

Bollettino

della

Società Paleontologica Italiana

Pubblicato sotto gli auspici
del Consiglio Nazionale delle Ricerche

Volume 43, n. 1-2, 2004

Proceeding of the
1st MEETING OF THE ITALIAN OSTRACODOLOGISTS
“IN MEMORY OF GIULIANO RUGGIERI”

Rimini, February 12-14, 2003

Editors:
Elsa Gliozzi
Antonio Russo

MUCCHI - MODENA

<i>Bollettino della Società Paleontologica Italiana</i>	43 (1-2), 2004	ISSN 0375-7633	123-128	–	Modena, Novembre 2004
---	----------------	----------------	---------	---	-----------------------

Measurement of the uplift of the La Starza Marine Terrace (Pozzuoli-Italy) by ostracod assemblages

Giuliano CIAMPO

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

KEY WORDS – *Ostracoda, Palaeobathymetry, Holocene, Campi Flegrei, South Italy.*

ABSTRACT– *The uplift of the marine terrace of La Starza (Pozzuoli - South Italy) has been calculated on the basis of ostracod assemblages. The very swift uplift occurred between 8 and 4.5 kyr BP and it lifted the terrace by at least 68 m.*

RIASSUNTO – [Misura del sollevamento del terrazzo marino di La Starza (Pozzuoli) per mezzo delle associazioni ad ostracodi] – *Viene calcolato il sollevamento del terrazzo marino di La Starza, avvenuto tra 8000 e 4500 anni fa, sulla base delle associazioni ad ostracodi. Il calcolo, eseguito secondo una metodica proposta recentemente dallo scrivente, indica un sollevamento massimo di oltre 60 m. L'entità del sollevamento non è giustificabile con fenomeni eustatici, ma, in accordo con altri Autori, andrebbe attribuito a fattori vulcano-tettonici.*

INTRODUCTION

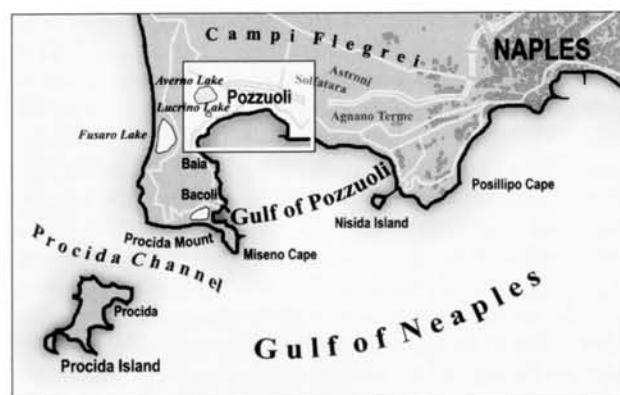
Campi Flegrei is an explosive caldera created by collapse during two major volcanic events (Text-fig. 1). This caldera was the source of two large volcanic deposits in the Campanian plain, namely Campanian ignimbrite 34 kyr BP, and Neapolitan yellow tuff, 11 kyr BP. Campi Flegrei has had only one small historical eruption, which formed Monte Nuovo in 1538. About one-third of Campi Flegrei is below sea level, forming Pozzuoli Bay. Since the formation of Neapolitan yellow tuff, two major periods of eruptive activity occurred in Campi Flegrei from 10 to 8 kyr BP and again from 4.5 to 3.7 kyr BP (Dvorak & Mastrolorenzo, 1991).

The marine terrace of La Starza (Text-fig. 2) is parallel to the northern coastline of Pozzuoli Bay from Monte Nuovo to Pozzuoli. It is bounded by a seacliff from 25 to more than 40 m above mean sea level. Exposed in this section are three marine layers

