Preliminary data on the Holocene Foraminifera of the Cilento continental shelf (Tyrrhenian Sea)

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Abstract

The present paper supplies the first data on the foraminiferal assemblages and ecology in Holocene surface sediments of the Campanian continental shelf, in the area off the Cilento promontory.

Different types of assemblages have been distinguished and they have been related with parameters as depth, type of sediment and presence of algal and plant remains.

Our study has pointed out the strong prevalence of benthic species both in infralittoral and circalittoral samples and the absence of species that are extinct or indicative of particular paleoclimatic episodes. The age of the assemblages is therefore Holocene, with the exception of a group of foraminifers, presumably reworked, similar to microfaunas of Tyrrhenian age.

The composition of the assemblages, in relation with the known chemical-physical parameters (type of sediment, algal and plant remains, fluvial input and water-depth) has put in evidence that:
- there is an almost perfect agreement, both in the infralittoral and in the circalittoral zone, between type of sediment and the characteristic foraminiferal assemblages;
- as to the algal and plant remains, present in all the samples, in the infralittoral zone the abundance of epiphytic species is in agreement with the presence of P. oceanica and of crusty and branching Melobesioidae;
- on the contrary in the circalittoral zone the presence of epiphytic species, along with algal remains, is probably due to phenomena of transport from shallower levels.
- the fluvial input, given by the rivers Solofrone and Alento, causes a sensible increase of euryhaline species, even if it has not a decisive effect on their global frequency.

Finally some remarks are made on the ecological meaning of some species, that, for some of them, is not in agreement with what reported in previous papers.

Keywords: Foraminifera, Ecology, Holocene, Cilento, Thyrrhenian Sea, Italy.

RIASSUNTO

Nel presente lavoro vengono forniti i primi dati sulle associazioni e sull’ecologia dei foraminiferi presenti nei sedimenti superficiali di età olocenica nella piattaforma continentale campana, nell’area prospiciente la porzione settentrionale del Cilento.

Sono stati individuati vari tipi di associazione e sono stati messi in rapporto ai parametri noti, quali la profondità, il tipo di sedimento e la presenza di popolamenti vegetali.

Lo studio effettuato ha messo in evidenza la forte prevalenza delle specie bentoniche nei campioni sia infralitorali che circalitorali e l’assenza di specie estinte o comunque significative di particolari episodi paleoclimatici.

L’età delle associazioni è dunque olocenica, fatta eccezione per un gruppo di foraminiferi, presumibilmente rimaneaggiati, simili a microfaune di età tirreniana.

La composizione delle associazioni, in relazione con i parametri chimico-fisici noti (tipi di sedimento, popolamenti vegetali, apporti fluviali e profondità) ha evidenziato una corrispondenza pressoché totale delle associazioni caratteristiche, riguardo ai tipi di sedimento presenti e non sempre invece nei confronti dei popolamenti vegetali e degli apporti fluviali.

Vengono inoltre fornite osservazioni sui significati ecologici di alcune specie, non corrispondenti, per alcune di esse, a quelli noti in letteratura.


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RESUMEN

En este trabajo se dan los primeros datos sobre las asociaciones de foraminíferos y su ecología en los sedimentos holocenos superficiales de la plataforma continental de Campania, en el área al norte de Cilento.

Se han caracterizado varias asociaciones y se las ha relacionado con la profundidad, tipo de sedimento y praderas de algas.

El estudio ha puesto de manifiesto el predominio de las especies bentónicas, tanto en las muestras infra como circalitorales, y la ausencia de especies extintas o indicativas de episodios paleoclimáticos particulares. La edad de las asociaciones es holocena, salvo un grupo probablemente retrabajado, similar a las faunas tirrenienses.

La composición de las asociaciones en relación con los parámetros físico-químicos conocidos (sedimento, vegetación, influencia fluvial y profundidad) puso en evidencia que, respecto al tipo de sedimento, hay una correspondencia casi total con las asociaciones características. Por el contrario, no siempre la hay respecto de la vegetación ni de los aportes fluviales.

Por otra parte, se han realizado observaciones sobre el significado ecológico de algunas especies, que no se corresponden con lo referido en la literatura.

Palabras clave: Foraminíferos, Ecología, Holoceno, Cilento, Mar Tirreno, Italia.

