

Calcareous plankton in the DSDP Hole 125 - Leg. 13 (Ionian Sea - Eastern Mediterranean): a review

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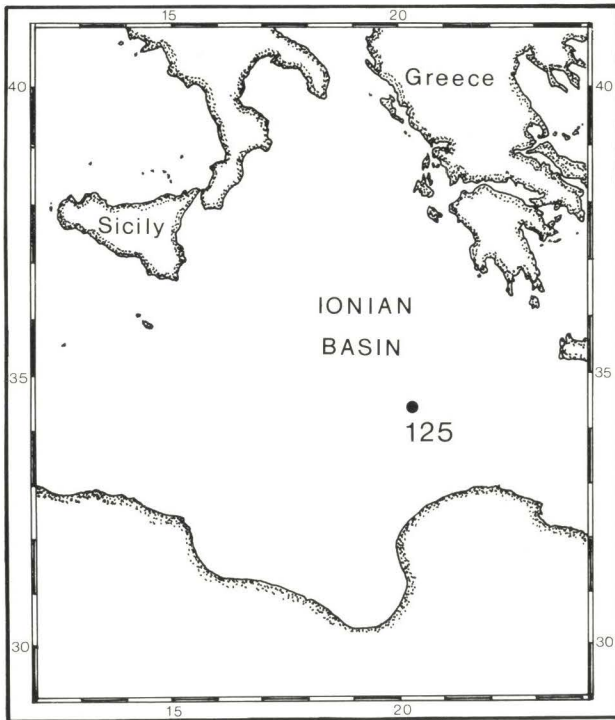
ABSTRACT — *A review of the calcareous nannoplankton and planktonic foraminifera of Hole 125 (DSDP Leg 13) made it possible to recognize many biostratigraphic events which date the studied sequence as Upper Pliocene to Pleistocene. By correlation with the Vrica stratotype section for the N/Q boundary, the Plio/Pleistocene boundary has been recognized at the top of Core 4, where Gephyrocapsa oceanica s.l. and the first consistent left coiling specimens of Globigerina pachyderma appear; Globigerina cariacensis first occurs at the base of Core 3. In the interval between Samples 4-3-99 cm and 4-2-105 cm, within the « Globorotalia inflata zone » and the « Discoaster brouweri subzone » (Uppermost Pliocene), many specimens of Globorotalia truncatulinoides are present. Globorotalia truncatulinoides excelsa appears in Sample 2 CC, where it is found in association with Globorotalia truncatulinoides. A major hiatus has been recognized between the top of Core 3 and the base Core 2, and corresponds at least to the Sicilian stage. A cold peak already recognized in Core 2 cannot be correlated with the base of the Glacial Pleistocene, since it is recorded a few centimeters below the FAD of Pseudoemiliana lacunosa, which has been dated at 0.46 MA. The absence of specimens of Emiliana huxleyi at the top of the sequence implies that the sediments deposited at least during the last 0.26-0.27 MA are missing in Hole 125.*

RIASSUNTO — [Revisione del plankton calcareo del pozzo 125 (DSDP Leg 13) nel Mar Ionio (Mediterraneo orientale)] — *La revisione del nannoplankton calcareo e dei foraminiferi planctonici del pozzo 125 (DSDP Leg 13) ha permesso di evidenziare una successione di eventi biostratigrafici che rendono possibile riferire la successione studiata all'intervallo Pliocene superiore/Pleistocene. Per correlazione con la sezione della Vrica, sezione stratotipica del limite N/Q, il limite Plio/Pleistocene è stato posto in coincidenza della sommità della Carota 4, dove compaiono Gephyrocapsa oceanica s.l. e i primi numerosi individui di Globigerina pachyderma sinistrorsa, mentre alla base della Carota 3 compare Globigerina cariacensis. Nell'intervallo compreso tra i Campioni 4-3-99 cm e 4-2-105 cm, riferibile alla « zona Globorotalia inflata » e alla « subzona Discoaster brouweri » (Pliocene superiore), sono presenti numerosi individui di Globorotalia truncatulinoides, mentre Globorotalia truncatulinoides excelsa compare a partire dal Campione 2 CC, in associazione con G. truncatulinoides. Tra la sommità della Carota 3 e la base della Carota 2 è stata individuata la mancanza di uno spessore di sedimenti corrispondenti almeno a tutto l'intervallo attribuibile al Siciliano. Il picco freddo individuato nella Carota 2 non può essere correlato con la base del Pleistocene glaciale, trovandosi pochi centimetri al di sotto della comparsa di Pseudoemiliana lacunosa, datata a 0.46 MA. In considerazione dell'assenza di individui di Emiliana huxleyi alla sommità della successione, si ritiene che i sedimenti depositatisi durante gli ultimi 0.26-0.27 MA siano assenti nella successione studiata.*

INTRODUCTION

In the present paper we report the results obtained in the biostratigraphic study of the Hole 125 sequence (Deep Sea Drilling Project, Leg 13, Site 125) concerning the planktonic foraminifera and the calcareous nannoplankton. We have chosen this deep sea succession because it is considered an important reference sequence in the Eastern Mediterranean region. It is located along the « Mediterranean Ridge » in the central Ionian basin (lat. 30° 37' 49" N; long. 20° 25' 76" E) (text-fig. 1).

Described as « an excellent section of biogenic, pelagic sediments », it has been subject of numerous biostratigraphic and paleoclimatic studies (Cita *et al.*, 1973; Cita *et al.*, 1974; Thunell, 1979, 1979a, 1979b; Stradner, 1973; Bukry, 1973; Gartner, 1973; Bizon and Müller, 1978; Müller, 1978). However, we deemed it necessary to re-examine this succession in the hope of obtaining a more detailed biostratigraphic documentation in the Upper Pliocene/Pleistocene interval, while taking into account the results and improvements in Pliocene/Pleistocene biostratigraphy



Text-fig. 1 - Location of DSDP Site 125.

during the past few years.

In regard to the calcareous nannofossils, papers appearing as initial reports (Bukry, 1973; Gartner, 1973; Stradner, 1973) were not detailed enough and sometimes gave contradictory results. This justified the need for us to study this reference section in more detail, and gave us the chance to test the biostratigraphic scheme already proposed by Raffi and Rio (1979) in a report about the Western Mediterranean Site 132 succession.

In previous papers concerning plankton foraminifera (Cita *et al.*, 1973; Bizon and Müller, 1978; Thunell, 1979) the Plio/Pleistocene boundary has been recognized by using different marker species and consequently placed at different levels in the Hole 125 sequence. For these reasons, it was necessary to re-examine the sequence in reference to the recent revision and proposal of a new definition of the Pliocene/Pleistocene boundary stratotype in the Vrica section (Pasini *et al.*, 1977; Colalongo *et al.*, 1982).

MATERIAL

The lithologic log, the analyzed samples and the biostratigraphic data of the Hole 125 succession are illustrated in text-fig. 2.

As reported in the core descriptions, two lithologic units were distinguished at this Hole. They are, from top to bottom:

1) plastic marly oozes with beds of sapropels and ash, encountered between the top and 17 meters (Core 1 and 2), with high calcium carbonate content mainly consisting of nannoplankton;

2) foraminiferal nanno-oozes and sapropels, recovered between 17 meters and the drilling break at about 71 meters. These oozes are tiffer, more heterogeneous and richer in foraminifera than the overlying sediments.

Looking at the lithologic column, we can notice that the recovered cores are largely disturbed. As stated in the Initial Reports of Leg 13 (part 1, Site Reports, chapter 7), « some sections were void, due to loss of material during retrieval, others were "soupy"; also, the high water content precluded measurements of in situ values » of physical properties. Moreover, some sections were deformed by drilling operations (in text-fig. 2 « D » indicates intervals with plastic deformation, « W » those with watering).

Disregarding these physical disturbances, the succession was sampled, except Core 8, in which only the core-catcher was recovered. Both foraminifera and calcareous nannofossils from 64 samples have been studied. In regard to the calcareous nannofossils, 64 smear slides were analyzed using a light microscope at 1200X magnification; furthermore a supplementary analysis at the Scanning Electron microscope was carried out in the four samples of Core 1.