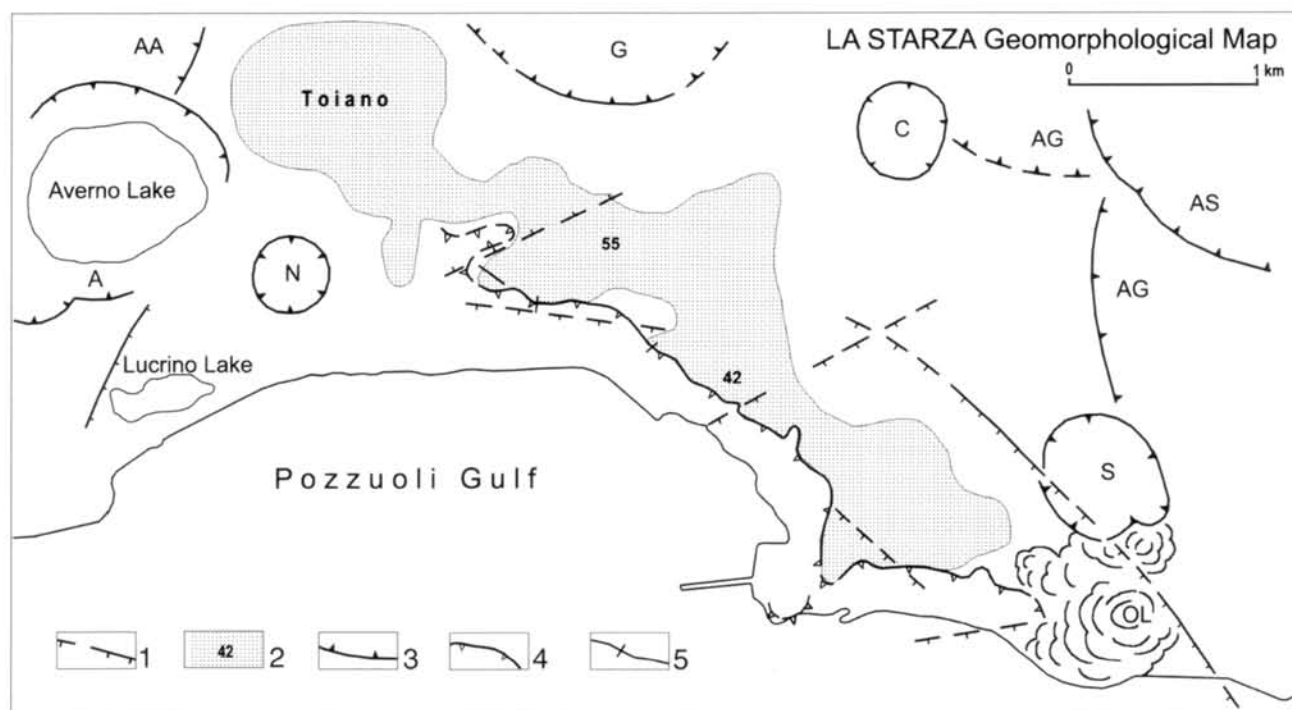
separated by tephra layers erupted from Campi Flegrei. These marine layers represent three different transgressions of the sea that occurred from 8.4 to about 4 kyr BP. The position of these marine layers tens of meters above present sea level cannot be explained solely by eustatic sea level changes during the past 8 kyr, and it has been linked to bradyseismic and volcano-tectonic movements (Cinque *et al.*, 1985). The uppermost and youngest marine layer was uplifted at least 40 m in less than 3 kyr. Most of this uplift occurred during a long quiescent period from 8 to 4.5 kyr BP (Cinque *et al.*, 1985; Dvorak & Mastrolorenzo, 1991).

In order to reconstruct palaeobathymetries and palaeoecologic events (Amore *et al.*, 1988a, b), two sections were sampled along the cliff, in resorts known as Proprietà Fusco and Proprietà Sersale (Text-fig. 3). Both are about 40 m thick, starting from 8 m above sea level. Foraminifera, ostracoda and molluscs were studied. On the basis of these assemblages, palaeobathymetries were assumed to be from –10 m to a maximum of –40, –50 m (P. Fusco). The marine facies were rapidly replaced by continental sediments towards the top. Moreover, the Sersale section was slightly more proximal compared to the Fusco section.

Ostracods have great sensitivity to environmental factors especially to nature and grain size of the substratum, salinity, food supply and depth. With respect to depth, many species seem to have a restricted ecological valence irrespective of other factors. Accordingly, palaeobathymetric curves based on quantitative analysis of ostracod assemblages have been constructed from cores drilled on the Tyrrhenian shelf, late Pleistocene-Holocene in age (Ciampo, 2003). These curves reflect the climatic events of this time



Text-fig. 1 - Location map.



Text-fig. 2 - Campi Flegrei geomorphologic map: 1) faults rims; 2) terraced surface and its elevation above sea level; 3) volcanic; 4) La Starza cliff; 5) studied sections (from Cinque *et al.*, 1988, modified).

interval as indicated by palaeoclimatic curves based on planktonic foraminifera, calcareous nannofossils, pteropods, pollens and $\delta^{18}\text{O}$ (Amore *et al.*, 2000, Bucchieri *et al.*, 2002; Amore *et al.*, in press).