INTRODUCTION

The present paper supplies the first data on the foraminiferal assemblages and ecology in Holocene surface sediments of the Campanian continental shelf, in the area off Cilento; this area, lying between the Gulf of Salerno and the Gulf of Policastro, is delimited to the north by the mouth of the river Solofrione and to the south by the mouth of the river Alento.

The assemblages studied come from 10 bottom samples, more or less regularly distributed along the coast from north to south, collected partly in the Gulf of Salerno (B.110-B.113) and partly off the Cilento promontory (B.125-130) (Fig.1).

The distribution of the sampling sites holds a certain interest because the samples come from two areas with a different geomorphological and sedimentological history (Bartolo et al., 1983). The Gulf of Salerno and the Sele Plain, lying behind the former, were affected during the Plio-Quaternary by strong subsidence which led to the accumulation of more than 1000 m of sediments (Ippolito et al., 1973; Agip, 1977). The Cilento shelf, on the contrary, represents a structural high with modest Plio-Quaternary sedimentation. In particular, in the northern part of the Gulf of Salerno and off the river Alento it is possible to recognize a zone of normal sedimentation and in the Cilento shelf a zone of low sedimentation-rate and/or erosion. In this second zone there are more or less wide areas where the substrate is exposed. Moreover, sandy sediments, probably representing relict deposits, have been observed off Punta Licosa, and “coralligenic” (?) banks off Capo Palinuro. (Coppa et al., 1992).

Data on the distribution of foraminifers in the Gulf of Salerno and in the Gulf of Policastro, bordering the area studied in the present paper, have been supplied by Sgarrella and Barra (1985) and Sgarrella et al. (1985) respectively.

<table>
<thead>
<tr>
<th>SAMPLES</th>
<th>LATITUDE</th>
<th>LONGITUDE</th>
<th>DEPTH</th>
<th>SEDIMENT</th>
<th>WD</th>
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<tr>
<td>B.110</td>
<td>40°22’N</td>
<td>14°57’E</td>
<td>-23</td>
<td>ssS</td>
<td>100</td>
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<tr>
<td>B.125</td>
<td>40°13’N</td>
<td>14°53’E</td>
<td>-24</td>
<td>bG</td>
<td>81</td>
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<tr>
<td>B.126</td>
<td>40°12’N</td>
<td>14°50’E</td>
<td>-27</td>
<td>ssS</td>
<td>72</td>
<td>60.95</td>
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<td>B.127</td>
<td>40°11’N</td>
<td>14°58’E</td>
<td>-48</td>
<td>sM</td>
<td>21</td>
<td>1.25</td>
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<tr>
<td>B.128</td>
<td>40°16’N</td>
<td>15°05’E</td>
<td>-49</td>
<td>M</td>
<td>62.60</td>
<td>0.76</td>
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<tr>
<td>B.129</td>
<td>40°17’N</td>
<td>14°54’E</td>
<td>-51</td>
<td>sM</td>
<td>54.50</td>
<td>10.09</td>
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<td>B.130</td>
<td>40°13’N</td>
<td>15°01’E</td>
<td>-52</td>
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<td>59</td>
<td>21.18</td>
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<td>B.131</td>
<td>40°20’N</td>
<td>14°54’E</td>
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<td>B.132</td>
<td>40°16’N</td>
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<td>B.133</td>
<td>40°17’N</td>
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<td>M</td>
<td>110</td>
<td>0.16</td>
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Table 1. In the table it is given for each sample the code, geographical co-ordinates (latitude and longitude), water-depth (in m), type of sediment (bG= bioclastic gravel; bGsaS= bioclastic gravel and sandy silt; gsaM= gravelly sandy mud; saS= sandy silt; sM= muddy silt; sM= sandy mud; sM= silty mud; M= mud), weight (in g) of dried sediment (WD) and weight of washing residue for 100 g of dried sediment (WWR).

SAMPLING METHODS

The samples were collected by means of a Shipek grab during two scientific cruises of the N/O Bannock (1984, 1985). They have been dried in oven at 30°C, then weighted and a washed on sieves with 88 micron openings; the residue obtained has been dried again in oven at 30°C, weighted and splitted so to obtain fractions allowing to collect at least 300 specimens, the minimum number necessary for a correct statistical analysis (Blanc-Vernet, 1969). Sample codes, geographic co-ordinates, water-depth, type of sediment, weight of dried sediment and weight of washed residue per 100 g of dried sediment are given in Table 1.