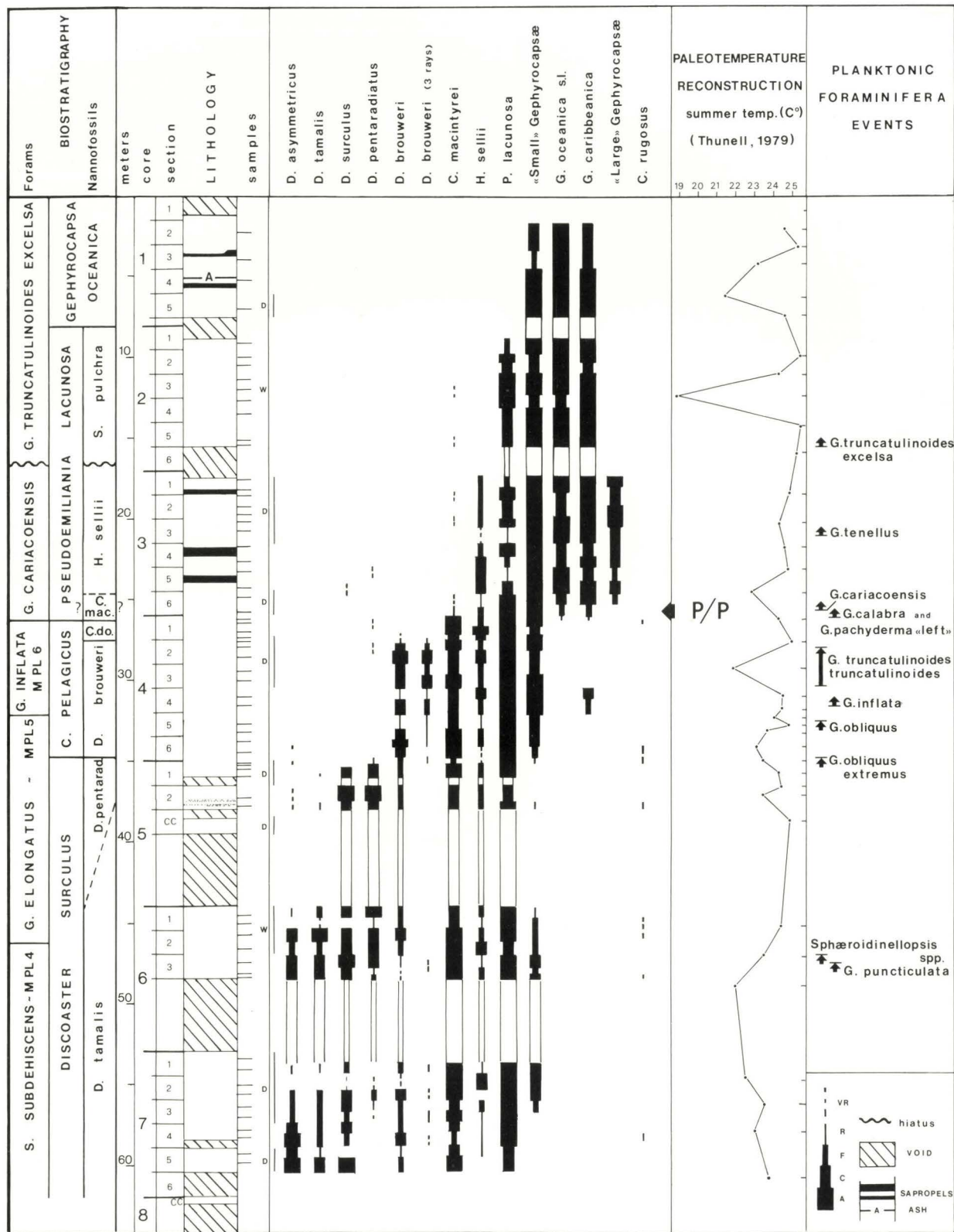
RESULTS

CALCAREOUS NANNOPLANKTON — The range chart of text-fig. 2, in which only significant species are reported, has been obtained applying the same methodology of semiquantitative analysis adopted in the study of Site 132 succession (see Raffi and Rio, 1979).

In all the samples examined, the nannofossils are abundant and generally in a good preservation state; reworked forms from Cretaceous and Paleogene are present.

The biostratigraphic position of the sequence is after the LAD (Last Appearance Datum) of *Reticulofenestra pseudoumbilica* and the FAD (First Appearance Datum) of *Pseudoemiliania lacunosa*; the chronostratigraphic position is referable to the Upper Pliocene/Pleistocene.

The Pliocene sediments (Cores 4 to 7) have rich and well diversified assemblages. Species of the genus *Discoaster* (*D. asymmetricus*, *D. tamalis*, *D. surculus*, *D. pentaradiatus* and *D. brouweri*), present from the base of the sequence, fluctuate in abundance throughout this interval. The genus *Scyphosphaera* is represen-



Text-fig. 2 - Lithologic log of Hole 125 and ranges of selected nannofossil species. «D» indicates intervals with plastic deformation, «W» those with watering. A= more than one specimen encountered in each field of view; C= one specimen in one to ten fields of view; F= one specimen every ten fields of view; R= few specimens in 100 fields of view; VR= very rare specimens encountered in standard analysis.

ted by a large number of species and specimens; *Helicospaera sellii*, *H. carteri*, *Rhabdosphaera clavigera*, *Calcidiscus leptoporus*, *C. macintyrei* and *Pseudoemiliana lacunosa* are all abundant. In Core 7, downhole contamination is indicated by the presence of specimens of *Gephyrocapsa oceanica* s.l., a typically Pleistocene species (Gartner, 1977a, 1977b; Rio, 1982). Further evidence of contamination may be given by the presence of some specimens of *Discoaster brouweri* 3-rayed variety (= *Discoaster triradiatus* Tan Sin Hok) in Cores 6 and 7, a species which generally thrives in the upper part of the *D. brouweri* type range. Moreover, signs of disturbance in this interval are emphasized by both planktonic foraminiferal data and in the Initial Reports of Site 125, where they referred about « chunks » from Cores 1 and 3 in very disturbed sections of Cores 6 and 7.

In the Pleistocene interval corresponding to Cores 1 to 3, the nannofossil assemblages assume different features: the *Discoasters* have progressively faded out, the genus *Scyphosphaera* is still common but is represented by fewer species, and the placoliths (*Pseudoemiliana lacunosa* and *Gephyrocapsa*) dominate the assemblages. Furthermore, numerous specimens of *Syracosphaera* and *Pontosphaera* are characteristic in these Pleistocene assemblages.

NANNOFOSSIL EVENTS AND BIOZONATION — In spite of the downhole reworking and the recovery disturbances, the recorded nannofossil events seem to reflect the biostratigraphic scheme known in the Mediterranean and extra-Mediterranean areas. In regard to the adopted zonation, we applied the one proposed in the study of the Site 132 sequence by Raffi and Rio (1979), which is similar to more well-known biozonations (Gartner, 1969, 1977a; Schmidt, 1973; Bukry, 1975; etc.). The events used in the biostratigraphic subdivision of this succession (text-fig. 2) are described and discussed below.

LADs of *Discoaster asymmetricus* and *Discoaster tamalis*.

These two events, which mark the top of the « *D. tamalis* subzone » of the « *D. surculus* zone », are not well defined. In fact, the two species occur consistently up to Sample 6-1-49 cm, just below a thick unrecovered interval, but rare specimens have been found in Core 5. Therefore, it is difficult to locate the boundary between « *D. tamalis* » and « *D. pentaradiatus* » subzones as it may lie between Cores 5 and 6 and correspond to the unrecovered interval (text-fig. 2).

LADs of *Discoaster surculus* and *Discoaster pentaradiatus*.

These events occur in Samples 5-1-47 cm and 5-1-7 cm respectively. Because the separation between these two samples is short, the events are considered simultaneous, as they are in the Site 132 sequence. In oceanic successions with higher sedimentation rates, the *D. pentaradiatus* LAD follows the *D. surculus* LAD at a short but sufficient distance to define the biozone NN 17 of Martini (1971) or the equivalent « *D. pentaradiatus* subzone » of Bukry (1975). The extinction level of *Discoaster surculus* and *Discoaster pentaradiatus* marks the top of our « *D. surculus* zone ».

LAD of *Discoaster brouweri*.

This event, occurring in Sample 4-2-7 cm, defines the boundary between the « *D. brouweri* subzone » and the « *Crenalithus doronicoides* subzone » of the « *Coccolithus pelagicus* zone ». The extinction of the 3-rayed variety of *D. brouweri* occurs at this level. The development of this 3-rayed form in the upper part of the *D. brouweri* type range has been recorded in many other oceanic and Mediterranean successions and on-land sections (Stradner, 1973; Raffi and Rio, 1979; Müller, 1978; Rio *et al.*, in press; Backman and Shackleton, in press).

EXPLANATION OF PLATE 1

- Figs. 1-2 - *Globigerina calabra* Colalongo & Sartoni. (50). 1) Umbilical view; 2) Spiral view. Sample 125-3-6-141.
 Fig. 3 - *Globigerina umbilicata* Orr & Zaitzeff. (x 50). Umbilical view. Sample 125-4-1-91.
 Figs. 4-7, 11 - *Globigerina* aff. *calida* Parker. (x 50). 4, 5, 7) Umbilical view; 6, 11) Spiral view. Sample 125-4-3-44.
 Fig. 8 - *Globigerina praecalida* Blow. (x 50). Spiral view. Sample 125-6-2-106.
 Figs. 9-10 - *Globigerina digitata* Brady. (x 50). 9) Spiral view; 10) Umbilical view. Sample 125-3-1-57.
 Figs. 12-14 - *Globigerina cariacensis* Rögl & Bolli. (x 50). 12) Umbilical view; 13) Lateral view; 14) Spiral view. Sample 125-3-5-131.
 Fig. 15 - *Globigerina apertura* Cushman. (x 50). Umbilical view. Sample 125-4-5-64.
 Figs. 16-18 - *Globigerina rubescens* Hofker. (x 100). 16, 17) Umbilical view; 18) Spiral view, specimen with secondary apertures. Sample 125-4-5-64.
 Fig. 19 - *Globigerina praedigitata* Parker. (x 100). Umbilical view. Sample 125-5-2-138.
 Fig. 20 - *Globigerina bulloides* d'Orb. (x 50). Umbilical view. Sample 125-4-5-64.
 Fig. 21 - *Globigerina* cf. *quadrilatera* Galloway & Wissler. (x 25). Umbilical view. Sample 125-6-2-106.
 Fig. 22 - *Globigerina falconensis* Blow. (x 50). Umbilical view. Sample 125-4-5-114.



FAD of *Gephyrocapsa oceanica* s.l.

This form has been identified using the taxonomic concept explained in Raffi and Rio (1979, p. 155) and in Rio (1982). Its appearance defines the base of the « *P. lacunosa* zone » and occurs in Sample 4-1-19 cm, approximately 150 cm above the LAD of *D. brouweri*. These two events occur close to each other in deep-sea sequences of the Caribbean, Western Equatorial Pacific and Tasman Sea (Gartner, 1977a). In the Western Mediterranean, as well as in other deep-sea sequences (Bukry, 1973, 1975; Rio, 1982) the gap between them defines the « *Crenalithus doronicoides* subzone ».

LAD of *Calcidiscus macintyreii*.

This event probably occurs in Sample 3-6-40 cm (130 cm above the FAD of *Gephyrocapsa oceanica* s.l.) where only one specimen is recorded. The disappearance of the bulk of the specimens occurs in Sample 3-6-141 cm. Müller (in Bizon and Müller, 1978) recorded this event in this same material in Section 1 of Core 4 and utilized it to place the Pliocene/Pleistocene boundary. We consider this incorrect because the LAD of *C. macintyreii* is clearly above the *G. oceanica* s.l. FAD (Gartner, 1977a) and is above the Pliocene/Pleistocene boundary as defined in Italy in the Vrica section (Colalongo *et al.*, 1982). Furthermore, in many Mediterranean on-land sections the *C. macintyreii* LAD is difficult to recognize (Raffi and Rio, 1979). This event marks the upper boundary of the « *C. macintyreii* subzone » of the « *P. lacunosa* zone ».

LAD of *Helicosphaera sellii*.

