, p. 89, pl. 2, figs. 1-2 (*cum syn.*).

Remarks – The specimens found in the Capo Rossello borehole show a remarkable constancy in the



Text-fig. 2 – Distribution of specimens abundance and simple species diversity in the studied interval.

SPECIES / SAMPLES	95.96-95.91	95.02-94.97	93.95-93.90	90.89-90.84	89.97-89.92	88.77-88.72	87.87-87.82	87.00-86.95	84.86-84.81	83.87-83.82	82.87-82.82	81.84-81.79	80.84-80.79	79.81-79.76	78.63-78.58
<i>Agrenocythere pliocenica</i> (Seguenza, 1880)	15	8	5	3	2	4	1	1	1	2	1	3	2	1	2
<i>Anchistrocheles interrupta</i> Aiello, Barra & Bonaduce, 1995		7	2	4	1	10	1		1	1		2			
<i>Argilloecia acuminata</i> G.W. Muller, 1894	2	15	3		1	31				3		4	7		
<i>Argilloecia bensoni</i> Barra, Aiello & Bonaduce, 1996	4	1	3			3							1		
<i>Argilloecia fatua</i> Barra, Aiello & Bonaduce, 1996										1					
<i>Argilloecia gonzalezi</i> Barra, Aiello & Bonaduce, 1997		2										1			
<i>Argilloecia kissamovens</i> Sissingh, 1972	14	5	7	4	7	2		1	2	2		6	4	3	1
<i>Argilloecia micra</i> Bonaduce, Aiello & Bonaduce, 1996	5	4			2	3	1					2			
<i>Argilloecia subtilis</i> Barra, Aiello & Bonaduce, 1996						1									
<i>Argilloecia trapezium</i> Barra, Aiello & Bonaduce, 1996	1		1			1							1		
<i>Argilloecia</i> sp. 1		6				4	3			4					
<i>Argilloecia</i> sp. 2	4	1													
<i>Argilloecia</i> sp. 3		2		2		3						3	1		2
<i>Bairdoppilata profunda</i> Aiello, Barra & Bonaduce, 2000	3	4	2	2	2	11	1		2	2	1	1	7	1	1
<i>Buntonia dertonensis</i> Ruggieri, 1954				1		2		1			1				1
<i>Buntonia textilis</i> Bonaduce, Ciampo & Masoli, 1976									1						
<i>Bythocypris bosquetiana</i> (Brady, 1866)	1	3				2			1			1	2		
<i>Bythocypris obtusata producta</i> (Seguenza, 1880)	5	8	3	1		9	1	1		1			2		1
<i>Cardobairdia</i> ? <i>asymmetrica</i> (van den Bold, 1946)				1		1									
<i>Cytherella gibba</i> Aiello, Barra, Bonaduce & Russo, 1996									1						
<i>Cytherella robusta</i> Colalongo & Pasini, 1980		4	3	3	1	7	4		2	3	1	2	7	1	1
<i>Cytherella vulgatella</i> Aiello, Barra, Bonaduce & Russo, 1996	4														
<i>Cytheropteron bifidum</i> Colalongo & Pasini, 1980	1	1	1	1						1		1	1		
<i>Cytheropteron (A.) denticulatum</i> Aiello, Barra & Bonaduce, 1996	4	3	3		1	3	1		1	4		3			
<i>Cytheropteron omega</i> Aiello, Barra & Bonaduce, 1996		6	1	3		7				1		5	1		1
<i>Cytheropteron (A.) p. gilesi</i> Aiello, Barra & Bonaduce, 1996	8	2	1	1	1	2	2	1				1	3	1	
<i>Cytheropteron pseudoalatum</i> Colalongo & Pasini, 1980						1						1			
<i>Cytheropteron sulcifer</i> Aiello, Barra & Bonaduce, 1996	4	1	3			3				1		8	1		1
<i>Cytheropteron venustum</i> Bonaduce, Ciampo & Masoli, 1976		1					1			1		3	1		
<i>Cytheropteron</i> sp. 1												1			
<i>Eucythere pubera</i> Bonaduce, Ciampo & Masoli, 1976								1				2			
<i>Hemiparacytheridea leopardina</i> (Ruan & Hao, 1988)						1									
<i>Henryhowella sarsii profunda</i> Bonaduce, Barra & Aiello, 1999	1	2	4	2		2		3	1		4	3	1	1	1
<i>Krithe compressa</i> (Seguenza, 1880)	14	35	11	8	6	36	12	3	1	3		3	14	1	3
