Rivista Italiana di Paleontologia e Stratigrafia	volume 101	numero 1	tavole 1-2	pagine 63-80	Maggio 1995

NUMMULITE BIOSTRATIGRAPHY AT THE MIDDLE/UPPER EOCENE BOUNDARY IN THE NORTHERN MEDITERRANEAN AREA

CESARE ANDREA PAPAZZONI & ACHILLE SIROTTI

Key-words: Biostratigraphy, Nummulites, Middle/Upper Eocene boundary, Northern Mediterranean.

Riassunto. Sono state studiate le associazioni a macroforaminiferi (principalmente Nummulitidi) di alcune successioni delle aree veneta (M.ti Berici e Lessini), spagnola (bacino dell'Ebro) e rumena (Cluj-Napoca) in prossimità del limite Eocene medio-superiore. I risultati hanno permesso di migliorare la risoluzione stratigrafica delle biozone a Nummuliti. Lo studio della successione di Mossano e la correlazione con alcune altre successioni dell'area veneta hanno suggerito l'opportunità di sostituire la Zona a *Nummulites brongniarti* (parte alta dell'Eocene medio) con due biozone: una inferiore, a *N. lyelli*, ed una superiore, a *N. biedai*. Inoltre si è ravvisata l'opportunità di ridenominare la Zona a *N.* aff. *fabianii* come Zona a *N. variolarius/incrassatus*. Questa suddivisione è applicabile anche nelle aree rumena e spagnola.

Secondo le interpretazioni correnti, la base del Priaboniano (=Eocene superiore) è stata posta alla base della Zona a *N. fabianii* s.s., oppure alla base della Zona a *N. variolarius/incrassatus*. In entrambi i casi, si propone di considerare la successione di Mossano, in cui la sedimentazione è relativamente continua, come una possibile candidata ad ospitare il "Global Stratotype Section and Point" della base del Priaboniano.

Abstract. Some larger foraminiferal assemblages (mostly nummulitids) near the Middle/Upper Eocene boundary have been investigated. Sections of the Veneto area (Berici and Lessini Mts., northern Italy) were studied and compared with others of the same age from Spain (Ebro basin) and Romania (Cluj-Napoca). In the Veneto area the results allow to split the upper Middle Eocene *Nummulites brongniarti* Zone into two biozones: a lower *N. lyelli* Zone and an upper *N. biedai* Zone. The *N.* aff. *fabianii* Zone is here renamed *N. variolarius/incrassatus* Zone. This subdivision can also be recognized in Spain and Romania.

According to the current conceptions, the base of the Priabonian (= Upper Eocene) could correspond either to the base of the *N. fabianii* s.s. Zone or to the base of the *N. variolarius/incrassatus* Zone. Anyway, the Mossano succession could be a potential Global Stratotype Section and Point for the base of the Priabonian.

Introduction.

In recent years the Middle/Upper Eocene boundary has been long debated. In the past, the whole Middle Eocene was identified with the Lutetian Stage (e.g. Hottinger et al., 1956, tab. 1; Pomerol, 1964, tab. 3), whereas the Priabonian in the Mediterranean domain and the Bartonian in the northern basins were regarded as synonyms of the Upper Eocene (e.g. Schaub, 1968). Since the 1960s improvement of the biostratigraphy allowed this subdivision to be refined and the relative position of the stages specified. Hottinger & Schaub (1960) introduced the "Biarritzian" Stage to fill the gap between the Lutetian and the Priabonian in carbonate platform facies. However, during the "Colloque sur l'Éocène" this proposal was rejected (Propositions, 1969) and the stage declassed to a "Biarritzian biozone," although still today this stratigraphic term is widely employed by students of larger foraminifera. Bombita (1964) proposed the "Napocian" Stage to complete the stratigraphic succession between the Middle and the Upper Eocene. However, this term remained restricted to the Romanian area and never came into the international usage. Cavelier & Pomerol (1976) pointed out that the Bartonian underlies the Priabonian, and this is now agreed upon by most stratigraphers. Thus, the Middle/Upper Eocene boundary was equated to the Bartonian/Priabonian boundary. The Bartonian stratotype contains the calcareous nannofossil zones NP16 (partim)-NP17 (Aubry, 1985, 1986), whereas the Biarritzian stratotype contains the NP 17 Zone (Mathelin & Sztràkos, 1993), so we could assume the "Biarritzian" correlates at least with the upper part of the Bartonian.