This event has been placed within the unrecovered interval between Cores 2 and 3. In the underlying in-

terval typical specimens are continuously distributed up to Sample 3-1-59 cm. This datum level represents the top of the « *H. sellii* subzone » of the « *P. lacunosa* zone ».

LAD of *Pseudoemiliana lacunosa*.

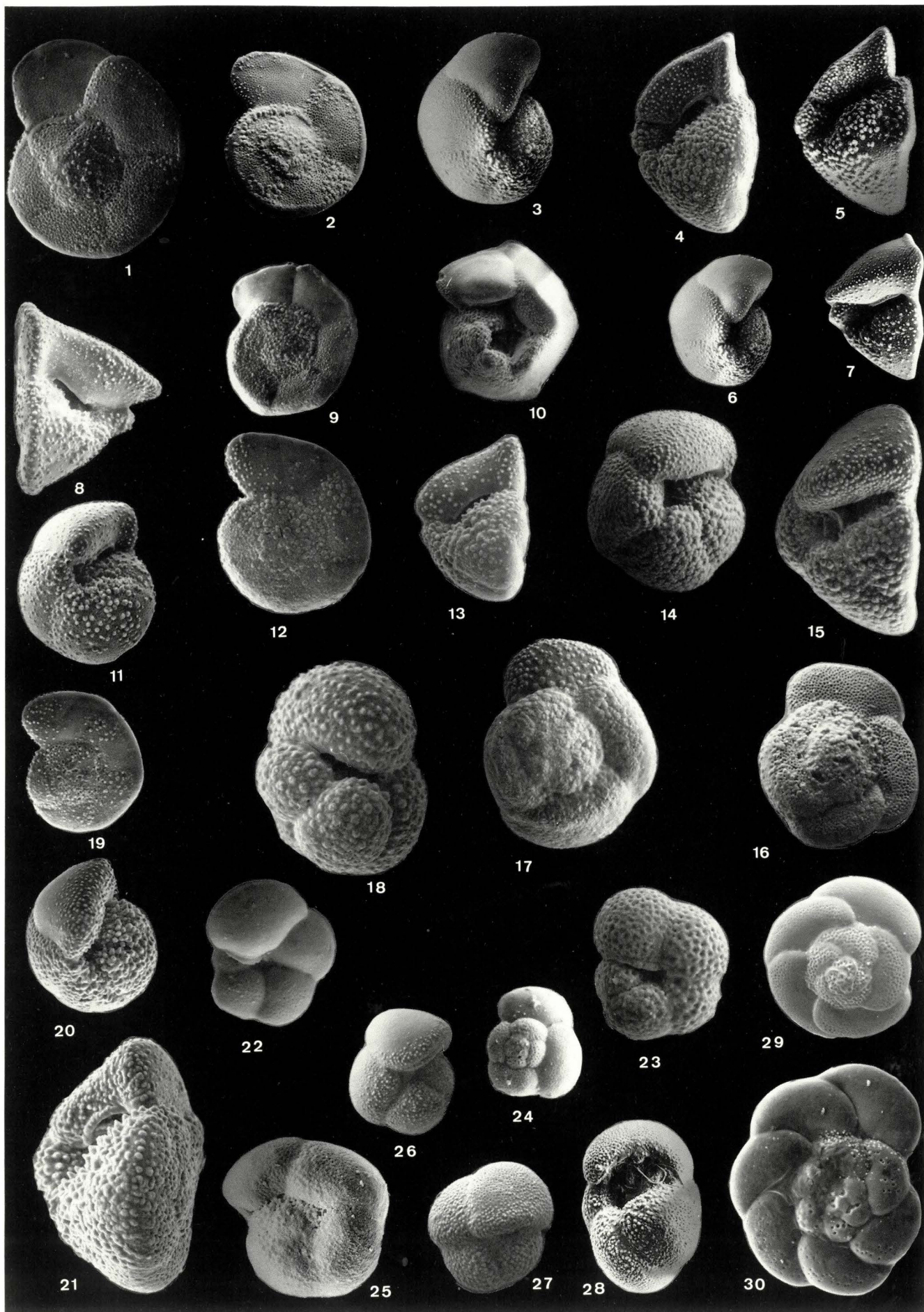
The extinction level of *P. lacunosa* occurs in Sample 2-1-109 cm, just below a gap in recovery. It defines the upper boundary of the « *P. lacunosa* zone ». This extinction is considered a global synchronous event by Thierstein *et al.* (1977), corresponding to an age of 0.458 MA and occurring within the isotopic Stage 12 of Emiliani. *P. lacunosa* LAD was recognized at this same position in the Eastern Mediterranean Core RC 9-181 (identified and located by H. Thierstein in Vergnaud Grazzini *et al.*, 1977).

Analyses of the samples from Core 1 by scanning electron microscopy were carried out to check the presence of *Emiliana huxleyi*, a small form difficult to recognize at the light microscope and important for the Pleistocene stratigraphy. The chronostratigraphic position of the FAD of *E. huxleyi* is about 0.27 MA (Thierstein *et al.*, 1977; Gartner, 1977a). After counting 300 specimens in each available sample from Core 1, we failed to find this species. Hence, we infer that the sediments deposited at least during the last 0.26-0.27 MA are missing in the Hole 125. The uppermost part of the sequence (Core 1) is referable to the « *Gephyrocapsa oceanica* zone » of Gartner (1977a).

As reported here, the only difference between this sequence and that at Site 132, is the absence of the « Small *Gephyrocapsae* » interval (see text-fig 2, and Raffi and Rio, 1979) in the former. This biostratigraphic interval, characterized by the predominance of

EXPLANATION OF PLATE 2

- Figs. 1-7 - *Globorotalia truncatulinoides* (d'Orb.). (1-5 x 50; 6-7, x 25). 1, 2) Spiral view; 3, 6) Umbilical view; 4, 5, 7) Lateral view. Sample 125-4-3-44.
- Figs. 8-10 - *Globorotalia truncatulinoides excelsa* Sprovieri, Ruggieri & Unti. (x 50). 8) Lateral view; 9) Spiral view; 10) Umbilical view. Sample 125-2-5-116.
- Figs. 11-13 - *Globorotalia tosaensis tenuitbeca* Blow. (x 50). 11) Umbilical view; 12) Spiral view; 13) Lateral view. Sample 125-4-3-44.
- Figs. 14-16 - *Globorotalia crassaformis* (Galloway & Wissler). (x 50). 14) Umbilical view; 15) Lateral view; 16) Spiral view. Sample 125-6-2-106.
- Fig. 17 - *Globorotalia crassaformis ronda* Blow. (x 50). Spiral view. Sample 125-3-6-141.
- Fig. 18 - *Globorotalia pseudopima* Blow. (x 100). Umbilical view. Sample 125-4-6-97.
- Figs. 19-21 - *Globorotalia tosaensis* Takayanagi & Saito. (x 50). 19) Spiral view; 20) Umbilical view; 21) Lateral view. Sample 125-4-3-44.
- Fig. 22 - *Globorotalia bermudezi* Rögl & Bolli. (x 100). Umbilical view. Sample 125-5-2-79.
- Fig. 23 - *Globorotalia acostaensis* Blow. (x 100). Umbilical view. Sample 125-4-6-97.
- Figs. 24-28 - *Globorotalia bononiensis* Dondi. (25, 27, 28 x 50; 24, 26 x 25). 24, 25) Spiral view; 26, 27) Umbilical view; 28) Lateral view. Sample 125-6-1-49.
- Figs. 29-30 - *Globorotalia* spp. ex group *Globorotalia scitula* (Brady). (29 x 50; 30 x 100). 29) Sample 125-4-1-99; 30) Sample 125-2-4-97.



small forms ($< 3.5 \mu\text{m}$) within the population of the genus *Gephyrocapsa* and the absence or the sharp decrease of large and medium sized forms was recognized in Eastern Pacific and Caribbean by Gartner (1977a) and introduced as a biozone in his revised zonation of the Pleistocene. It was also recognized in the Western Mediterranean (Raffi and Rio, 1979; Di Stefano and Rio, 1981). In the section under study, we failed to recognize this interval; in fact, we recorded the LAD of *H. sellii* (an event which precedes the « Small *Gephyrocapsa* zone ») before an unrecovered interval overlain by sediments with an assemblage characterized by a well developed population of *Gephyrocapsae*, including forms of 2 to 5 μm (assemblage of the « *S. pulchra* subzone » of Raffi and Rio, 1979). Therefore, supposing the « Small *Gephyrocapsa* zone » of Gartner is valid in Eastern Mediterranean too (and there is no reason for assuming the contrary), there are two possible explanations of the absence of this zone: either (1) the interval coincides with the gap in the recovery, or (2) a hiatus in the sedimentation. Other evidences, such as the features of the nannofossil and foraminiferal assemblages and hypothetical evaluations of sedimentation rates, support the assumption of a hiatus and are discussed later.

FORAMINIFERA

Planktonic foraminifera are abundant, varied and extremely well preserved in all samples. Following the biostratigraphic scheme proposed by Cita (1973, 1975), Ruggieri and Sprovieri (1975) and Colalongo and Sartoni (1979), the base of the sequence must begin after *Globorotalia margaritae* LAD (base of MPL 4 Zone) and extend past the *Globorotalia truncatulinoides excelsa* Mediterranean appearance. Its chronostratigraphic position is referable to the Upper Pliocene/Pleistocene interval. Strong downhole contamination in Cores 6 and 7 is evident in the presence of frequent specimens of latest Pliocene and Pleistocene species (*Globorotalia crassaformis* and, particularly *Globorotalia inflata*) in these Lower Pliocene sediments. Scattered specimens of the latter are also found in Core 5.

Benthic foraminifera are extremely rare throughout the sequence, and are indicative of a very deep environment. However, (samples from Cores 6 and 7 and Sample 5-2-136 cm) intermittent abundant benthic foraminiferal assemblages, with frequent shallow water species, are observed. The possible implications concerning the presence of these displaced shallow water species are discussed later on. In the range chart of text-fig. 3 the distribution of the planktonic foraminifera and two significant benthic species are reported.