METHODS AND RESULTS

The method to calculate palaeobathymetries was proposed for studying upper Pleistocene-Holocene cores from the continental shelf of the Tyrrhenian Sea (Ciampo, 2003). The starting point was from actual bathymetric ostracoda distribution in the Mediterranean Sea, based principally on Bonaduce *et al.* (1975) and Breman (1975), where quantitative data are available, but also on the abundant literature in this regard. Selected species (widely cited species with a comparable depth range) were chosen in order to bound bathymetric intervals in which each sample of the cores fell. Then, to calculate the depth, the percentage of each species in the core samples was compared with linear and polynomial (second order) percentages of the same species currently living in the Mediterranean Sea, within the bounded intervals. The average between the means of the sums of linear and polynomial values is the inferred depth. After the despatch of the article (November 2001) studies to refine the method continued. The bathymetric distribution of the selected species was checked again, and more than 200 controls on actual ostracod

assemblages were carried out using different parameters. Thus a more detailed table (table of first order markers) to determine the bathymetric interval of fossil samples was obtained (Tab. 1). Furthermore, the linear distribution of bathymetric range of species proved to give extreme results. Thus the method was modified by using the polynomial (fourth and sixth order) patterns of distribution, which seems to give better results. These innovations are now applied to the ostracod assemblages recorded in the La Starza section.

The ostracod assemblages of the Sersale section are usually poor and carapaces are often decalcified. The assemblages from the Fusco section are more abundant and better preserved. As the method requires at least 100 specimens, palaeobathymetries of only four samples for Fusco and one alone for Sersale could be calculated. The usable samples of Fusco (521, 570, 572, 573) were taken between 15 and 18 m above sea level. The assemblage at altitude 15 m (Sample 521) is dominated by *Cytheretta judea* (4.8%), *Loxoconcha ovulata* (13.4%), *L. rhomboidea* (4.3%), and *Semicytherura incongruens* (32.1%). In the overlying samples, *Costa edwardsi*, *Cytheropteron ruggierii*, *Hiltermannicythere turbida*, *Leptocythere ramosa*, *Loxoconcha subrugosa*, *Sagmatocythere versicolor* increase, while the species abundant in the first sample show a sharp decrease. From the table of first order markers, the depth interval of sedimentation, for sample 521,