<i>Krithe iniqua</i> Abate, Barra, Aiello & Bonaduce, 1993	13	19	16	10	8	33			5	9	1	9	8		7
<i>Krithe keyi</i> Breman, 1978															1
<i>Krithe monosteracensis</i> (Seguenza, 1880)	1	2	1	8		9	3		1			2			1
<i>Krithe pernoidea</i> (Bornemann, 1855)		2													
<i>Krithe perpulchra</i> Abate, Barra, Aiello & Bonaduce, 1993						3				1			4		
<i>Macrocypris nimia</i> Maddocks, 1990	2			2		2	1		1	2		1	1		
<i>Macrocypris arcuata</i> Colalongo & Pasini, 1980		1	1	1		4			1				1		
<i>Macrosarisa</i> sp. aff. <i>M. hiulca</i> Maddocks, 1990										6		2			
" <i>Macrosarisa</i> " sp. 1						1									
<i>Microceratina polygonia</i> (Colalongo & Pasini, 1980)				1				1		1					
<i>Monoceratina</i> sp. cf. <i>mediterranea</i> Sissingh, 1972		1													
<i>Oblitacythereis mediternea</i> Benson, 1977	1	1	1	1		4		1	1	1	1	1	2		1
<i>Occultocythereis culter</i> Aiello, Barra & Bonaduce, 2000	3	8	1			12	1					2	3		1
<i>Paijenborchella iocosa</i> Kingma, 1948												1			
<i>Paijenborchella malaiensis cymbula</i> Ruggieri, 1950	1	6	2	2	1	5						1	1	1	1
<i>Paracytherois acuminata</i> G.W. Muller, 1894		5				7						1	5		1
<i>Paracytherois</i> ? <i>oblonga</i> G. W. Muller, 1894		11				9	1			10		14	14		
<i>Parahemingwayella tetrapteron</i> (Bonaduce, Ciampo & Masoli, 1976)	1	3	2			2			1	6		11	1		
<i>Parakrithe acuta</i> Aiello, Barra, Abate & Bonaduce, 1993	3					2							3		
<i>Parakrithe ariminensis</i> (Ruggieri, 1967)	14	8	3	1		8		5	3	2	2	3	3	8	2
<i>Parakrithe dimorpha</i> Bonaduce, Ciampo & Masoli, 1976	3	1		1		2		1		1		3	3	5	2
<i>Parakrithe</i> sp. 1												3			
<i>Pedicythere polita</i> Colalongo & Pasini, 1980		3	4		1	4				2		1	2		
<i>Pontocypris acuminata</i> Bonaduce, Ciampo & Masoli, 1976													1		
<i>Pontocypris</i> aff. <i>acuta</i> Bonaduce, Ciampo & Masoli, 1976		4				4				2		1			
<i>Profundocythere</i> sp. 1	1	1	1	2		4				1		1	1		
<i>Propontocypris dromas</i> Aiello, Barra & Bonaduce, 2000		3				3									
<i>Propontocypris</i> ? <i>P. pirifera</i> (G.W. Muller, 1894)		1				1									
<i>Propontocypris</i> sp. 1			1												
<i>Pseudocythere (D.) armata</i> Bonaduce, Masoli, Pugliese & McKenzie, 1980		1		1		1							3		
<i>Pseudocythere (D.) mediterranea</i> Bonaduce, Masoli, Pugliese & McKenzie, 1980	2	5	3			7	3		1	3			1		
<i>Quasibuntonia radiatopora</i> (Seguenza, 1880)			1												1
<i>Retibythere (B.) scaberrima mediterranea</i> (Colalongo & Pasini, 1980)					2	2							2		
<i>Typhlocythere ruggieri</i> Bonaduce, Ciampo & Masoli, 1976												1			
<i>Typhlocytherura calabra</i> Colalongo & Pasini, 1980	1	5	2									5			
<i>Xestoleberis prognata</i> Bonaduce & Danielopol, 1988	1	4	5	3	1	19	1	1		1	2	27	8	1	1
<i>Xylocythere producta</i> (Colalongo & Pasini, 1980)			1						1						

Tab. 1 – Distribution of the species recorded in the studied part of the Capo Rossello borehole.

outline of their valves, which fits well with both Atlantic and Mediterranean Pliocene specimens. The larger size of the types is due, in our opinion, to intraspecific variability.