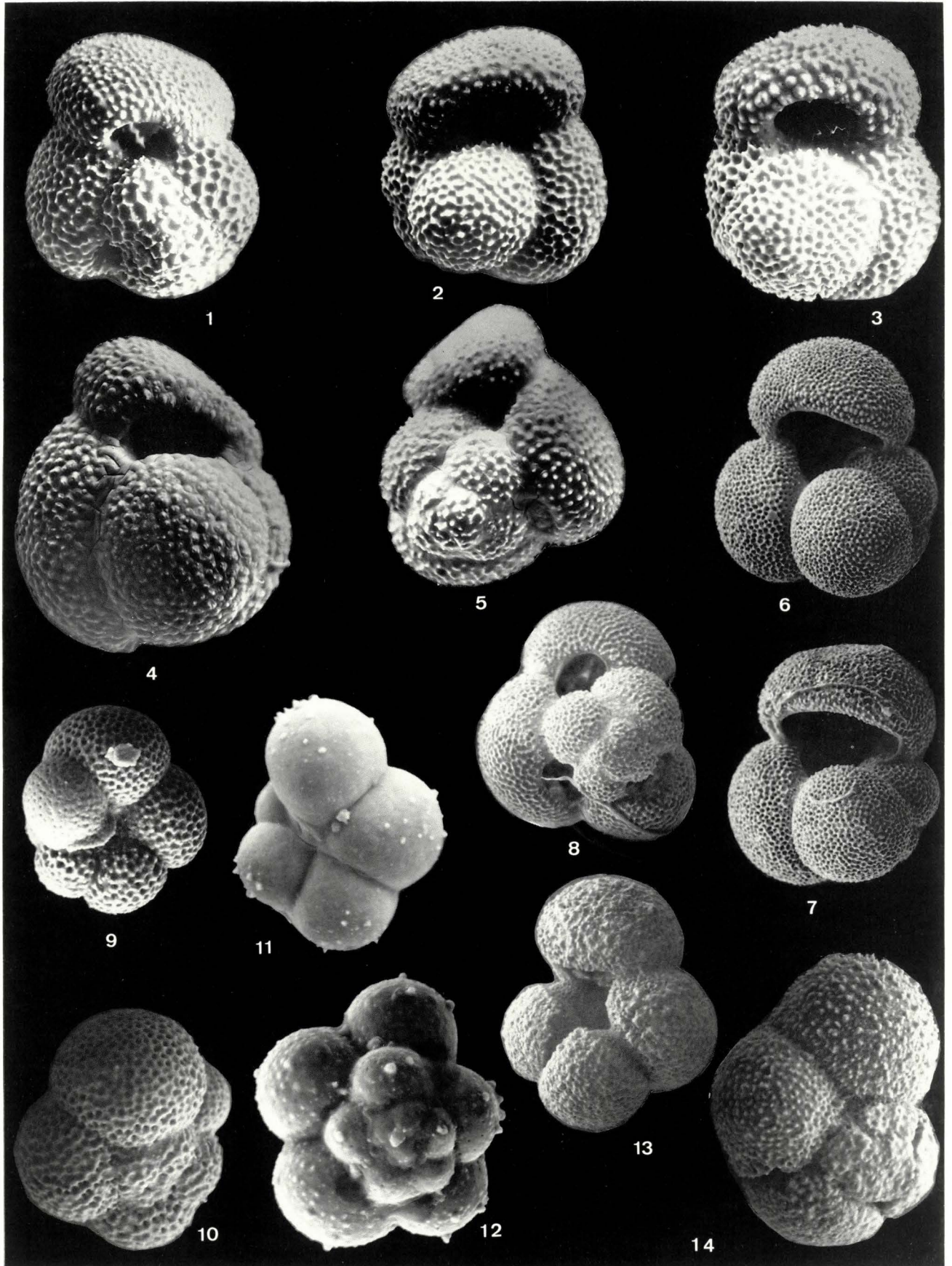
FORAMINIFERAL EVENTS AND BIOSTRATIGRAPHY.

PLANKTONIC FORAMINIFERA — A six-fold standard zonation for the Pliocene deep-sea record of the Mediterranean, as recorded during Leg 13 of the D.S.D.P., was introduced by Cita (1973). It was revised by the same author in 1975, when some biozones were redefined and an abbreviated terminology with letters and numbers (MPL 1 - MPL 6) was proposed.

Since this time, some difficulties have arisen in the recognition of the uppermost biozone (MPL 6, *Globorotalia inflata* zone), defined at the base by the massive population decrease of *Globigerinoides obliquus extremus*, and at the top by the first occurrence of *Globorotalia truncatulinoides*. In fact, taxonomic problems concerning the former taxon and the rather difficult recognition of its massive population decrease near *Globorotalia inflata* appearance level, made the identification of this lower boundary ambiguous; Sprovieri (1978), when adopting Cita's zonal scheme, arbitrarily recognized the MPL 5-MPL 6 boundary by the *Globorotalia inflata* appearance level. Some authors (Bizon and Müller, 1978; Thunell, 1979) consider the first appearance of *Globorotalia inflata* in the Mediterranean an unreliable datum. Results from the comparative study (foraminifera and calcareous nannoplankton) of several suitable sections accurately sampled in Western Mediterranean (Rio *et al.*, in press) indicate that the Mediterranean appearance of *Globorotalia inflata* is a (sufficiently) isochronous biostratigraphic event, and can be confidently used as boundary definition of a biozone. At the present time, the definition of the upper boundary of the MPL 6 biozone appears totally unreliable. In the same study quoted above, Rio *et al.*

EXPLANATION OF PLATE 3

- Figs. 1-3 - *Globigerinoides obliquus* Bolli. (x 60). 1) Spiral view; 2, 3) Umbilical view. Sample 125-4-5-64.
 Figs. 4-5 - *Globigerinoides obliquus extremus* Bolli. (x 60). 4) Umbilical view; 5) Spiral view. Sample 125-5-1-7.
 Figs. 6-8 - *Globigerinoides* sp. aff. *Globigerinoides obliquus* Bolli. (x 60). 6, 7) Umbilical view; 8) Spiral view. Sample 125-3-1-121.
 Figs. 9-10 - *Globorotaloides hexagonus* (Natland). (x 60). 9) Umbilical view; 10) Spiral view. Sample 125-6-2-106.
 Figs. 11-12 - *Hastigerinella riedeli* Rögl & Bolli (x 200). 11) Umbilical view; 12) Spiral view. Sample 125-1-5-107.
 Fig. 13 - *Neogloboquadrina atlantica* Berggren (x 50). Umbilical view. Sample 125-6-2-106.
 Fig. 14 - *Globorotalia incisa* Brönniman & Resig. (x 100). Spiral view. Sample 125-5-1-47.



realized that the FAD of *Globorotalia truncatulinoides* is a Pliocene event and occurs at levels which approximate the *Globorotalia inflata* appearance. Consequently, we followed the emendation to the definition of MPL 6 (*Globorotalia inflata* zone) suggested by Rio *et al.* (in preparation) who define its base by the appearance of *Globorotalia inflata* and the top by the appearance of *Globigerina cariacensis*, which practically coincides with the massive population increase of left coiling *Globigerina pachyderma*. In the stratotype section at Vrica (see Colalongo *et al.*, 1982), this upper boundary is coincident with the N/Q boundary.

Several planktonic foraminiferal events can be recognized in the sequence of Hole 125, and allow us to apply the proposed biostratigraphical zonal scheme. MPL 4 biozone is recognized in the interval between the base of the sequence and Sample 6-2-106 cm. In Sample 7-2-101 cm, *Globorotalia margaritae*, which is always extremely rare and not well preserved, apparently disappears; data from calcareous nannoplankton indicate an age for this interval younger than the LAD of *Globorotalia margaritae* (see Rio *et al.*, in preparation, for discussion on the timing of the Mediterranean exit of *Globorotalia margaritae*). Although an extension of its range cannot be ruled out, these specimens are here considered reworked: in the same levels strong evidence of displaced shallow water and upper bathyal benthic species into meso- to deep bathyal sediments demonstrates a local mixture of sediments of different origin.

In the two samples of Section 7-2, rare specimens of the *Globorotalia menardii* group are recorded, but they are not considered reworked. Scattered, sometime frequent specimens of this taxon have been recorded elsewhere in Southeastern Sicily (Casale, 1964; Sprovieri, 1974, 1975) from sediments belonging to the lower part of the Pliocene, without evidence of displaced fauna or other Miocene markers.

The LAD of *Globoquadrina* complex is recorded in Sample 6-3-109 cm. This agrees quite well with data from several on-land sections in Southeastern Mediterranean (Crete and Sicily; Zachariasse, 1975; Di Grande, 1968; Sprovieri, 1974; Rio *et al.*, in preparation), where this extinction level is recorded close to the *Sphaeroidinellopsis* spp. LAD. In Hole 125 the *Sphaeroidinellopsis* spp. LAD is recorded in Sample 6-2-106 cm and represents the base of the MPL 5 biozone.

Globorotalia puncticulata is typical and frequent up to Sample 6-3-130 cm; atypical, smaller morphotypes and variants (cfr. Brolsma, 1978, pl. 7, figs. 4a-g) are present, scattered and rare up to Sample 5-1-7 cm. Their tests are more compressed, have thinner and smoother walls, finer perforations, and more highly arched apertures. In Hole 125 the extinction level of *Globorotalia puncticulata* is recorded in Sample 6-3-130 cm, where the last typical and frequent specimens are recognized. In accordance with data from land-sections in this area of the Mediterranean, this extinction predates the *Sphaeroidinellopsis* LAD.