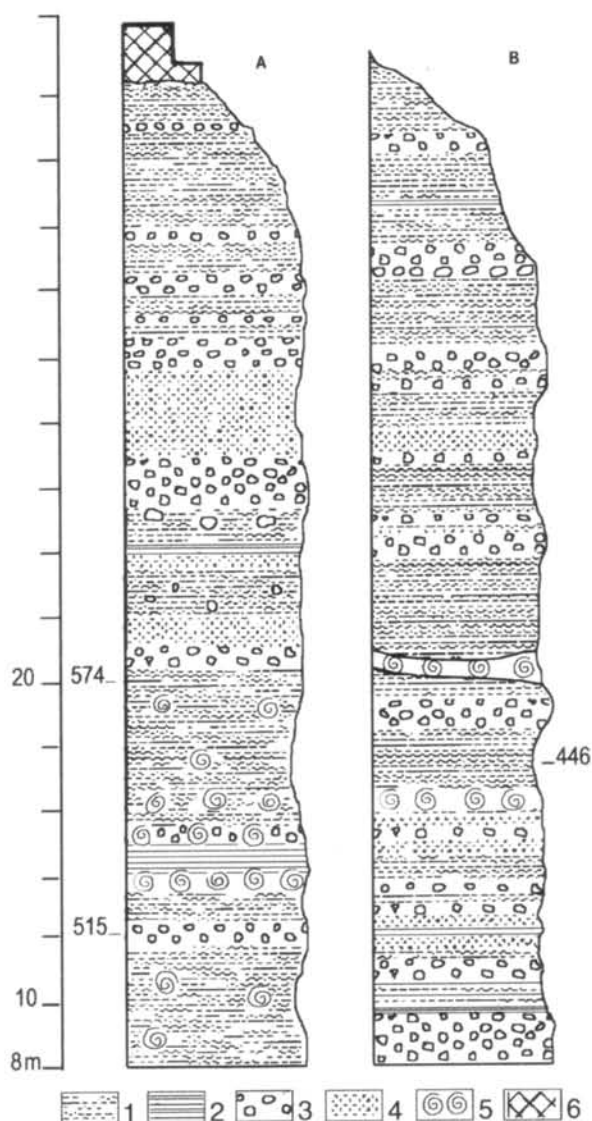


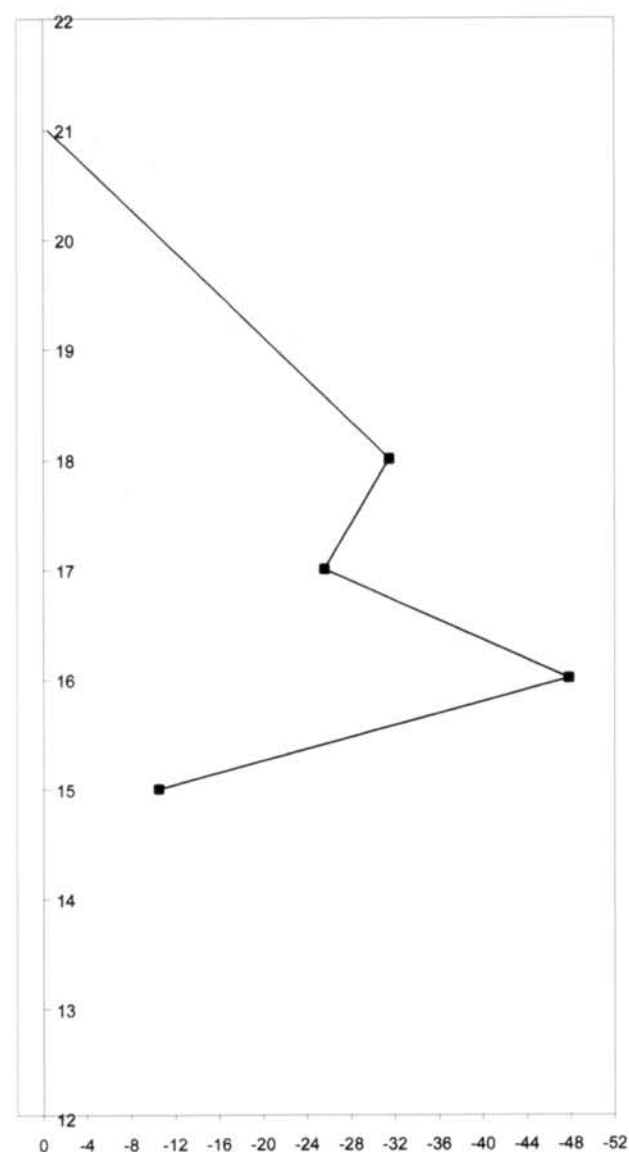
Fig. 3 - Stratigraphic columns: A) Fusco P.; B) Sersale P. Legend: 1) ash; 2) silt; 3) pumice; 4) sand; 5) fossiliferous beds; 6) roman ruins (from Amore *et al.*, 1988b, modified).

is between 0 and -25 m established by the percentages of *Cytheretta adriatica* and *Loxoconcha ovulata*. Thus, the percentages of the species recorded in the sample, compared with the average of polynomial (fourth, sixth order) patterns of the current distribution of the species in the Mediterranean Sea, gives a depth of -10.5 m. Thus, the sample at 16 m a.s.l. (sample 570) gives a depth of -47.8 m (which is the maximum recorded depth), the sample at 17 m a.s.l. (572) -25.6 m, and the sample at 18 m a.s.l. (573), which precedes a negative phase of the bradyseism of the Campi Flegrei, shows a depth of -31.5 m. At about 21 m marine sediments are replaced by continental pumices (Text-fig. 4). The only utilisable sample

of Sersale (about 17 m a.s.l.), which is dominated by *Carinocythereis bairdi* (11.3%), *Cytheridea neapolitana* (27.4%) and *Hiltermannicythere turbida* (12.9%), gives a calculated depth of -28.37 m.

CONCLUSIONS

Volcano-tectonic movements in the Campi Flegrei area increased markedly between 6.75 and 4.05 kyr BP, uplifting the most recent marine sediments up to 30 m a.s.l. (Cinque *et al.*, 1985). Bathymetric analysis on the basis of ostracod assemblages of La Starza marine sediments showed a very swift uplift, which reaches a maximum of about 68 m. Sersale seems to be slightly more proximal than Fusco.



Text-fig. 4 - Bathymetric variations inferred for Fusco P.