Genus *MACROSARISA* Maddocks, 1990
MACROSARISA sp. aff. *M. hiulca* Maddocks, 1990
 Pl. 1, fig. 6

Remarks – This species of *Macrosarisa* differs from *M. hiulca* Maddocks, 1990 due to the less sinuous outline and the higher length/height ratio. The poor state of preservation of the recovered specimens does not allow the description of this possibly new species.

“*MACROSARISA*” sp.1
 Pl. 1, fig. 9

2000 “*Macrosarisa*” sp.1 AIELLO, BARRA & BONADUCE, pp. 89–90, pl. 2, fig. 4.

Remarks – Similarly to the finding in the Monte S. Nicola section (Aiello *et al.*, 2000) this species is present in one sample, near the M Pl 3 – M Pl 4 boundary.

Family PONTOCYPRIDIDAE G.W. Müller, 1894
 Genus PONTOCYPRIS Sars, 1866
PONTOCYPRIS aff. *P. ACUTA* Bonaduce, Ciampo & Masoli, 1976
 Pl. 1, fig. 2

Remarks – This form differs in lateral outline from *P. acuta* which shows a more acuminate posterior end. The form named *Pontocypris* aff. *P. acuta* in Aiello *et al.* (2000; p. 90, pl. 2, fig. 6), differs slightly, due to its rounded antero-dorsal outline.

Genus PROPONTOCYPRIS Sylvester-Bradley, 1947
PROPONTOCYPRIS ? *PIRIFERA* (G.W. Müller, 1894)
 Pl. 1, fig. 1

?1894 *Pontocypris pirifera* G.W. MÜLLER, p. 247, pl. 10, figs. 1–3, 18–20, 22–24; pl. 38, fig. 52.

Remarks – Some of the specimens of *P. pirifera* figured by Athersuch & Whittaker (1982, pl. 9, 70, fig. 3) differ slightly from the form found in the Pliocene due to its more rounded anterodorsal margin.

Superfamily CYTHERACEA Baird, 1850
 Family TRACHYLEBERIDIDAE Sylvester-Bradley, 1948
 Genus HENRYHOWELLA PURI, 1957
HENRYHOWELLA Sarsii PROFUNDA
 Bonaduce, Barra & Aiello, 1999

1998 *Henryhowella asperrima* (Reuss) – BARRA *et al.*, p. 85.
 1999 *Henryhowella sarsii* (G.W. Müller) *profunda* BONADUCE, BARRA & AIELLO, p. 68, pl. 1, figs. 5–12; pl. 4, figs. 1–8.

Remarks – This subspecies, previously identified as *H. asperrima* Reuss, first occurs in the Pliocene of the Mediterranean almost corresponding with the M Pl 1 – M Pl 2 boundary (Barra *et al.*, 1998).

Family CYTHERURIDAE G.W. Muller, 1894
 Genus HEMIPARACYTHERIDEA Herrig, 1963
HEMIPARACYTHERIDEA LEOPARDINA (Ruan & Hao, 1988)
 Pl. 1, fig. 14

1988 *Bythoceratina leopardina* RUAN & HAO, p. 257, pl. 41, figs. 20–23.
 1995 *Hemiparacytheridea leopardina* (Ruan & Hao, 1988) – AYRESS *et al.*, pp. 219–220, figs. 5 F–L. (*cum syn.*).