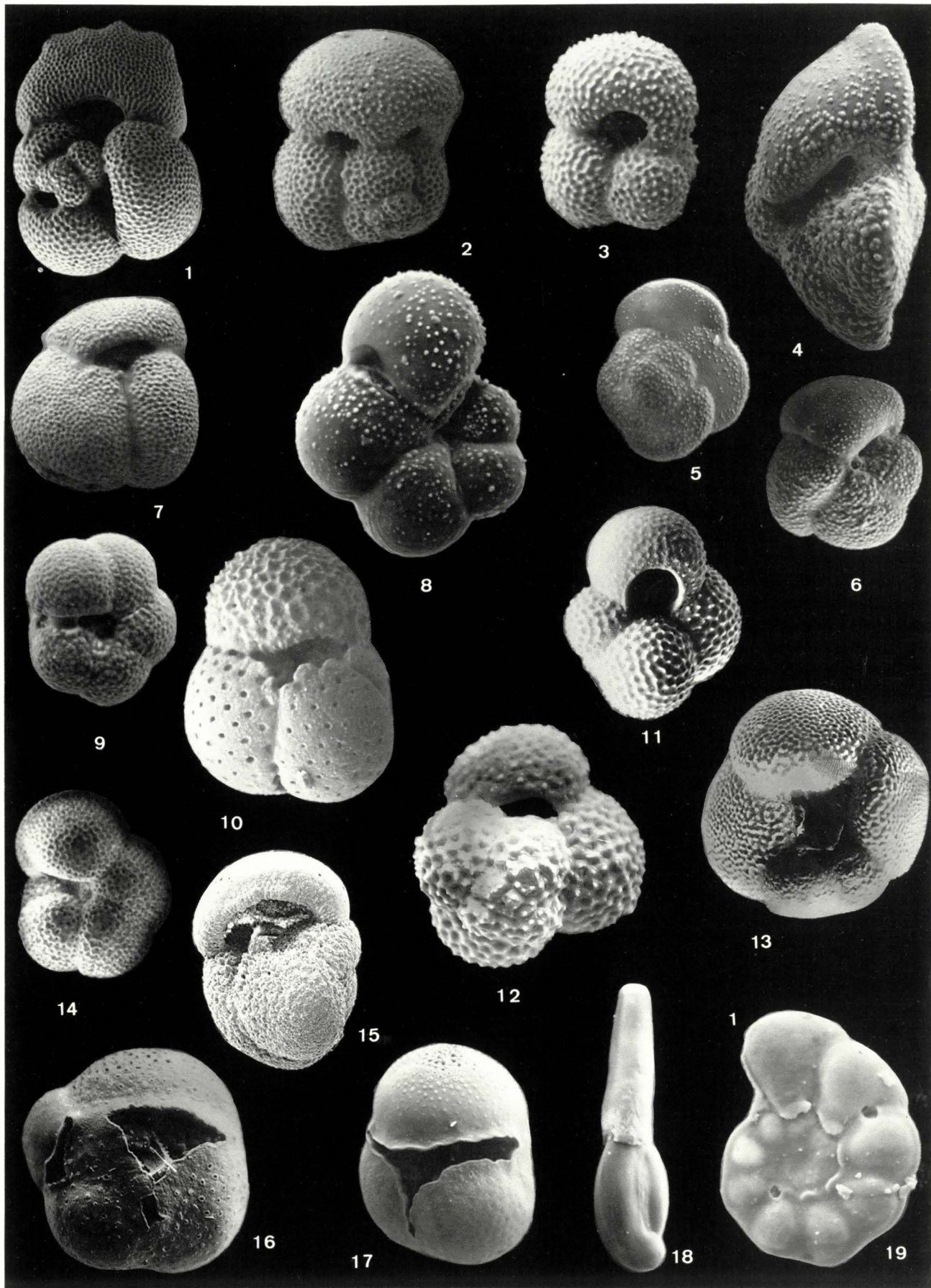
The strong downhole contamination in this interval prevents the recognition of the FADs of *Globorotalia crassaformis*, *Globorotalia aemiliana* and *Globorotalia bononiensis*. These forms, which are present from the base of the sequence, have always their first occurrence close to the *Sphaeroidinellopsis* LAD in land-sections (Rio *et al.*, in preparation).

In Sample 6-2-106 cm *Globorotalia pseudopima* appears, and it is never abundant. Again, the noise due to downhole contamination in this interval makes the FAD of the species uncertain, since it is generally not recorded in the Mediterranean.

The presence of *Neogloboquadrina atlantica* from Sample 6-2-106 cm to Sample 6-1-49 cm is noteworthy. It is considered (Poore, 1982) a subpolar species and, therefore, indicative of cold water masses.

EXPLANATION OF PLATE 4

- Fig. 1 - *Globigerinoides* cf. *fistulosus* (Schubert). (x 40). Spiral view. Sample 125-4-1-19.
 Figs. 2-3 - *Globigerinoides ruber* (d'Orb.). (x 80). 2) Spiral view; 3) Umbilical view. Sample 125-4-5-114.
 Figs. 4-6 - *Globorotalia crassaformis aemiliana* Colalongo & Sartoni. (4 x 80; 5, 6 x 40). 4) Lateral view. 5) Spiral view; 6) Umbilical view. Sample 125-6-2-106.
 Fig. 7 - *Globigerinoides conglobatus* (Brady). (x 40). Ventral view. Sample 125-4-5-114.
 Fig. 8 - *Globigerinita iota* Parker. (x 150). Umbilical view. Sample 125-2-4-97.
 Fig. 9 - *Neogloboquadrina dutertrei* (d'Orb.). (x 80). Umbilical view. Sample 125-3-1-57.
 Fig. 10 - *Sphaeroidinellopsis subdehiscens* Blow. (x 80). Umbilical view. Sample 125-6-2-106.
 Figs. 11-12 - *Globigerinoides tenellus* Parker. (x 150). 11) Umbilical view; 12) Spiral view. Sample 125-2-4-97.
 Fig. 13 - *Globoquadrina altispira* (Cushman & Jarvis). (x 50). Umbilical view. Sample 125-6-3-109.
 Fig. 14 - *Globorotalia blowi* Rögl & Bolli. (x 80). Umbilical view. Sample 125-3-1-57.
 Fig. 15 - *Globorotalia inflata* (d'Orb.). (x 80). Lateral view. Sample 125-4-2-105.
 Figs. 16-17 - *Sphaeroidinella dehiscens* (Parker & Jones). (x 80). 16) Spiral view; 17) Umbilical view. Sample 125-4-3-44.
 Fig. 18 - *Articulina tubulosa* Seguenza. (x 80). Sample 125-3-6-141.
 Fig. 19 - *Hyalinea baltica* (Schroeter). (x 150). Sample 125-3-1-121.



In Sample 5-2-97 cm the disappearances of *Globorotalia crassaformis aemiliana* and *Globorotalia bonniensis* are recorded. The positions of these two events, as compared to those of the calcareous nannoplankton (LAD of *Discoaster tamalis* below and LADs of *Discoaster surculus* and *D. pentaradiatus* above), agree with data from land-sections in Sicily.

In Sample 5-1-47 cm, *Globorotalia incisa* appears (it is here recorded for the first time in the Mediterranean basin). According to Brönnimann and Resig (1971), its stratigraphic distribution corresponds to the interval between Zone N 18 and Zone N 20 of the Blow's zonation. Consequently, its appearance in Hole 125 succession and in other sections in Sicily, where it is recorded in levels roughly correlatable with Blow's Zone N 20, is younger and surely due to immigration.

Globigerinoides obliquus extremus disappears in Sample 5-1-7 cm, and *Globigerinoides obliquus* disappears in Sample 4-5-64 cm, where it is rare and represented by smaller specimens. Only specimens with four chambers in every whorl of the spire are here referred to the latter species. Morphotypes with three chambers per whorl and four chambers only in the final whorl and a large oblique primary aperture are not referred to *Globigerinoides obliquus*. They range higher, approximately till Sample 2-3-39 cm. In the two samples from Section 3-1, morphotypes with quite large tests with four subglobular chambers per whorl, a large oblique primary aperture and two or three large supplementary apertures on the spiral side are present. They have been referred to *Globigerinoides* aff. *obliquus* (Pl. 3, figs. 6-8). Coincident with the *Globigerinoides obliquus* extinction are the disappearances of *Globorotalia acostaensis* e *Globigerina apertura*.