1 order markers	FO	LO	%	min.	max.	%	min	max	%	min	max	%	min	max	%
<i>Argilloecia acuminata</i> G.W.Mueller	40		2	60	1170	7	130		8	180		15	270		
<i>Argilloecia micra</i> Bonaduce, Ciampo & Masoli			1	150	2650	6,5	210								
<i>Argilloecia</i> spp.			2,6	70	290	6	70	1250	22	215					
<i>Bosquetina dentata</i> (G.W.Mueller)			2	30	230	6	60	230	12	70		20	70	150	
<i>Buntonia textilis</i> Bonaduce, Ciampo & Masoli			1	50		2	70	330	3	100	360	6	120	330	8
<i>Bythocypris</i> spp.	170														
<i>Bythoceratina reticulata</i> Bonaduce, Ciampo & Masoli			0,5	>100											
<i>Callistocythere crispata</i> (Brady)			1	0	190	5	60	120							
<i>Callistocythere intricatoides</i> Ruggieri			3	0	50										
<i>Callistocythere rastrifera</i> Ruggieri			1,5	0	100										
<i>Carinocythereis antiquata</i> (Baird)			1	0	130	6	0	80	13	0	70				
<i>Caudites calceolatus</i> Costa		30													
<i>Cluthia keiji</i> Neale			2,4		<250										
<i>Costa edwardsi</i> (Roemer)			2	10	90	7	10	70							
<i>Cytherea alveatum</i> Bonaduce, Ciampo & Masoli			1		300										
<i>Cytherea adriatica</i> Ruggieri	0	60	1	0	50	2	0	25							
<i>Cytherea judea</i> (Brady)			1	0	100										
<i>Cytheridea neapolitana</i> Kollmann			2	0	100	6	0	80	30	20	75				
<i>Cythereis frequens</i> G.W.Mueller			1	0	150										
<i>Cytheropteron alatum</i> Sars	50		1	70	750	2	90	750							
<i>Cytheropteron hadriaticum</i> Bonaduce, Ciampo & Masoli			0,5	70	540	1	80	300	3	190					
<i>Cytheropteron garganicum</i> Bonaduce, Ciampo & Masoli			1	130	540	2	150	330	3	150	315	7	180	260	
<i>Cytheropteron monoceros</i> Bonaduce, Ciampo & Masoli			1	60	740	4	70	230							
<i>Cytheropteron vespertilio</i> (Reuss)		600	1	60	700	2	60	260							
<i>Eucythere curta</i> Ruggieri			1	50	220										
<i>Eucythere pubera</i> Bonaduce, Ciampo & Masoli			0,5	110	750										
<i>Hemicytherura videns</i> (G.W. Mueller)			>1		90										
<i>Henryhowella sarsi</i> (G.W. Mueller)			2	70	740	16	80	260							
<i>Hiltermannicythere turbida</i> (G.W. Mueller)			2	0	100	6	0	50	10	0	35				
<i>Krithe caudata</i> Breman	200														
<i>Krithe praetexta</i> (Sars)			2	30	160										
<i>Leptocythere bacascol</i> (Rome)			2	0	110	3	0	70	10	10	60				
<i>Leptocythere levis</i> (G.W. Mueller)			>1		90										
<i>Leptocythere ramosa</i> (Rome)			1	0	125	2	0	90							
1 order markers	FO	LO	%	min.	max.	%	min	max	%	min	max	%	min	max	%
<i>Loxococoncha ovulata</i> (Costa)		125	1	0	120	4	0	60	10	0	25				
<i>Loxococoncha rhomboidea</i> (Fischer)		125	1	0	100										
<i>Loxococoncha subrugosa</i> Ruggieri	0	150	1	0	125	11	0	100							
<i>Loxococoncha turbida</i> G.W.Mueller			1	0	85	5	0	65	10	0	30				
<i>Loxococonchidea minima</i> Bonaduce, Ciampo & Masoli			2	90		9	110								
<i>Monoceratina mediterranea</i> (Sissingh)			1	70	750	2	70	330	8	190	220				
<i>Monoceratina obita</i> Bonaduce, Ciampo & Masoli	70														
<i>Neocythereis fasciata</i> (Brady & Robertson)			1	0	70										
<i>Neocythereis subspiralis</i> (Brady, Crosskey & Robertson)		50													
<i>Paradoxostoma</i> spp.			2		150										
<i>Parahemingwayella tetrapterum</i> (Bonaduce, Ciampo & Masoli)			0,2	150	240	0,6	160	600							
<i>Pedicythere phryne</i> Bonaduce, Ciampo & Masoli			0,5	>150		2	200								
<i>Pedicythere tessellata</i> Bonaduce, Ciampo & Masoli			0,3	200											
<i>Polycyope demulderi</i> Sissingh		1000	3	90	700										
<i>Polycyope frequens</i> G.W. Mueller			1	110	1000	5	170	1000							
<i>Polycyope orbuliniformis</i> Breman			2	210											
<i>Polycyope parareticulata</i> Bonaduce, Ciampo & Masoli			2	100	1250										
<i>Polycyope reticulata</i> G.W. Mueller	70	1250	1	80	700	5	130	500	7	150	300				
<i>Polycyope vasfiensis</i> Sissingh	60	2350	1	80	1000	4	105	1000	14	200					
<i>Polycopsis quadridentata</i> Bonaduce, Ciampo & Masoli	70		1	160	1000	3	220								
<i>Pontocythere turbida</i> (G.W. Mueller)			2	0	120	30	0	50							
<i>Pseudocythere armata</i> Bonaduce, Masoli, Pugliese e McKenzie			1,5	180											
<i>Pseudocythere caudata</i> Sars	20	1200	1	60		4	120	220							
<i>Pterygocythereis jonesi</i> (Baird)			1	10	230	7	40	130							
<i>Pterygocythereis shveteri</i> Athersuch			1	10	200	5	60	125							
<i>Rectobuntonia miranda</i> Bonaduce, Ciampo & Masoli			0,2	>110											
<i>Sagmatocythere versicolor</i> (G.W. Mueller)			2	0	195	5	10	120	10	10	110				
<i>Semicytherura incongruens</i> (G.W. Mueller)			2	0	195	6	0	110	20	0	30				
<i>Semicytherura ruggieri</i> Pucci			2	20	175										
<i>Semicytherura suicata</i> G.W. Mueller			1	0	80	3	0	30							
<i>Typhlocythere ruggieri</i> Bonaduce, Ciampo & Masoli			0,5	>100											