The International Subcommission on Paleogene Stratigraphy recently pointed out that stages are defined no more by their stratotypes (Hedberg, 1976), but by the Global Stratotype Section and Point (GSSP) of their lower boundaries (Cowie et al., 1986; Jenkins & Luterbacher, 1992; Salvador, 1994). According to these statements, the base of the Priabonian Stage also defines the Middle/Upper Eocene boundary.

- Istituto di Paleontologia dell'Università di Modena, via Università 4, 41100 Modena.

The work of the Subcommission is still in progress and an agreement about this problem has not been achieved to date.

The present study on the larger foraminiferal fauna from carbonate platform facies is a contribution to the solution of this stratigraphic problem. We analysed some stratigraphic sections from the northern Mediterranean area, i.e. Veneto (northern Italy), Spain and Romania, in the aim of clarifying the stratigraphic relationships between the base of the type-Priabonian and the uppermost Middle Eocene. The sections have been selected for their apparently continuous sedimentation across the Middle/Upper Eocene boundary. We emphasize that this continuity is very rare: the marine sedimentation in most regions stops at (or just before) the end of the Middle Eocene.

According to Papazzoni (1993) *Nummulites* cf. *hormoensis* Nuttall & Brighton refers to the specimens from western Europe (Schaub, 1981) of *Nummulites ptukhiani* Kacharava (former "*Nummulites praefabianii*") and *Nummulites* aff. *fabianii* Auct., whereas *Nummulites ptukhiani* s.s. is restricted to Armenia and eastern Europe. *Nummulites garnieri sturi* Vanova has the priority upon *Nummulites praegarnieri* Schaub and similarly *Spiroclypeus carpaticus* (Uhlig) has the priority upon *Spiroclypeus granulosus* Boussac.

To reconstruct the paleoenvironments we applied to the larger foraminiferal assemblages a paleoecological model which is a critical synthesis of different models (Arni, 1965; Setiawan, 1983; Hallock & Glenn, 1986), together with sedimentological observations on thin sections (Wilson, 1975; Flügel, 1982). Our model (Papazzoni, 1993, 1994) includes four facies:

A) outer platform with low-energy hydrodynamic regime, characterized by flattened species such as *Nummulites chavannesi*, *N. lyelli*, *N. striatus*, *Operculina* spp., *Discocyclina* spp., *Asterocyclina* spp., *Spiroclypeus carpaticus*, etc.;

B) inner platform with high-energy hydrodynamic regime, characterized by robust or encrusting species such as *Nummulites biedai*, *N. perforatus*, *N. beaumonti*, *N. discorbinus*, *Gypsina* sp., *Sphaerogypsina globula*, etc.;

C) inner platform with low-energy hydrodynamic regime, characterized by *Nummulites* ex gr. *fabianii*, *N. variolarius/incrassatus*, *Calcarina* sp., *Fabiania* sp., *Chapmanina gassinensis*, *Gypsina linearis*, *Silvestriella tetraedra*, etc.;

D) "restricted lagoon" or innermost, very shallow platform, characterized by abundant Miliolidae, Alveolinidae, *Orbitolites*, etc.

Where the larger foraminifera are lacking, to deduct the paleoenvironments we rest on other fossil content or on sedimentological data.

Status of the Priabonian Stage.

The original definition of the Priabonian dates back to Munier-Chalmas & de Lapparent (1893); they described three sections which, as a whole, represent a composite stratotype.

From top to bottom they are:

3) "Marnes de Brendola";

2) "Groupe des couches à *Orbitoides* de Priabona";

1) "Assises de La Granella" (*Cerithium diabolii* beds of Boro-Granella *Auct.*).

The Boro locality, at the foot of the Granella hill, is close to the village of Priabona (Lessini Mts.), whereas Brendola is about twenty km south-east, in the north-western margin of the Berici Mts. These three localities represent the type-area of the Priabonian.

Fabiani (1915) pointed out that at Boro the "*Cerithium diabolii* beds" overlay a basaltic conglomerate. These beds are related to a transgressive pulse which follows the regressive interval of the latest Middle Eocene (Piccoli & De Zanche, 1968), as also confirmed by Roveda (1961). In a borehole at the foot of the Granella hill, Piccoli & Massari Degasperi (1968) observed oxidized basalt with evidences of subaerial exposure resting on limestones with *Nummulites* ex gr. *millecaput*. These authors inferred the presence of a gap between the topmost Middle Eocene sediments and the lowermost Upper Eocene deposits in the type-area.