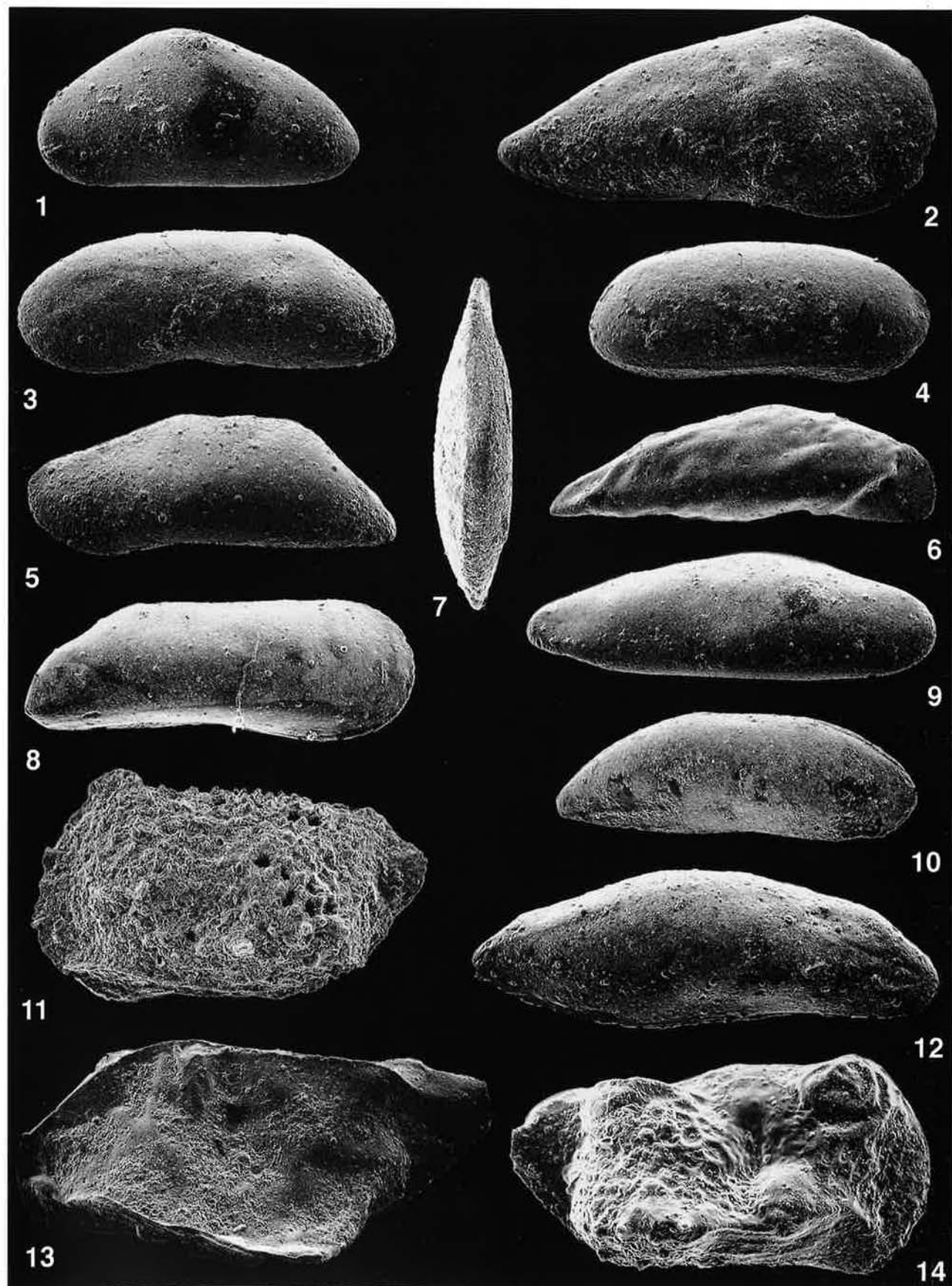
Remarks – The present is the first Mediterranean finding of this bathyal-abyssal species previously reported from the Indo-Pacific and North Atlantic (Ayress *et al.*, 1995, with literature). It ranges from Middle Eocene to the Recent, at depths greater than 1400 m.