Tab. 1 - table of first order markers: FO absolute first occurrence, LO absolute last occurrence, % = per cent value of an actual species in the Mediterranean Sea which corresponds a min. and a max. bathymetry.

P. Fusco/samples	517	518	519	520	521	570	572	573
m above sea level	12	13	13	15	15	16	17	18
<i>Agiloechia minor</i>							0,3	0,3
<i>Aurila convexa</i>			1,3					
<i>"Bythocythere" minima</i>					0,5			
<i>Callistocythere flavidofusca</i>					2,7		0,5	2,7
<i>Callistocythere littoralis</i>					0,5			0,3
<i>Callistocythere lobiancoi</i>					0,5			
<i>Callistocythere pallida</i>								0,2
<i>Callistocythere sp.</i>							0,3	
<i>Carinocythereis antiquata</i>					3,2		1,1	0,7
<i>Carinocythereis bairdi</i>					0,5	5	2,6	5,6
<i>Costa edwardsi</i>	*		2,6	*		7,9	16	5,8
<i>Cytheretta adriatica</i>					3,7			
<i>Cytheretta judea</i>			1,3	*	4,8			2,7
<i>Cytheridea neapolitana</i>	*		3,9			2,2	0,3	7,3
<i>Cithereis sp.</i>						23	16	7,8
<i>Cytheroma variabilis</i>						0,7	0,3	0,3
<i>Cytheromorpha nana</i>							0,3	
<i>Cytheropteron rotundatum</i>						0,7	7,3	6
<i>Eucythere curta</i>			1,3					
<i>Eucytherea alata</i>								0,2
<i>Eucytherea gibbera</i>								0,3
<i>Hemicytherea deflorei</i>								0,3
<i>Hemicytherea videns</i>								
<i>Hiltemannicythere turbida</i>					0,5	2,2	4,7	6,9
<i>Leptocythere levis</i>								0,2
<i>Leptocythere macella</i>						6,4	2,1	1,3
<i>Leptocythere ramosa</i>					0,5	10	24	18
<i>Leptocythere rara</i>								
<i>Loxocaula decipiens</i>							0,3	0,3
<i>Loxocaula eubea</i>								1,2
<i>Loxocaula gibberosa</i>								1,2
<i>Loxocaula ovulata</i>	*		12		13			0,5
<i>Loxocaula rhomboidea</i>					4,3	2,2	1,1	0,8
<i>Loxocaula stellifera</i>								
<i>Loxocaula subrugosa</i>						2,9	2,6	2
<i>Loxocaula turbida</i>			1,3					0,2
<i>Microcythere vitrea</i>					0,5	0,7	0,3	0,3
<i>Neocythereis complicata</i>							0,3	
<i>Neocythereis subspiralis</i>					2,7			
<i>Paracytheridea depressa</i>					0,5			
<i>Paracytheridea sp.</i>							0,3	
<i>Paradoxostoma atrum</i>						0,7		
<i>Paradoxostoma fuscum</i>								