Nearly all the samples come from the area of low sedimentation-rate; the sediments consist of bioclastic gravel, bioclastic gravel mixed with sandy silt, gravelly sandy mud, sandy mud, muddy silt, silty mud and mud. In particular three samples collected in the vicinity of the mouths of the rivers Solofrione (B.110, B.111 - zone of low sedimentation-rate) and Alento (B.129 - zone of normal sedimentation) are represented by sandy silt and mud respectively.
The biogenic fraction of the samples is conspicuous and mainly made of foraminiferal tests; small gastropods, fragments of cheilostome and cyclostome bryozoan colonies and ostracods occur subordinately; small bivalves are even more subordinate. Sponge spicules, little anellids, scaphopods, pteropods, fragments of branchiurid chelae and echinoids are present quite occasionally.

Plant remains are represented in almost all the samples by phanerogam frustules and lumps of broken fibres. Small branches and/or crusts of calcified Melobesioidae are also abundant but only in few samples; numerous brown Algae frustules (Cystoseira) have been found only in B.126.

THE ASSEMBLAGES: COMPOSITION AND INTERPRETATION

In all the samples the foraminifers are present with numerous, normal size and well preserved tests; 218 species have been recognized, 207 of them are benthic (Table 2).

In the following pages the typical assemblages found in the sediments of the infralittoral and circalittoral zone (sensu Peres and Picard, 1964) are schematically reported. The assemblages were individuated taking into consideration all the species

Table 2. In this table the samples are listed with reference to the marine zones (infralittoral and circalittoral) in order of increasing water-depth. For each sample it is given the frequency of each benthic species as a percentage of the total number of benthic foraminifers (X = percentage lower than 0.5%); the presence (+) of planktic species; water-depth at sampling site; type of sediment (bG= bioclastic gravel; bGsaS= bioclastic gravel and sandy silt; gsM= gravelly sandy mud; saS= sandy silt; mS= muddy silt; saM= sandy mud; sM= silty mud; M= mud); type of vegetation (C=Cystoseira; bM= branching Melobesioidae; cM=crustose Melobesioidae; P=P. oceanica); percentage of benthos on the total of foraminiferal fauna.
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<td>SPECIES SAMPLES</td>
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<td>Flavonol</td>
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<td>Porphyridium sp.</td>
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<td>Bryum chamaecnymoideo (PRONBIN)</td>
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<td>Bartramia viridula (COLETA)</td>
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<td>Bartramia pellita (PARR)</td>
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<td>Bartramia purpurea (HENK, ALLEN &amp; EGGLESTON)</td>
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<td>Bartramia pellita (PARR)</td>
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present with percentages higher than 3%, listed in decreasing frequency order.

The ecological significance of the various species is given with reference to the literature (Blanc-Vernet, 1969; Haake, 1977; Blanc-Vernet et al., 1979; Venec Peyre, 1984; Sgarrella and Barra, 1985; Sgarrella et al., 1985; Coppa, 1987, 1988; Jorissen, 1988).

**Infralittoral zone**

**(B.110, B.125, B.126)**

Benthic foraminifers exceed 98%; planktic foraminifers are quite occasional and represented by 9 species, never occurring all together in each sample.

**Sandy silt**

B.110 (-23 m).

**Assemblage:** Ammonia beccarii, Cribroelphidium granosum, Cribronoion cuvillieri, Hyperammina elongata, Haynesina depressula, Ammobaculites agguitatus, Ammobaculites globigeriniformis, Ammonia parkinsoniana and Textularia candeianna.

**Biolastic gravel**

B.125 (-34 m).

**Assemblage:** Planorbilina mediterraneensis, Cibicides lobatus, Asterigerinata mamilla and Elphidium crispum.

**Biolastic gravel and sandy silt**

B.126 (-37 m).

**Assemblage:** Asterigerinata mamilla, Rosalina bradyi, Rosalina concinna, Rosalina globularis, Cibicides refulgens, Rosalina obtusa, Quinqueloculina aff. paravula and Discorbinella bertheloti.