During the "Colloque sur l'Éocène" the Priabonian was defined as the stratigraphic interval between the *Nummulites brongniarti*, *N. perforatus*, *Alveolina elongata* Zone ("Biarritzian") and the *Nummulites intermedius* Zone (Oligocene) (Colloque sur l'Éocène, 1969). This implied the extension of the Priabonian to include the *Nummulites* aff. *fabianii* Zone (Castellarin & Cita, 1969); this zone is lacking in the holostratotype but is represented in the Mossano section, at that time chosen as a reference section (hypostratotype). Ungaro (1969) in studying the Mossano section did not clearly define the Middle/Upper Eocene boundary and the problem of the base of the Priabonian remained unsolved.

Our research focused on studying in detail the Mossano section and its correlation with the holostratotype. Moreover, the correlations were extended to other sections of the Lessini and Berici Mts., and to some Spanish and Romanian successions.

The stratigraphic sections.

1 - Berici Mts. (Veneto).

In this area three sections were sampled and studied: Mossano, Pederiva ("Cava Zengele" in

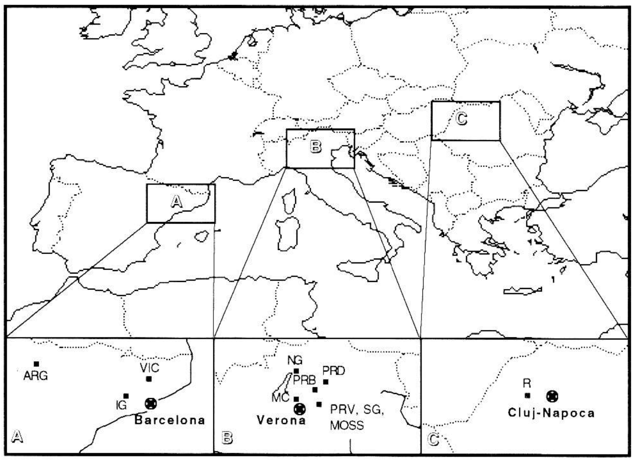


Fig. 1 - Location map of the sections sampled.
A) Spain. ARG=Arguis; IG=Igualada; VIC=Vic.
B) Veneto. MOSS=Mossano; PRV=Pederiva di Grancona; SG=San Germano dei Berici; PRB=Priabona; MC=Monte Cavro; NG=Nago; PRD=Pradipaldo.
C) Romania. R=Leghia, Cluj, Mera.

Schweighauser, 1953), and San Germano dei Berici, about two km south of Pederiva (Fig. 1B).

A) The Mossano section is the most interesting for its completeness and accessibility. Our samples were taken following approximately the paths reported by Schweighauser (1953) and Herb & Hekel (1973), along the road from Mossano to C. Leonardi and Monte Stria. The recent works to widen the road increased the size of the outcrops and revealed two direct faults just before the crossroad to Olivari (Papazzoni & Sirotti, 1993). The lithologic units recognized are, from top to bottom (Fig. 2a):

4) marls and marly limestones with bryozoa and discocyclinids (over 36 m);
3) nodular limestones with small nummulites (20 m);
2) massive limestones with *Nummulites biedai* (23 m);
1) bedded limestones with *Nummulites lyelli* and *Nummulites* cf. *dufrenoyi* (16 m).

The distribution of foraminiferal assemblages is plotted in Tab. 1.

The paleoecological interpretation of this succession (Papazzoni, 1994) suggests a progressive lowering of the relative sea level during the time corresponding to the deposition of the units 1-3 (Fig. 2a): unit 1 can be interpreted as an outer platform facies; unit 2 consists of sandy shore sediments settled near the outer margin of the inner platform, whereas unit 3 was deposited in a more protected, low-energy environment of an open platform. A new sudden deepening, associated with an increase in terrigenous input, is demonstrated by the overlaying marly unit 4, indicative of an outer platform environment.

B) In Pederiva di Grancona, on the northern side of the Liona Valley, the most striking feature is the nummulite bank cropping out at the periphery of the village. We sampled the southern side of M. Vagina, just above the village, following the paths of Fabiani (1915) and Schweighauser (1953). The strata, except for the lower part of the section, are not well exposed because of the dense vegetation. The lithologic units recognized are, from top to bottom (Fig. 2b):

4) marls and marly limestones with pelecypods and echinoids (over 15 m);
- 10 m covered
3) nodular limestones with miliolids and small nummulites (6 m exposed and 11 m covered);
- 4 m covered
2) massive limestones with *N. lyelli* (13 m);
- 3 m covered
1) *N. lyelli* bank (10 m).