<i>Paradoxostoma incongruens</i>						0,7	0,3	
<i>Paradoxostoma versicolor</i>						0,7		
<i>Polycopse reticulata</i>						0,7		
<i>Pontocythere turbida</i>			*		0,5		0,3	0,2
<i>Procytherideis retifera</i>					0,5			0,7
<i>Propontocypris pirifera</i>						2,2		
<i>Propontocypris solida</i>						0,7	0,5	0,7
<i>Pseudopammocythere similis</i>						2,9	6,8	3,1
<i>Ptherygocythereis jonesi</i>	*		2,6		0,5		0,3	0,5
<i>Ptherygocythereis siveteri</i>							2,3	1,7
<i>Rectobuntonia subulata</i>						0,7	1,3	1,8
<i>Sahania subulata</i>						0,7		0,2
<i>Sclerochilus contortus</i>								0,3
<i>Sagmatocythere napollana</i>						0,7	0,3	0,7
<i>Sagmatocythere versicolor</i>						2,9	2,3	4,3
<i>Semicytherura acuta</i>						14	0,3	0,3
<i>Semicytherura acuticostata</i>						1,6	0,5	1,7
<i>Semicytherura alifera</i>						1,1		
<i>Semicytherura costata</i>							1,1	
<i>Semicytherura dispar</i>						0,7	0,3	0,2
<i>Semicytherura incongruens</i>	*		74	*		32	6,4	0,5
<i>Semicytherura mediterranea</i>								1,2
<i>Semicytherura paradoxa</i>								0,2
<i>Semicytherura punctata</i>						4,3		0,3
<i>Semicytherura quadridentata</i>						0,5	2,9	0,5
<i>Semicytherura rara</i>								0,5
<i>Semicytherura rarecostata</i>						0,7		
<i>Semicytherura ruggieri</i>						5,7	1,3	0,5
<i>Semicytherura sulcata</i>						3,2	1,4	0,3
<i>Xestoleberis communis</i>						1,1		
<i>Xestoleberis dispar</i>	*					0,5	2,2	0,5
<i>Xestoleberis fuscomaculata</i>								0,3
<i>Xestoleberis plana</i>							1,1	
<i>Semicytherura spp.</i>						57	18	5,6
								12
N° of specimens	9	10	76	10	187	140	385	606
Bathymetric interval:								
min.					0	20	10	0
max					25	70	70	50
Bath. from polynomial 4or.					9,2	50	30	29
Bath. from polynomial 6or.					12	46	21	34
Bathymetry					11	48	26	32

Tab. 2 - distribution of ostracoda in Fusco P.

It is difficult to verify the accuracy of the inferred depths. The similarity of the curves among ostracods, foraminifera, calcareous nannofossils, pteropods, pollen and $\delta^{18}\text{O}$ is a qualitative indication. But, if we consider the sea level to be stable in the last 6 kyr, it is possible to have a quantitative indication. From 6 to 0 kyr BP, 28 samples are available from different cores; mean absolute error (absolute numbers, without +/-) is 1.48 m (of course the number of available samples is not yet sufficient). Excluding core C9 (10 samples from the Gulf of Gaeta), which has been greatly disturbed mainly by anoxic conditions, the mean error is 0.83 m. Prior to these innovations the mean error was about 5 m.