At -23m, where the influence of fluvial input is strong (Coppa, 1991, B.110 = CO.565), the euryhaline species Ammonia parkinsoniana, Cribroelphidium granosum, Cribronoion cuvillieri and Haynesina depressula are dominant (Fig. 2b) together with Ammonia beccarii (Fig. 2d). Among the agglutinated species (18.7%), some are very fragile (Eggerelloides scabrus, Siphonaperta aspera dilatata) and have been recorded on low energy bottoms (Blanc-Vernet et al., 1979). The epiphytic and muddy species are absent (Fig. 3).

At -34m and at -37m the sediments are characterized, in agreement with the presence of P. oceanica and of crusty and branching Melobesioideae, by epiphytic species (Planorbulina mediterraneensis and Cibicides lobatus at -34m, Rosalina bradyi, Rosalina globularis, Rosalina obtusa and Cibicides refulgens at -37m) (Fig. 2a) and by Asterigerinata mamilla. This species (Fig. 2d) is associated with Elphidium crispum in the biologic gravel and with Discorbinella bertheloti in the biologic gravel mixed with sandy silt. In these two samples the euryhaline and muddy species are absent (Fig. 3).

**Cirralittoral zone**

**(B.128, B.113, B.127, B.112, B.129, B.111 and B.130)**.

Also in this zone the benthic foraminifers prevail (90.6% - 99%); planktic foraminifers are represented by 9 species, not present in all the samples.

**Sandy mud**

B.128 (-52 m).

**Assemblage:** Melonis barleeanum, Valvulineria bradyana, Ammonia beccarii, Neocoenobita terquemi, Cribronoion cuvillieri, Bucella granulata, Rosalina bradyi and Asterigerinata mamilla.

**Gravelly sandy mud**

B.113 (-69 m).

**Assemblage:** Melonis barleeanum, Ammonia beccarii, Valvulineria bradyana, Neocoenobita terquemi, Gavellinopsis praegeri, Rosalina bradyi and Cassidulina carinato.

In the sandy-muddy sediments Melonis barleeanum prevail. This ubiquitous species is associated with the muddy species Valvulineria bradyana and with the sandy species Bucella granulata, (only at -52m), Neocoenobita terquemi, Asterigerinata mamilla and Ammonia beccarii (Fig. 2d). Gavellinopsis praegeri and Cassidulina

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**Plate I**

3. Ammobaculites agguitanus (d’Orbigny). Side view. B.129. x156.
4. Textularia candeianna d’Orbigny. Side view. B.112. x147.
8. Textularia pseudorugosa Lacroix. Side view. B.125. x30.
10. Triloculina sp. Side view. B.112. x45.
11. Quinqueloculina sp. Side view. B.111. x73.
Plate I
Figure 2 a-d. Frequency of the characteristic species in function of sediment type (bG= bioclastic gravel; bGsaS= bioclastic gravel and sandy silt; gsaM= gravelly sandy mud; saS= sandy silt; mS= muddy silt; saM= sandy mud; sM= silty mud; M= mud), water-depth and the algal and plant remains (C= Cystoseira; bM= branching Melobesioidae; cm=crustose Melobesioidae; P= P. oceanica).

carinata are present only at -69m with low percentages (Fig. 2c).

In these two samples Rosalina bradyi is the only epiphytic species: the euryhaline species are occasionally represented only at -52m by Cribrooniion cuvillieri (Fig. 2b).

Silty mud
B.127 (-48 m).
Assemblage: Valvulinera bradyana, Ammonia beccarii, Reussella spinulosa, Gavelinopsis praegeri, Rosalina globularis, Cribroelphidium anglicum and Rosalina obtusa.

Muddy silt
B.112 (-51 m).
Assemblage: Valvulinera bradyana, Textularia candeiiana, Asterigerinata adriatica, Ammonia beccarii, Neoconorbina terquemi, Bulimina aculeata, Melonis barleeanum, Rosalina bradyi an Cribrooniion cuvillieri.

In the silty-muddy sediments the species Valvulinera bradyana is dominant, associated with the muddy species Reussella spinulosa, Gavelinopsis praegeri at -48m, Bulimina aculeata and Asterigerinata adriatica at -51m (Fig. 2c). Also Ammonia beccarii (Fig. 2d) is dominant in these samples, associated at -51m with Neoconorbina terquemi and with the ubiquitous species Textularia candeiiana and Melonis barleeanum. The euryhaline species Cribroelphidium anglicum and Cribrooniion cuvillieri are occasionally represented (Fig. 2b), as well as the epiphytic species Rosalina bradyi, Rosalina globularis, Rosalina obtusa (Fig. 2a), this probably in connection with phenomena of transport from more shallow levels.