In unit 1 the assemblage (Tab. 1) is dominated by the B forms of *Nummulites lyelli* d'Archiac & Haime and *N. biarritzensis* d'Archiac; *N.* cf. *dufrenoyi* d'Archiac & Haime is rare. The abundance of flattened forms points to an outer platform paleoenvironment (Hallock & Glenn, 1986). The overlaying unit 2 contains a foraminiferal assemblage typical of higher-energy conditions, probably in a more proximal setting. The shallowing-upward trend continues with unit 3, indicating a very shallow "restricted lagoon" (Hallock & Glenn, 1986). A deepening is recorded by the marly sediments of unit 4, indicative of a shift to an open platform paleoenvironment with an increase in terrigenous supply. The general trend matches the one recognized at Mossano, although the vegetation cover prevents to establish if the transition is continuous or sharp. The presence of the miliolid limestones at the top of the regressive cycle leads us to suggest that Pederiva was closer to the coastline than Mossano, where this proximal facies is missing.

C) S. Germano dei Berici is on the eastern side of the Liona Valley. Our samples were collected along the road (Via Lupia) from the village of S. Germano to Monte Lupia. The outcrops are rather continuous in the lower part of the section, whereas in the middle part the real thickness of the covered portion could not be estimated due to the supposed presence of a direct fault. The lithologic units recognized are, from top to bottom (Fig. 2c):

6) massive limestones with small nummulites (over 10 m);
5) *N. fabianii* bank (4 m);
4) bedded limestones with discocyclinids (10 m);
3) nodular limestones with miliolids and small nummulites (9 m exposed and 2 m covered);
- covered (thickness uncertain)
2) massive limestones with *N.* cf. *dufrenoyi* and *N.* ex gr. *perforatus* (18 m exposed and 16 m covered);
1) *N.* cf. *dufrenoyi* bank (1-2 m).

Paleoecological succession of the fossil assemblages (Tab. 1) from the three lower units shows a