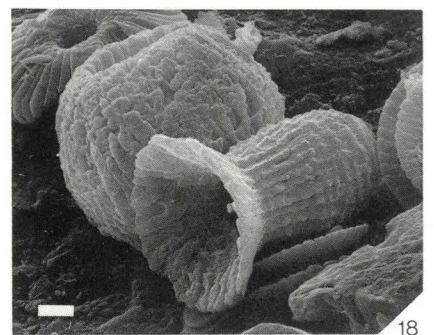
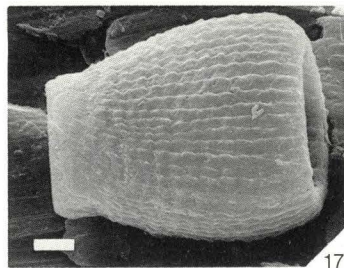
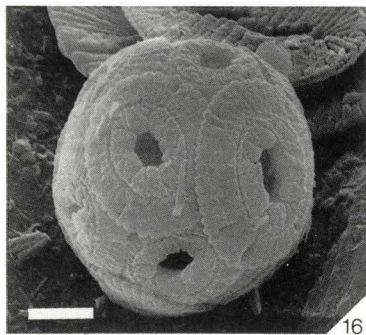
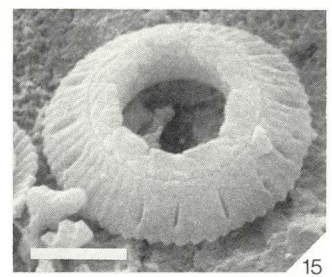
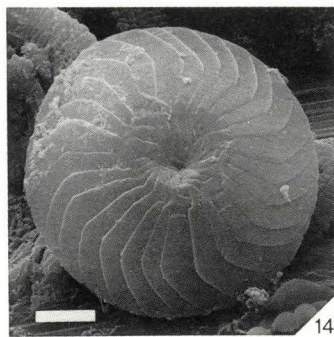
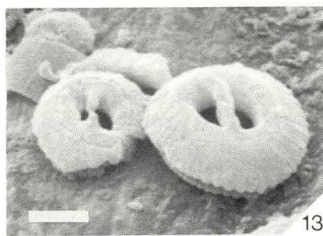
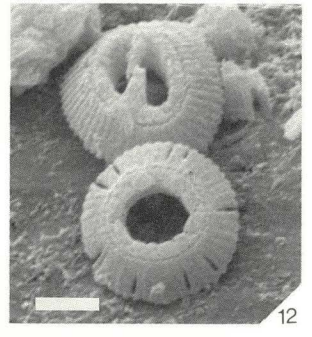
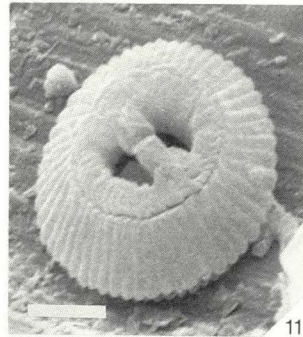
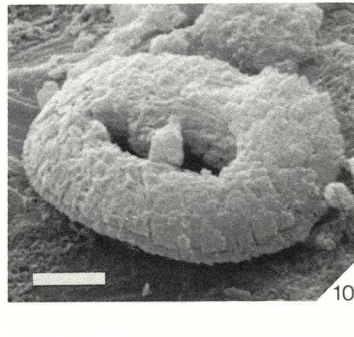
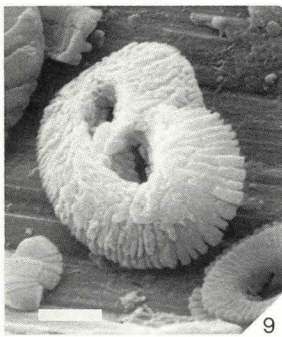
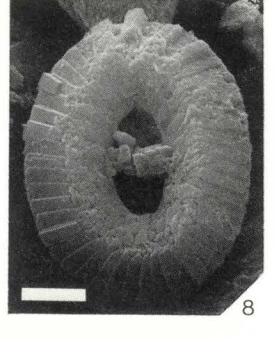
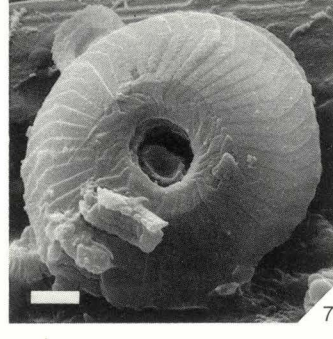
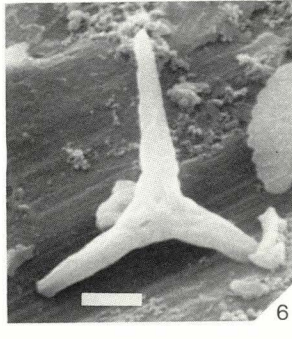
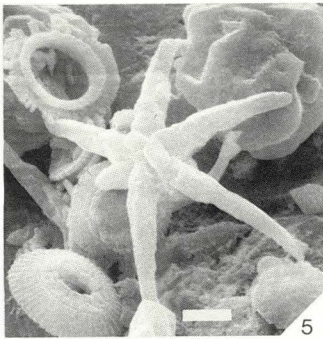
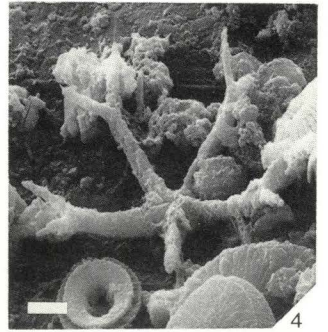
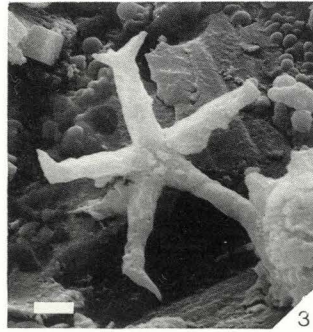
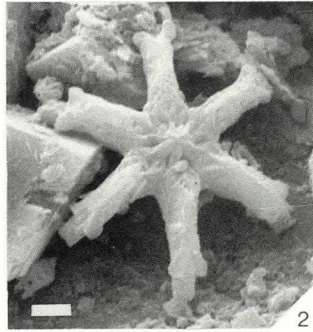
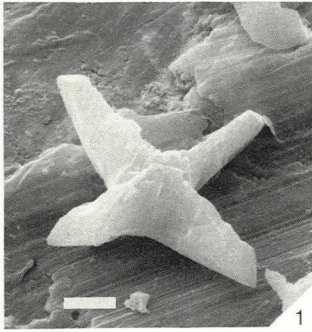
In Sample 4-6-97 cm the last specimens of *Globorotalia crassaformis* are recorded.

The appearance of *Globorotalia inflata* occurs in Sample 4-4-104 cm, just above the LAD of *Globigerinoides obliquus*, and the base of M PL 6 biozone is so recognized. This species, very rare in Sections 3 and 4 of Core 4, blooms shortly afterwards, and from Section 2 its occurrence is continuous and abundant. The rare and scattered specimens recorded below Section 4-4 and the numerous ones in Cores 6 and 7 are considered downhole contaminants. Actually, according to calcareous nannoplankton data, *Globorotalia inflata* always appears in the upper part of the *Discoaster brouweri* range (Rio *et al.*, in press). The first occurrences of both *Globanomalina praepumilio* and *Globigerina* aff. *calida* (sensu Colalongo and Sartoni, 1977) are coincident with the *Globorotalia inflata*. *Globorotalia praepumilio*, generally not recorded in the Mediterranean, is rare and ranges up to Sample 3-1-57 cm. *Globigerina* aff. *calida*, recorded just below the N/Q boundary in the Vrica section by Colalongo and Sartoni (1977), is present up to Sample 4-1-19 cm. Some specimens of this taxon are very advanced forms and similar to *Globigerina calida*, from which they differ in not possessing such a widely open spire and having less elongate chambers.

In Sample 4-3-99 cm the FAD of *Globorotalia truncatulinoides* is recorded. This species is present only in a short interval of the Pliocene sequence, up to Sample 4-2-105 cm, where it is associated with *Globorotalia tosaensis* and *Globorotalia tosaensis tenuithecata* (not recorded from older levels). It is particularly frequent in Sample 4-3-44 cm, where many specimens of *Sphaeroidinella debiscens* are also present. The assemblage in this particularly short interval is extremely peculiar, and it has also been found in several land-sections in Sicily and Northern Italy. The calcareous nanofossils confirm the Mediterranean ap-

EXPLANATION OF PLATE 5

- Fig. 1 - *Discoaster tamalis* Kamptner, Sample 125-6-2-22.
 Fig. 2 - *Discoaster surculus* Martini & Bramlette, Sample 125-6-2-22.
 Figs. 3, 4 - *Discoaster pentaradiatus* Tan Sin Honk; 3) Sample 125-6-2-22, 4) Sample 125-6-1-49.
 Fig. 5 - *Discoaster brouweri* Tan Sin Hok, Sample 125-4-2-105.
 Fig. 6 - 3-rayed specimen of *Discoaster brouweri* Tan Sin Hok, Sample 125-4-2-105.
 Fig. 7 - *Calcidiscus macintyreii* (Bukry & Bramlette), Sample 125-6-1-49.
 Fig. 8 - *Coccolithus pelagicus* (Wallich), Sample 125-6-1-49.
 Figs. 9, 10 - *Helicosphaera sellii* (Bukry & Bramlette), etched specimens; 9) Sample 125-4-1-99, 10) Sample 125-4-2-105.
 Fig. 11 - *Gephyrocapsa oceanica* s.l., Sample 125-3-3-17.
 Fig. 12 - Large *Gephyrocapsa* and *Pseudoemiliana lacunosa* (Kamptner), Sample 125-3-3-17.
 Fig. 13 - *Gephyrocapsa oceanica* s.l. and large *Gephyrocapsa*, Sample 125-3-3-17.
 Fig. 14 - *Calcidiscus leptoporus* (Murray & Blackman), Sample 125-6-1-49.
 Fig. 15 - *Pseudoemiliana lacunosa* (Kamptner), Sample 125-4-2-105.
 Fig. 16 - Complete coccosphere of small *Reticulofenestra*, Sample 125-4-1-99.
 Fig. 17 - *Scyphosphaera recta* (Deflandre), Sample 125-4-1-99.
 Fig. 18 - *Scyphosphaera intermedia* Deflandre, Sample 125-4-1-99.
 Scale bar = 2 μ m



pearance of *Globorotalia truncatulinoides* as Pliocene in age, and it is well correlatable with its oceanic FAD (Rio *et al.*, in press).

In Sample 4-2-7 cm, *Hastigerinella riedeli* appears and is then present in almost every sample until the top of the sequence. This small but well defined species is recorded for the first time in Pliocene sediments (MPL 6 biozone) of the Mediterranean; very similar specimens were recently reported by De Castro Coppa (1979) from a short section of Pleistocene (Emilian) age. Consequently, its real Mediterranean appearance level and distribution must be checked in other sections before it should be considered a new marker species for latest Pliocene and lower Pleistocene sediments.

In Sample 4-1-19 cm left coiling specimens of *Globigerina pachyderma* are found in association with the first specimens of *Globigerina calabra* (*Globigerina* cf. *calabra* is present in Sample 4-1-41 cm); in Sample 3-6-141 cm *Globigerina cariacensis* appears (*Globigerina* cf. *cariacensis* is present in Sample 4-1-19 cm). Therefore, the top of MPL 6 biozone (and the base of *Globigerina cariacensis* biozone, corresponding to the N/Q boundary) is recognized in Sample 4-1-19 cm.

Globigerinoides tenellus appears in Sample 3-4-14 cm, where only one typical specimen is present; it becomes more frequent in subsequent samples. In Section 4-5, specimens very similar to *Globigerinoides tenellus*, with a supplementary aperture on the spiral side, have been found (in the same level *Globigerinoides tenellus* is recorded by Thunell, 1979). Nevertheless, these specimens are characterized by an aperture bordered by a thick rim and are here included in *Globigerina rubescens*; occasional specimens of this species with anomalous dorsal supplementary apertures have been described and figured by Rögl and Bolli (1973). *Globigerinoides tenellus* is not characterized by an evidently bordered aperture and is considered restricted to the Pleistocene. In this same section of Hole 125, Cita *et al.* (1973) and Cita *et al.* (1974) recorded the appearance of this taxon much higher (Sample 2-5-118 cm). According to calcareous nannoplankton data, this event is a little younger in regard to its position at other Mediterranean localities, where it somewhat corresponds to the LAD of *Calcidiscus macintyreii* and the base of « Large *Gephyrocapsae* » interval.