Family BYTHOCYTHERIDAE Sars, 1866
 Genus MONOCERATINA Roth, 1928

EXPLANATION OF PLATE 1

- Fig. 1 - *Propontocypris* ? *pirifera* (G.W. Müller, 1894), LV, Stn. TPM 88.77–88.72, B.O.C. 2476, (× 156).
 Fig. 2 - *Pontocypris* aff. *P. acuta* Bonaduce, Ciampo & Masoli, 1976, RV, Stn. TPM 95.02–94.97, B.O.C. 2477, (× 156).
 Fig. 3 - *Argilloecia* sp. 1, LV, Stn. TPM 95.02–94.97, B.O.C. 2478, (× 156).
 Fig. 4 - *Argilloecia* sp. 3, RV, Stn. TPM 88.77–88.72, B.O.C. 2479, (× 156).
 Fig. 5 - *Argilloecia* (?) sp. 2, LV, Stn. TPM 95.02–94.97, B.O.C. 2480, (× 156).
 Fig. 6 - *Macrosarisa* sp. aff. *M. hiulca* Maddocks, 1990, RV, Stn. TPM 83.87–83.82, B.O.C. 2481, (× 78).
 Figs. 7, 10 - *Paracytherois* ? *oblonga* G.W. Müller, 1894, 7) CC, Stn. TPM 83.87–83.82, B.O.C. 2482, (× 156); 10) RV from CC, Stn. TPM 80.84–80.79, B.O.C. 2483, (× 156).
 Fig. 8 - *Krithe perpulehra* Abate *et al.*, 1993, RV, Stn. TPM 80.84–80.79, B.O.C. 2484, (× 117).
 Fig. 9 - “*Macrosarisa*” sp. 1, RV, Stn. TPM 88.77–88.72, B.O.C. 2485, (× 78).
 Fig. 11 - *Typhloeucytherura calabra* Colalongo & Pasini, 1980, LV Stn. TPM 81.84–81.79, B.O.C. 2486, (× 273).
 Fig. 12 - *Paracytherois acuminata* G.W. Müller, 1894, RV, Stn. TPM 88.77–88.72, B.O.C. 2487, (× 156).
 Fig. 13 - *Monoceratina* sp. cf. *mediterranea* Sissingh, 1972, LV, Stn. TPM 95.02–94.97, B.O.C. 2488, (× 117).
 Fig. 14 - *Hemiparacytheridea leopardina* (Ruan & Hao, 1988), RV, Stn. TPM 88.77–88.72, B.O.C. 2489, (× 273).

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



MONOCERATINA sp. cf. MEDITERRANEA Sissingh, 1972
Pl. 1, fig. 13

Remarks – A single valve has been found in sample 95.02-94.97. It differs from *Monoceratina mediterranea* Sissingh, 1972 (pp. 152-153, pl. 12, figs. 13-14), described from the Lower Pleistocene of Rhodos, in its slightly different outline.

Family PARADOXOSTOMATIDAE Brady & Norman, 1889
PARACYTHEROIS ACUMINATA G.W. Müller, 1894
Pl. 1, fig. 12

1894 *Paracytherois acuminata* G.W. MÜLLER, pp. 326-327, pl. 22, figs. 5, 17-18, 22.

1971 *Paracytherois acuminata* G.W. Müller – BARBEITO-GONZALEZ, p. 317, pl. 39, figs. 1a-1b.

1976 *Paracytherois acuminata* G.W. Müller – BONADUCE *et al.*, pp. 120-121, pl. 71, figs. 12-13.

1998 *Paracytherois acuminata* G.W. Müller – BARRA *et al.*, p. 85.

Remarks – *P. acuminata* has been found in the Mediterranean in shallow waters, but is always very rare (G.W. Müller, 1894; Barbeito-Gonzalez, 1971; Bonaduce *et al.*, 1976). In the bathyal Pliocene sediments of Capo Rossello it occurs rather commonly.

PARACYTHEROIS ? OBLONGA G.W. Müller, 1894
Pl. 1, figs. 7, 10

?1894 *Paracytherois oblonga* G.W. MÜLLER, p. 326, pl. 22, figs. 4, 20.

1998 *Paracytherois ? oblonga* G.W. Müller – BARRA *et al.*, p. 85.

Remarks – This form has a very delicate carapace which is mainly compressed and deformed in the specimens recovered in the samples of the Capo Rossello borehole. Consequently a certain specific determination is not possible.

ACKNOWLEDGMENTS

The authors thank Prof. Gioacchino Bonaduce (Università di Napoli "Federico II") for suggestions and his critical review of the manuscript and the referees, Prof. Giuliano Ruggieri (Palermo) and Prof. Robin Whatley (Aberystwyth), for their appropriate remarks and improvements. Mr. Antonio Canzanella (Università di Napoli "Federico II") carefully carried out the SEM micrographs.