REFERENCES

- AMORE, O., BARRA, D., CIAMPO, G., RUGGIERO TADDEI, E., RUSSO, G.F. & SGARRELLA, F., 1988a, Il Terrazzo della Starza: Associazioni fossili e batimetria: Mem. Soc. Geol. It., 41: 969-981.
- , —, —, —, — & —, 1988b, Paleoeologia dei depositi terrazzati de La Starza (Pozzuoli): Atti V Simposio Ecol. Paleocol. Comun. Bent.: 455-499.
- , CAFFAU, M. & MORABITO, S., in press, Late- Pleistocene-Holocene palaeoclimate and related palaeoenvironmental changes as recorded by calcareous nannofossils and planktonic foraminifera assemblages in the southern Tyrrhenian Sea (Cape Palinuro, Italy): Marine Micropaleontology.
- , CIAMPO, G., DI DONATO, V., ESPOSITO, P., RUSSO ERMOLLI, E. & STAFFI, D., 2000, An integrate micropaleontological approach applied to Late Pleistocene-Holocene palaeoclimatic

P.Sersale/Sample	446
<i>Callistocythere flavidofusca</i>	0,8
<i>Callistocythere folliculosa</i>	
<i>Callistocythere littoralis</i>	
<i>Callistocythere lobiancoi</i>	0,8
<i>Carinocythereis antiquata</i>	
<i>Carinocythereis bairdi</i>	4,8
<i>Costa edwardsi</i>	19,4
<i>Cytheridea neapolitana</i>	15,3
<i>Cytheromorpha nana</i>	
<i>Cytheropteron rotundatum</i>	0,8
<i>Eucythere curta</i>	
<i>Hemicytherura defiorei</i>	
<i>Hiltermannicythere turbida</i>	7,3
<i>Leptocythere levis</i>	0,8
<i>Leptocythere ramosa</i>	6,5
<i>Loxoconcha rhomboidea</i>	0,8
<i>Loxoconcha sp.</i>	
<i>Loxoconcha ovulata</i>	3,2
<i>Microcythere vitrea</i>	0,8
<i>Neocythereis aff. vricae</i>	0,8
<i>Paracytheridea depressa</i>	
<i>Paracytheridea sp.</i>	
<i>Pontocythere turbida</i>	
<i>Pseudopsammocythere similis</i>	4,8
<i>Pterygocythereis siveri</i>	
<i>Rectobuntonia subulata</i>	4
<i>Sagmatocythere versicolor</i>	0,8
<i>Semicytherura alifera</i>	0,8
<i>Semicytherura incongruens</i>	16,1
<i>Semicytherura ruggieri</i>	4
<i>Semicytherura sulcata</i>	1,6
<i>Urocythereis margaritifera</i>	
<i>Xestoleberis dispar</i>	6,5
<i>Semicytherura spp.</i>	22,5
N° of specimens	124
Bathymetric interval:	
min	10
max	50
Bath. from polynomial 4ord.	28,3
Bath. from polynomial 6ord.	28,4
Bathymetry	28,3

Tab. 3 - distribution of ostracoda in Sersale P.

changes (Gaeta Bay, Italy): *Climates: Past and Present*. Geol. Soc. London, Special Publ. 181: 95-111.

BONADUCE, G., CIAMPO, G. & MASOLI, M., 1975, Distribution of ostracoda in the Adriatic Sea: *Pubbl. Staz. Zool. Napoli*, 40 (1): 1-154.

BREMAN, E., 1975, Distribution of ostracodes in the bottom sediments of the Adriatic Sea: *Vrije Univ. Amsterdam, Offset Krips Repr.*, Meppel.: 1-165.

BUCCHERI, G., CAPRETTO, G., DI DONATO, V., ESPOSITO, P., FERRUZZA, G., PESCATORE, T., RUSSO ERMOLLI, E., SENATORE, M.R., SPROVIERI, M., BERTOLDO, M., CARELLA, D. & MADONIA, G., 2002, A high resolution record of the last deglaciation in the southern Tyrrhenian Sea: environmental and climatic evolution: *Marine Geology*, 186: 447-470.

CIAMPO, G., 2003, Reconstruction of Late Pleistocene-Holocene palaeobathymetries from ostracoda on the Tyrrhenian continental shelf: *Geobios*, 36: 1-11.

CINQUE, A., LAURETI, L., & RUSSO, F., 1985, Le variazioni della linea di costa lungo il litorale campano durante il Quaternario: *La "Terra"*, 5: 19-25.

DVORAK, J.J., & MASTROLORENZO, G., 1991, The mechanism of recent vertical crustal movements in Campi Flegrei caldere, southern Italy: *Geol. Soc. of America, Special Paper* 263: 1-47.

(manuscript received October 23, 2003

accepted March 18, 2004)

Giuliano CIAMPO

Dipartimento di Scienze della Terra
Università degli Studi di Napoli "Federico II"
Largo S. Marcellino 10, 80138 Napoli, Italy