Plate II

1 Quinqueloculina dathiersi Schlumberger. Side view. B.127. x106.
2 Quinqueloculina disparilis d’Orbigny. Side view. B.126. x44.
3 Quinqueloculina sp. Side view. B.110. x89.
4 Quinqueloculina jugosa Cushman. Side view. B.126. x90.
5 Quinqueloculina rugosa d’Orbigny. Side view. B.126. x77.
6 Quinqueloculina viennensis Y. et J. Le Calvez. Side view. B.125. x59.
7 Buccella granulata Di Napoli. Spiral side. B.128. x133.
8 Planorbulina mediterraneensis. d’Orbigny. Umbilical side.
The photograph shows the specimen in life position, epiphytic on a P. oceanica frustule. B.126. x106.
9 Rosalina sp. Umbilical side. B.113. x64.
10 Rosalina sp. Spiral side. B.110. x61.
11 Planorbulina mediterraneensis d’Orbigny. Umbilical side. B.126. x41.
12 Rosalina bradyi (Cushman). Spiral side. B.126. x85.
14 Buccella granulata Di Napoli. Umbilical side. B.111. x185.
Figure 3. Relation between epiphytic species, euryhaline species, species typical of sandy and muddy bottoms in function of sediment type (bG= bioclastic gravel; bGsaS= bioclastic gravel and sandy silt; gsaM= gravelly sandy mud; sas= sandy silt; mS= muddy silt; sM= sandy mud; S= silty mud; M= mud) and water-depth.

Mud
B.129 (-49 m).
Assemblage: Valvulineria bradyana, Ammonia beccarii, Cribronionin cuvillieri, Gavelinopsis praegeri, Nonionella turgida, Melonis barleeanum, Ammobaculites agglutinans and Cribroelphidium granosum.

B.111 (-53 m).
Assemblage: Valvulineria bradyana, Cribronionin cuvillieri, Bulimina aculeata, Cribroelphidium granosum, Bulimina marginata, Nonionella turgida, Gavelinopsis praegeri and Bulimina elongata subulata.

B.130 (-72 m).
Assemblage: Valvulineria bradyana, Cassidulina carinata, Ammonia beccarii, Globocassidulina subgloboza, Cribroelphidium granosum and Bulimina marginata.

In the sediments Valvulineria bradyana is dominant, associated with other muddy species (Bulimina spp., Gavelinopsis praegeri, Cassidulina carinata, Globocassidulina subgloboza and Nonionella turgida) (Fig. 2c). The sandy species are absent; only at -49 m and at -72 m they are represented by Ammonia beccarii (Fig. 2d). The influence of two rivers Alento and Solofrone determines (at -49 m and at -53 m) the high frequency of the euryhaline forms (Ammobaculites agglutinans, Cribroelphidium granosum and Cribronionin cuvillieri) (Fig. 2b) and of species with an agglutinated test, among which Eggerelloides scabrum. The epiphytic species are absent, in accordance with the water-depth (Fig. 2a).

The composition of the benthic assemblages, in relation with the known chemical-physical parameters (type of sediment, algal and plant remains, fluvial input and water-depth) shows that:

- there is an almost perfect agreement, both in the infralittoral and in the circlallittoral zone, between type of sediment and the characteristic foraminiferal assemblages.

As shown in Fig. 3, going from more or less coarse sandy sediments to silty and muddy sediments there is on one side a sharp increase of species characteristic of muddy substrates, whose frequency fluctuates in relation with the grain size. On the other side there is a decrease, even if less evident, of the species characteristic of sandy sediments. As to the algal and plant remains, present in all the samples, in the infralittoral zone the abundance of epiphytic species is in agreement with the presence of P. oceanica and of crusty and branching Melobesioideae, whereas in the circlallittoral zone, their frequency drops dramatically. Finally, the fluvial input, given by the rivers Solofrone and Alento, seems to cause strong increases of euryhaline species, even if they are present also in other zones far from the fluvial mouths.

**OBSERVATIONS ON THE ECOLOGY OF SOME SPECIES**

An analysis of the assemblages composition in our samples shows that a complete agreement is not always found between the ecological meanings attributed in literature to the species (Blanc-Vernet, 1969; Blanc-Vernet et al., 1979; Venec Peyre, 1984; Jorissen, 1988; etc.) and the environmental parameters directly observed at sampling sites (grain-size of sediment, vegetation, water-depth and proximity of river mouths).