REFERENCES

- ABATE, S., BARRA, D., AIELLO, G. & BONADUCE, G., 1993, The genus *Krithe* Brady, Crosskey & Robertson, 1874 (Crustacea: Ostracoda) in the Pliocene - Early Pleistocene of the M. San Nicola Section (Gela, Sicily): Boll. Soc. Paleont. Ital., 32 (3): 349-366.
- , — & BONADUCE, G., 1994, The deep-water Xestoleberidinae Sars, 1928 (Crustacea: Ostracoda) in the Pliocene - Early Pleistocene of the M. San Nicola Section (Gela, Sicily): Rev. Esp. Micropal., 26 (2): 43-47.
- AIELLO, G., BARRA, D., ABATE, S. & BONADUCE, G., 1993, The genus *Parakrithe* van den Bold, 1958 (Ostracoda) in the Pliocene - Early Pleistocene of Sicily: Boll. Soc. Paleont. Ital., 32 (2): 277-285.
- , — & BONADUCE, G., 1994, L'ostracofauna plio-pleistocenica di M. San Nicola (Sicilia): un esempio di interpretazione ecologica e biostratigrafica: IV Conf. Scient. ann., Attiv. ric. Dip., Univ. Studi Napoli "Federico II": 23-25.
- , — & —, 1996a, The genus *Cytheropteron* Sars, 1866 (Crustacea: Ostracoda) in the Pliocene - Early Pleistocene of the M. San Nicola Section (Gela, Sicily): Micropaleontology, 42 (2): 167-178.
- , — & —, 1996b, *Anchistrocheles interrupta*, a new deep-water marine ostracod species (Pussellinae, Ostracoda) from the Plio-Pleistocene of the Mediterranean Basin: Boll. Soc. Paleont. Ital., 34 (3): 271-274.
- , — & —, 2000, Systematic and biostratigraphy of the ostracoda of the Plio-Pleistocene Monte S. Nicola section (Gela, Sicily): Boll. Soc. Paleont. Ital., 39 (1): 83-112.
- , — & RUSSO, A., 1996c, The genus *Cytherella* Jones, 1849 (Ostracoda) in the Italian Tortonian - Recent: Rev. Micropal., 39 (3): 171-190.
- ATHERSUCH, J., & WHITTAKER, J.E., 1982, On *Propontocypris pirifera* (G.W. Müller): Stereo-Atlas Ostracod Shells, 9: 69-76.
- AYRESS, M.A., WHATLEY, R., DOWNING, S.E. & MILLSON, K.J., 1995, Cainozoic and Recent Deep Sea Cytherurid Ostracoda from the South Western Pacific and Eastern Indian Oceans, Part I: Cytherurinae: Records of the Australian Museum, 47: 203-223.
- BARBEITO-GONZALEZ, P.J., 1971, Die Ostracoden des Küstenbereiches von Naxos (Griechenland) und ihre Lebensbereiche: Mitt. Hamburg. Zool. Mus. Inst., 67: 255-326, pls. 1-47.
- BARRA, D., AIELLO, G. & BONADUCE, G., 1996, The genus *Argilloecia* Sars, 1866 (Crustacea: Ostracoda) in the Pliocene - Early Pleistocene of the M. San Nicola Section (Gela, Sicily). In Keen, M. C. (ed.), Proc. 2nd Europ. Ostracod. Meet., Univ. Glasgow, Scotland, 1993: 129-134.
- , BONADUCE, G. & SGARRELLA, F., 1998, Paleoenvironmental bottom water conditions in the early Zanclean of the Capo Rossello area (Agrigento, Sicily): Boll. Soc. Paleont. Ital., 37 (1): 61-88.
- BENSON, R.H., 1972, The *Bradleya* Problem with descriptions of two new psychrospheric ostracode genera, *Agrenocythere* and *Poseidonamicus* (Ostracoda: Crustacea): Smiths. Contr. Paleobiol., 12: 1-138.
- BOLD, W.A. VAN DEN, 1958, Ostracoda of the Brasso Formation of Trinidad: Micropal., 4 (4): 391-418.
- BONADUCE, G., BARRA, D. & AIELLO, G., 1999, The genus *Henryhowella* Puri, 1957 (Crustacea, Ostracoda) in the Atlantic and Mediterranean from Miocene to Recent: Boll. Soc. Paleont. Ital., 38 (1): 59-72.
- , — & —, 2000, The ostracods of the Plio-Pleistocene Monte S. Nicola section (Gela, Sicily): an attempt of palaeoecological interpretation: Boll. Soc. Paleont. Ital., 39 (2): 157-164.
- , CIAMPO, G. & MASOLI, M., 1976, Distribution of Ostracoda in the Adriatic Sea: Pubbl. Staz. Zool. Napoli, 40, suppl. 1: 1-304.
- & DANIELOPOL, D., 1988, To see and not to be seen: the evolutionary problems of the Ostracoda Xestoleberididae. In Hanai, T., Ikeya, N. & Ishizaki, K. (eds.), Evolutionary Biology of Ostracoda, Proc. Ninth Int. Symp. Ostracoda: 375-398.
- & SPROVIERI, R., 1985, The appearance of *Cytheropteron testudo* Sars (Crustacea, Ostracoda) is a Pliocene event. Evidences from a sicilian sequence (Italy): Boll. Soc. Paleont. Ital., 23 (1): 131-136.
- BRADY, G. S., CROSSKEY, H. W. & ROBERTSON, D., 1874, A monograph of the Post-Tertiary Entomostraca of Scotland