The last important event in the planktonic foraminiferal assemblage is the appearance of *Globorotalia truncatulinoides excelsa* (with the reappearance of *Globorotalia truncatulinoides truncatulinoides*) in Sample 2 CC. The first appearance of *Globorotalia truncatulinoides excelsa* in the Mediterranean (already present in the Oceans in the *C. macintyreii* biozone at least) (Rio *et al.*, in press) is a consequence of its immigration

from the Atlantic into the Mediterranean, where this event is recorded at the base of the « Small *Gephyrocapsae* subzone » by Di Stefano and Rio (1981). Considering the data from calcareous nannoplankton, the first *Globorotalia truncatulinoides excelsa* record in this succession does not coincide with its first appearance in the Mediterranean. In fact, in Hole 125, the « Small *Gephyrocapsae* subzone » is not present and the interval corresponding to the Sicilian interval is assumed to be completely missing. In other Mediterranean localities the appearance of *Globorotalia truncatulinoides excelsa* is associated with more or less frequent specimens of *Globorotalia hessi*, *Globorotalia viola* and *Globorotalia crassaformis*. In the Hole 125 succession, we did not find any of these species, neither below nor above the « appearance » level of *G. truncatulinoides excelsa*.

BENTHIC FORAMINIFERA — *In situ* benthic foraminifera are extremely rare in Hole 125 and always indicative of very deep water. They were not studied in detail, but the distribution of two well known and widely used benthic species was followed and is reported in the range chart of text-fig. 3.

Articulina tubulosa is a deep water miliolid generally recorded (Colalongo *et al.*, 1980) from intra-Pleistocene deep sea sediments, and was recently reported by D'Onofrio (1981) in the Vrica section about 20 meters below the appearance of *Cytheropteron testudo*. In Hole 125 it appears in Sample 4-1-19 cm, corresponding to the base of the Pleistocene. It is then present in almost all the samples above that.

Hyalinea baltica is recorded in two samples (3-1-121 cm; 2-4-37 cm) where specimens are small and very rare. A very deep environment can account for such a scanty presence of this species, which has a general maximum depth limit at 900 - 1000 meters (Parker, 1958; Blanc-Vernet, 1969). Its appearance, close to the LAD of *Helicosphaera sellii*, is clearly delayed with reference to Italian onland sections, where *H. baltica* appears close to the extinction of *Calcidiscus macintyreii* and to the appearance of « Large *Gephyrocapsae* » (Raffi and Rio, 1980). Consequently, in Hole 125 the base of the « stage » Emilian, recognized in Italy by the appearance of *H. baltica* (Ruggieri *et al.*, 1974), (being this datum event unreliable) has been approximated on the basis of nannofossil data and is just above the LAD of *C. macintyreii*. *Hyalinea baltica* is a well known Pleistocene marker in the Mediterranean. Bizon *et al.* (1978) reported this species from Miocene (Langhian to Messinian) and Pliocene sediments recovered in Sites drilled during Leg 42 A (DSDP, Mediterranean Sea). Such quotation appears extremely surprising.

In samples from Core 7 and in Samples 6-2-106 cm, 5-2-138 cm, a benthic foraminiferal assemblage containing very shallow water forms (*Ammonia*, *Amphistegina*, *Elphidium*, *Bolivina*, *Discorbis*) has been recorded. In Sample 7-4-81 cm they are present together with a conspicuous deep water epibathyal to meso-bathyal benthic assemblage, very similar to the benthic assemblage recognizable in the Lower Pliocene « Trubi » marls in Sicily. All these forms are here considered displaced, probably carried down into the deepest part of the ancient basin by turbidity currents. The redeposited sediments, here testified by the shallow water benthic assemblage, possibly represent the distal front of the turbidite, because no definitive turbidites have been recognized in the lithological sequence.

RESULTS AND COMMENTS

As stated previously, the biostratigraphic signal in the basal part of this sequence is strongly disturbed by « noises » tied to downhole contamination, reworking, and the input of displaced shallow water material. So paleoclimatic observations, based on quantitative and semiquantitative analyses (Cita and Ciaranfi, 1973; Thunell, 1979, a, b) must also be considered questionable. In fact, those analyses were carried out on samples (at least in Cores 6 and 7) in which a percentage of specimens (evidently not restricted to the easy recognizable biostratigraphic markers) are considered to be displaced or downhole contaminants.

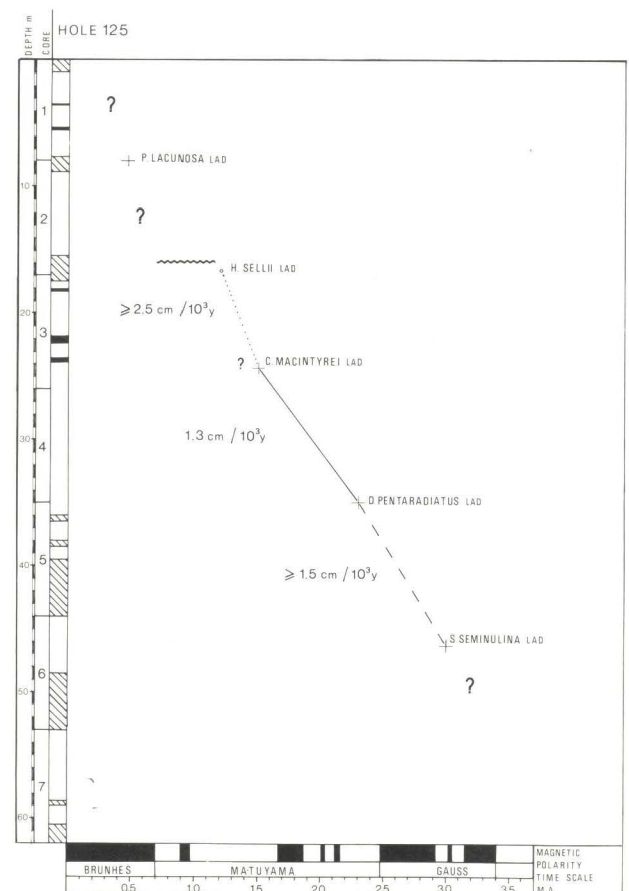
The depositional environment of the basal part of the sequence (considered « deep, far removed from land, isolated from turbidity currents, tranquil... »; p. 200 of the Initial Reports of Leg 13) is, on the contrary, intermittently disturbed by displaced shallow water material (up to Sample 5-2-72 cm). Such a finding is in contrast with the reconstruction of the subbottom topography in the Ionian basin, that postulates the presence of a deep submerged sill in this area during the lower part of the Upper Pliocene. It seems unlikely that displaced shallow water sediments, even as a distal turbidite, could have reached the top of a very prominent structural high. In accordance, a quite flat, deep sea bottom, far from land, is here postulated as being more likely in Pliocene. The uplift to its present topography evidently occurred later. In order to check the eventual response in the sedimentary conditions to changes in the regional geological setting, we tried to reconstruct a curve of the rate of sediment accumulation for the sequence of Hole 125. For this purpose, we chose the following biohorizons as marker points:

a) *Pseudoemiliania lacunosa* LAD, between Cores 2 and 1 at a depth of 8 m (0.458 MA);

- b) *Helicosphaera sellii* LAD, between Cores 3 and 2 (1.22 MA);
- c) *Calcidiscus macintyreii* LAD, in Core 3-6 (1.5 MA);
- d) *Discoaster pentaradiatus* LAD, in Core 5-1 (2.3 MA);
- e) *Sphaeroidinellopsis seminulina* LAD, in Core 6-2 (3.0 MA).

All these events follow in the same succession as known in the biostratigraphic scale and have been dated (Gartner, 1977a; Rio, 1982; Rio *et al.*, in preparation), thus providing a detailed framework for sedimentation rate control in this and many other oceanic and land successions (Rio *et al.*, in preparation).

The curve is plotted in text-fig. 4, but this reconstruction cannot be very accurate since the position of the sediment intervals in the incomplete Core barrels 5,6 and 7 is not exact. Hence, the position of some marker biohorizons recorded inside. Therefore, the accuracy of the estimated value for the sedimentation rate is feeble for these intervals. Notwithstanding, the inferred curve shows a significant trend and some comments can be made.



Text-fig. 4 - Rate of sediment accumulation in Hole 125.

In the highly disturbed Pliocene interval (corresponding to the MPL 4 zone and the «*Discoaster surculus* zone»), the rate of sediment accumulation has been estimated as a minimum value of 1.5 cm/1000 y, depending on the position of the recovered interval in the Core 5 (the dashed line in text-fig. 4). A moderate decrease of sedimentation rate is recorded upwards between *Discoaster pentaradiatus* LAD and *Calcidiscus macintyreii* LAD. The estimated value of 1.3 cm/1000 y is within the regime of purely pelagic sedimentation. This evaluation is reasonable because it occurs in an undisturbed continuously cored interval in which several biostratigraphic events are recorded in a sequence that matches well with data from land sections from neighboring areas (Rio *et al.*, in preparation). At the top of Core 4, the Pliocene/Pleistocene boundary is recognized in reference to the boundary stratotype proposed in the Vrica section (Colalongo *et al.*, 1982).

In regard to the Pleistocene interval, it is difficult to obtain a good reconstruction of the curve because of the presence of a hiatus and the absence of reliable marker points. The dotted line represents the sedimentation rate curve drawn between the *C. macintyreii* LAD and the *H. sellii* LAD (placed between Cores 3 and 2 just below the hiatus). In this interval an increase in the accumulation rate is recorded, reaching at least a value of 2.5 cm/1000 y. We point out that this value could be higher, assuming the presence of another anomaly in the sedimentation to explain the relative position of two datum levels: the *Calcidiscus macintyreii* LAD and the appearance of large specimens of genus *Gephyrocapsa*. In fact, these forms are generally recorded within the «*H. sellii* subzone» and their appearance is calibrated at 1.4 MA (Rio, 1982; Rio *et al.*, in preparation). Since they appear very close to *C. macintyreii* LAD in Hole 125, it seems justified to assume the presence of an anomaly. This anomaly could be a hiatus if the extinction level is considered the disappearance of the bulk of *C. macintyreii* specimens in Sample 3-6-139 cm. This hiatus in Section 6 of Core 3 would encompass a time of about 0.1 my. In this same interval in Core 3, other anomalous distributions of forms are recorded. *Globigerinoides tenellus* and *Hyalinea baltica*, which usually appear close to each other and to the *C. macintyreii* LAD, appear higher, near the extinction of *H. sellii*. This fact could indicate a younger entry of the two species. Anyhow, there is an abrupt change in the rate of sediment accumulation in Core 3, which is at least double that of the underlying interval. These anomalies in the sedimentation could be due to changes in the biologic productivity and to tectonic activity. This change in sedimentation is also exhibited by the presence of sapropels in Sections 1,4 and 5 of Core 3.