In particular the following remarks can be made:

- **Plate III**
- Among the species characteristic of sandy sediments (Fig. 2d), *A. beccarii* is abundant also on circalittoral muddy and muddy-sandy bottoms; 
- similarly *N. terquemi*, present in almost all the samples increases in the muddy sediments of the circalittoral zone; 
- the epiphytic species (*R. bradyi, R. globularis* and *R. obtusa*) are found also at depths below 40 m, probably in connection with phenomena of transport from more shallow levels (Fig. 2a); 
- the species with agglutinated fragile test (*E. scabrum* and *S. aspera dilatata*) (Pl. I, Figs. 5, 7), indicative of mobile low energy bottoms, are present with appreciable percentages only in proximity of river mouths (rivers Solorfone and Alento); 
- *C. granosum* and *C. cuvillieri* (Pl. IV, Figs. 2, 6), sensitive to salinity changes, are present, as well as in the zones influenced by the two rivers, also in others, where there is no evidence of deviations from normal salinity (Fig. 2b); 
- *C. anglicum*, euryhaline species, is present only at 48m, far from the river mouths (Fig. 2b).

On the contrary, as regards the species indicative of sandy sediments (Fig. 2d), the following species have been found in conditions confirming their ecologic meanings:

- *A. mamilla* (Pl. III, Figs. 11, 12) is typical of poorly sorted sands at water-depth of -37m and where the sandy fraction prevails; 
- *B. granulata* (Pl. II, Figs. 7, 14), found also on muddy substrates, is frequent only where a sandy fraction is present.

To the same extent the species typical of muddy bottoms (*B. aculeata, B. marginata, G. praegeri, V. bradyana* and *N. turgida*) characterize the circalittoral terrigenous muds (Fig. 2c), confirming once again their relation with the substrate grain-size.

Moreover *A. parkinsoniana*, is found only at -23m, in proximity of the river Solorfone mouth, this confirming its significance of euryhaline infralittoral species (Fig. 2b).

**REWORKED FAunas**

Analysis of the assemblages has shown that all the foraminifers present belong to living species. Extinct species and species indicative of particular climatic episodes occurred during the Quaternary are lacking: all the microfaunas are of Holocene age. An exception to this could perhaps be represented by a group of large size foraminifers, with worn tests of yellowish colour, belonging to the genera *Quinqueloculina* (*Q. disparilis* and *Q. viennensis*) and *Textularia* (*T. pseudorugosa*) found at -34m (B.125 - 37.8%) in bioclastic gravels. Similar occurrences have been reported in recent sediments along the coast of Lebanon (Moncharmont-Zei, 1968) and at the Cheradi Islands (Taranto) in sands of probable Tyrrenhenian age. Therefore it can not be excluded that, at least in a narrow zone of the shelf off Punta Liscia, marine sediments of older age could be present. It must be taken into account to this regard that in this zone, where the substrate is exposed, sandy sediments, probably representing relict deposits, have been identified by means of Mini Sparker profiles (Coppa et al., 1992).

**CONCLUSIONS**

The present study has evidenced the following points:

- the strong prevalence of benthic foraminifers that never drop below 90.6%; the very low frequency of the plankton does not allow any remark on type of climate; 
- the absence of extinct and palaeoecologically significant species: the assemblages are of Holocene age; 
- the presence in the bioclastic gravels of large size foraminifers with worn tests of yellowish colour, belonging to the genera *Quinqueloculina* and *Textularia*, that are reported both in warm areas and in sediments of probable tyrrenhenian age; 
- there is an almost perfect agreement, both in the infralittoral and in the circalittoral zone, between type of sediment and the characteristic foraminiferal assemblages; 
- as to the algal and plant remains, present in all the samples, in the infralittoral zone the abundance of epiphytic species is in agreement with the presence of *P. oceanica* and of crusty and branching Melobesioidae; 
- on the contrary in the circalittoral zone the presence of epiphytic species, along with algal and plant remains, is probably due to phenomena of transport from shallower levels;
- finally the fluvial input, given by the rivers Solofrone and Alento, seems to cause strong increases of euryhaline species, that however are present also in other zones, far from fluvial mouths.

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