- including species from England and Ireland: *Ann. Vol. (Monogr.) Palaeont. Soc.*, 28: 1-232.
- JONES, T.R., 1849, A monograph of the Entomostraca of the Cretaceous Formation of England: *Palaeont. Soc. London, Monogr.*: 1-40, 7 pls.
- MADDOCKS, R.F., 1990, Living and fossil Macrocyprididae (Ostracoda): The University of Kansas Paleontological Contribution, 2: 1-404.
- MÜLLER, G.W., 1894, Die Ostracoden des Golfes von Neapel und der angrenzenden Meeres-Abschnitte: Fauna und Flora, Herausgegeben von der Zoologischen Station zu Neapel, 21 (1-8): 1-404, 40 pls.
- POKORNY, W., 1955, Contribution to the morphology and taxonomy of the Subfamily "Hemicytherinae" Puri: *Acta Univ. Carolinae Pragae, Geologica*, 3: 1-35.
- RUAN, P. & HAO, Y., 1988, Systematic description of microfossil. 2. Ostracoda. In Rong, L. & Shu, Z. (eds.), Quaternary microbios in the Okinawa Trough and their Geological Significance: Chinese University of Geosciences (Beijing), Geological Publishing House: 227-394, pls. 33-74.
- RUGGIERI, G., 1953, Età e fauna di un terrazzo marino sulle coste ioniche della Calabria: *Giorn. Geol.*, 23: 20-168.
- , 1967, Due Ostracofaune del Miocene alloctono della Val Marecchia (Appennino settentrionale): *Riv. Ital. Paleont. Strat.*, 73 (1): 351-384.
- SARS, G.O., 1866, Översigt af Norges marine ostracoder: *Forhandlinger i Videnskabs - Selskabet i Christiania*: 1-130.
- SEGUENZA, G., 1880, Le formazioni terziarie della provincia di Reggio (Calabria): *Mem. R. Acc. Lincei*, s. 3, 6: 443 pp., pls. 4-17.
- SGARRELLA, F., SPROVIERI, R., DI STEFANO, E., CARUSO, A., SPROVIERI, M. & BONADUCE, G., 1999, The Capo Rossello bore-hole (Agrigento, Sicily) cyclostratigraphic and paleoceanographic reconstructions from the quantitative analyses of the Zanclean foraminiferal assemblages: *Riv. Ital. Paleont. Strat.*, 105 (2): 303-322.
- SISSINGH, W., 1972, Late Cenozoic Ostracoda of the South Aegean Island Arc: *Utrecht Micropal. Bull.*, 7: 187 pp.
- WAGNER, C.W., 1957, Sur les Ostracodes du Quaternaire Récent des Pays-Bas et leur Utilisation dans l'Étude géologique des Dépôts Holocènes: *Diss. Univ. de Paris*: 1-259.

(manuscript received December 14, 2000
accepted March 2, 2001)

Giuseppe AIELLO
Diana BARRA
Dipartimento di Scienze della Terra
Università di Napoli "Federico II"
Largo S. Marcellino 10, 80138 Napoli, Italy