Considering evidences from calcareous nannoplankton data, it appears that the hiatus between Cores 2 and 3 encompasses a time interval corresponding to the Sicilian stage. In the Sicilian stratotype section of Ficarazzi (Sicily, Palermo) (Di Stefano and Rio, 1981) two nannofossil biozones are represented: the «Small *Gephyrocapsae* subzone» and the «*Syracosphaera pulchra* subzone» (pars) of Raffi and Rio (1979). In the latter subzone, morphotypes of the species *Gephyrocapsa oceanica* with a diagonal bar aligned or nearly aligned with the short axis of the placolith are recorded (Rio, 1982). The absence of the interval in which the «Small *Gephyrocapsae*» are dominant and the interval with the above described morphotypes of *G. oceanica* is evidence that there is a gap in the sequence of Hole 125, corresponding at least to the entire Sicilian stage. A local ecological exclusion of these forms is unlikely, because they have been recorded elsewhere outside and within the Mediterranean basin (Rio, 1982). Even the possibility that the missing interval could be concentrated in the two meters interval between Cores 2 and 3, where there was no recovery, is not considered acceptable, because this thickness is too small for covering a time interval which is at least 0.3-0.4 my (Ruggieri *et al.*, in preparation). Therefore, the local appearance of *Globorotalia truncatulinoides excelsa* in Sample 2 CC does not correspond to its entry level in the Mediterranean, which marks the base of the Sicilian stage (Ruggieri and Sprovieri, 1975). It is not possible that any accurate evaluation of the sedimentation rate in the upper part of the Hole 125 sequence can be made. We can only assert that it might have undergone a further remarkable increase after the *Pseudoemiliana lacunosa* LAD at about 0.458 MA. In fact, if we assume that the top of the succession is at least before the *Emiliana huxleyi* FAD (the topmost layers where deposited before 0.27 MA), we obtain a minimum value of 4.2 cm/1000 y for the rate of sediment accumulation. As for as paleoclimatic observations, there is a peak in abundance of cold climate indicative species (as recorded by Cita *et al.*, 1973, and Thunell, 1979 a, b) in the upper part of Core 2 (text-fig. 2). Thunell (1979 a, b) correlated this climatic signal with the base of the «glacial Pleistocene», calibrated at about 0.8 MA in the Oceans (Shackleton and Opdyke, 1977). However, the signal is close to the extinction of *Pseudoemiliana lacunosa* (few centimeters below) and cannot be referred to an age as old as 0.8 MA. We consider this cold peak one of the several coolings already recognized in the Middle and Upper Pleistocene, and not to coincide with the base of the «glacial Pleistocene» as has been recognized in Cava Puleo (Palermo, Sicily) a few meters above the base of «*Syracosphaera pulchra* subzone» (Di Ste-

fano and Rio, 1981; Buccheri, 1982; Ruggieri *et al.*, in preparation). We did not find evidence of any other coolings in the Lower Pleistocene of Hole 125.

It is believed that the uplift of this area could have taken place in coincidence with the sharp increase in the sediment accumulation rate recorded just above the *C. macintyreii* LAD. The two supposed hiatuses would result from a sedimentary subtraction of sediments which could have occurred as a consequence of the tectonic movements. It is to be noted that in the Vrica section and in outcrops in the surrounding area of the Ionian basin, there is a change in the sedimentation regime just above the *C. macintyreii* extinction level and indications of a progressive decrease in sedimentation depth. In the neighbouring section of Le Castella, sediments of the Lowermost Pleistocene (Santernian and Emilian) are not found (Colalongo *et al.*, 1981). The Uppermost Pliocene sediments (corresponding to the «*Coccolithus pelagicus* zone» of Raffi and Rio, 1979, and to the «*Globorotalia inflata* zone») underlying the marker bed, at this section are overlain by sediments dated in the topmost Emilian and Sicilian stage (*Globigerina cariacensis* zone and *Globorotalia truncatulinoides excelsa* zone). Finally, in Sicily and Calabria regions a hiatus has been recognized (Ruggieri *et al.*, 1979, 1979 a) within the «*H. sellii* subzone», and is due to the transgression of the Upper Emilian-Sicilian sedimentary cycle. All these evidences of the tectonic evolution of the Ionian basin and surrounding area since the Lower Pleistocene are well in agreement with similar conclusions from the Hole 125 sequence.

We may then conclude that the sequence in Hole 125 has many drawbacks. The stratigraphic reworking and the downhole contamination in Cores 6 and 7 prevent detailed biostratigraphic and paleoclimatic analyses, and consequently the results are largely unreliable within this interval. Core 4 is the only undisturbed core and the biostratigraphic events are in normal sequence (one extant chronostratigraphic event, the N/Q boundary, is recognized at its top). Core 3, with almost complete recovery, displays a higher sedimentation rate. In this core, the recorded foraminiferal biostratigraphic events are not comparable with the general Mediterranean scheme. There are many possibilities that a major hiatus is present between Cores 3 and 2, encompassing an interval corresponding to, at least, the Sicilian stage (approximately a time interval of 0.35 MA). The cold peak recorded at the top of Core 2 cannot be referred to the base of Glacial Pleistocene. It could represent one of the several coolings due to the climatic deteriorations within Middle and Upper Pleistocene, with an age slightly older than 0.46 MA. Lastly, in Core 1, with two unrecovered intervals at the base and at the top, an extremely high sedi-

mentation rate, unusual in normal deep bathyal pelagic sediments, has been inferred.

THE LOWER PLEISTOCENE STRATIGRAPHY IN HOLE 125.

In the last years many papers by scientists of the Bologna School (Selli *et al.*, 1977; Colalongo and Pasini, 1980; Colalongo and Sartoni, 1977, 1979; Colalongo, Pasini and Sartoni, 1980) dealt with the definition of the N/Q boundary. According to these studies, this chronostratigraphic boundary could be placed in a well defined and suitable section (the Vrica section). There, close to a lithological level correlatable with the first appearance of the «northern guests» in the Mediterranean, many calcareous planktonic events occur. These events allow to correlate this lithological level outside the stratotype section and, *via* Mediterranean deep sea record, even outside the Mediterranean (Rio, 1982).

In the meantime, a revision based on field and laboratory data of the biostratigraphy and chronostratigraphy of the Lower Pleistocene was carried out by scientists of the Palermo School (Ruggieri *et al.*, 1974; Ruggieri and Sprovieri, 1975, 1977, 1977a, 1979). This revision resulted in a better understanding of the now widely accepted succession of biostratigraphic events recognizable in this time interval (see Italian Paleontological Society Congress held in Pisa, 1981; Italian Geological Society Congress held in Bologna, 1982).

Actually, a three-fold subdivision of the Mediterranean Lower Pleistocene seems justified and legitimated by two basic remarks: 1) the taxon previously reported in literature as *Globorotalia truncatulinoides* in Pleistocene sediments is now regarded as a different form (*G. truncatulinoides excelsa*). Its appearance is well above the base of the Pleistocene. As mentioned, the FAD of *Globorotalia truncatulinoides truncatulinoides* is an Upper Pliocene event (Rio *et al.*, in press); 2) *Hyalinea baltica* appears well above the entrance of «northern guests» in Mediterranean and below the first occurrence of *G. truncatulinoides excelsa*. Then, based on the successive appearances of *Arctica islandica* (or *Globigerina cariacensis*), *Hyalinea baltica* and *Globorotalia truncatulinoides excelsa*, three biozones, although of restricted regional value, can be easily recognized.

Calcareous nannofossils underwent marked evolutionary changes during Early Pleistocene, when a closely spaced sequence of LADs and FADs have been pointed out in this floral assemblage and have been absolutely dated by paleomagnetic methods (Gartner, 1977a; Rio, 1982). These same biostratigraphic events have been recognized in the sections where *Arctica*

islandica, *Hyalinea baltica* and *Globorotalia truncatulinoides excelsa* appearances have been detected. As a matter of fact, constantly the appearance of *Gephyrocapsa oceanica* s.l. approximates the Mediterranean appearance of the first « northern guests » (including *A. islandica*), the extinction of *Calcidiscus macintyreii* (or the appearance of the « Large *Gephyrocapsae* ») approximates the entry of *Hyalinea baltica*, and the extinction of *Helicosphaera sellii* virtually coincides with the Mediterranean appearance of *G. truncatulinoides excelsa*. Such a constant interrelation strongly supports that the biostratigraphic subdivision of the Lower Pleistocene, based on the successive Mediterranean entries of *A. islandica*, *H. baltica* and *G. truncatulinoides excelsa*, has a time significance. Consequently, three chronostratigraphic units, respectively Santerian, Emilian and Sicilian, were proposed for the time interval corresponding to the Lower Pleistocene (Ruggieri *et al.*, 1974; Ruggieri and Sprovieri, 1975).

Finally, the common paleontological characters of the faunistic assemblages throughout the Lower Pleistocene (presence of the « northern guests ») led to the proposition of a superstage (Selinuntian) which would include the three previously mentioned, more or less emended, or newly proposed, stages. If the Selinuntian is ranked as a stage, then Santerian, Emilian and Sicilian could be considered as local Mediterranean chronostratigraphic units (substages or chronozones) (Ruggieri *et al.*, in preparation).

As resulted from these new observations, in Hole 125 the N/Q boundary falls in Sample 4-1-19 cm, in a level different from those proposed by Cita (1973), Bizon and Müller (1978) and Thunell (1979). Moreover, since the FAD of *Hyalinea baltica* is unreliable in this sequence, it was possible only to roughly recognize two Mediterranean chronostratigraphic units of Lower Pleistocene, by means of nannofossil biostratigraphy. The data of calcareous plankton suggest that the interval corresponding to the Sicilian « stage » is not present in Hole 125 sequence.

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