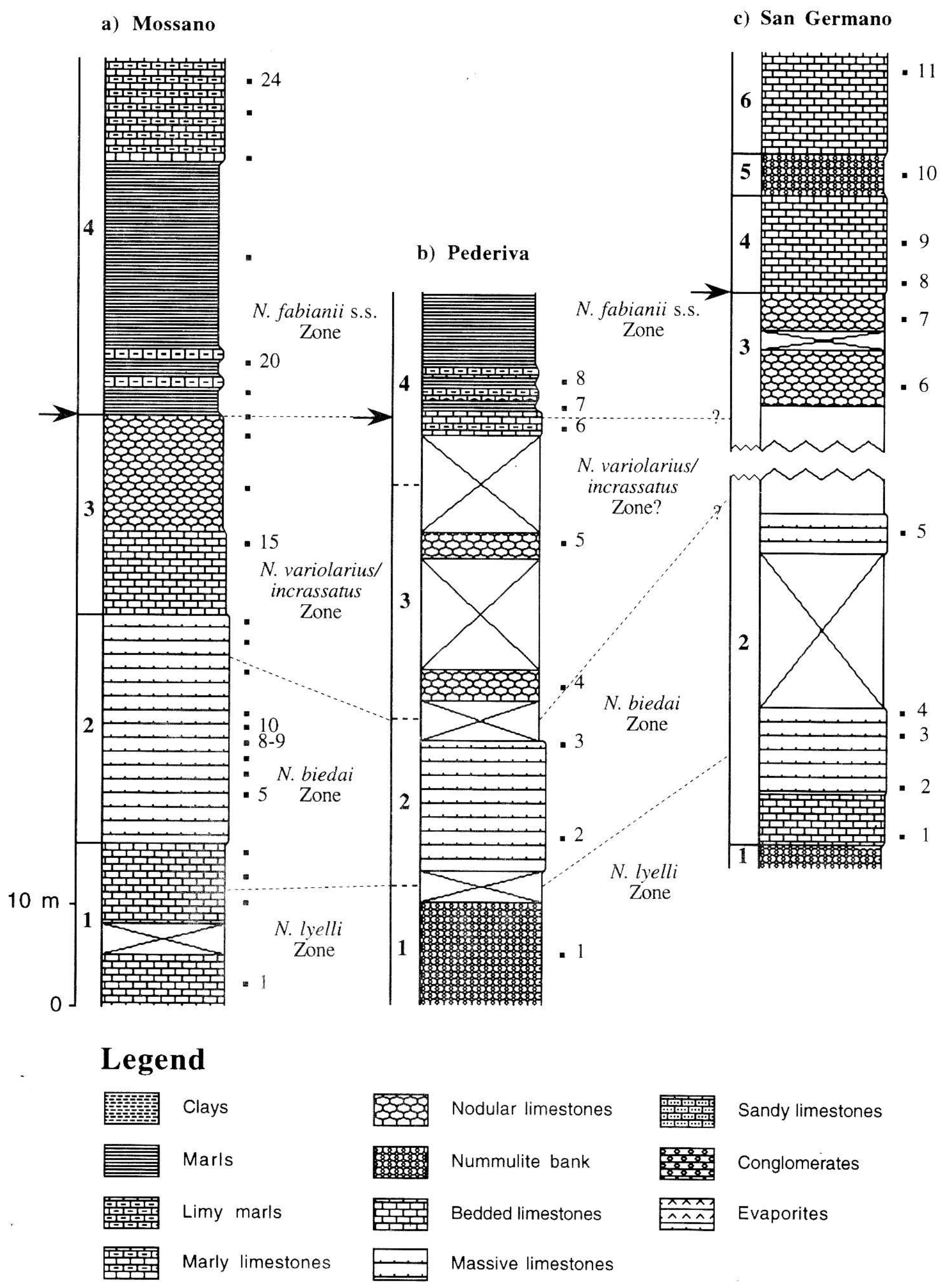


Fig. 2 - Correlation of the Mossano (a), Pederiva di Grancona (b) and San Germano dei Berici (c) sections based on nummulite zones. The numbers on the left of the columns refer to the lithologic units described in the text. The numbers on the right refer to the samples studied. The black arrows indicate the maximum relative sea-level fall.

striking resemblance with Pederiva as well as the same regressive trend. In the upper units (4-6), although the terrigenous input is not important in comparison with the previous sections, the discocyclinid limestones mark the beginning of the new transgressive cycle.

2 - Lessini Mts. (Veneto).

The sections sampled include the lower part of the Priabona section and the locality Monte Cavro, near Verona (Fig. 1B).

D) Several papers have been published on the larger foraminifera from Priabona. To quote only the more significant, Roveda (1961) studied the nummulitids from the Boro-Granella section, Sirotti (1978) investigated the discocyclinids from Priabona, whereas Setiawan (1983) carried out a detailed paleoecological interpretation of the sections of Priabona and the neighbouring Buso della Rana and Bressana (Ghenderle). The calcareous nannofossils were studied by Jossen (1982) and Verhallen & Romein (1983).

The lowermost portions of the Priabona section and the Boro-Granella section are correlatable (Hardenbol, 1968, p. 634). Since the latter could not be attained for this study, we sampled the lower part of the Priabona section, from the small spring along the road Priabona-Malo to the overriding road Priabona-Monte di Malo. The lithologic units recognized are, from top to bottom (Fig. 3a):

5) blue claystone (5 m);
- 4 m covered
4) *Discocyclina* marls (10 m);
- 3 m covered

Sample / Species	Numm. beaumonti/discorbinus	N. biarritzensis	N. biedai	N. aff. boulangeri	N. chavannesi	N. cf. dufrenoyi	N. fabianii	N. garnieri garnieri	N. cf. hormoensis	N. cf. hottingeri	N. lyelli	N. perforatus	N. pulchellus	N. stellatus	N. striatus	N. variolarius/incrassatus	Assilina sp.	A. exponens	Operculina alpina	O. aff. alpina	O. bericensis	O. gomezi	O. schwageri	Heterostegina reticulata	Spiroclypeus carpaticus	Discocyclina sp.	D. augustae	D. discus	D. dispansa	D. radians	D. trabayensis	Nemkovella strophiolata	Orbitoclypeus sp.	O. varians	Asterocyclina sp.	A. alticostata	A. kecskemetii	A. stella	A. stellata	Asterigerina sp.	Calcarina sp.	Chapmanina gassinensis	Eorupertia sp.	Fabiania sp.	Gypsina sp.	G. linearis	Haddonia heissigi	Halkyardia minima	Orbitolites sp.	Silvestriella tetraedra	Sphaerogypsina globula	Alveolinidae	Miliolidae	Rotaliidae indet.
MOSS 24					•									•		•						•		•	•					•									•	•														•
MOSS 23														•		•								•	•		•		•	•		•			•				•	•						•	•				•			•
MOSS 22					•									•		•			•			•		•	•		•												•															
MOSS 21					•										•				•			•		•	•		•		•	•		•		•					•	•											•		•	•
MOSS 20					•		•							•		•				•		•		•	•		•		•	•		•				•			•															•
MOSS 19																•				•				•	•		•		•	•	•		•						•															
MOSS 18					•		•							•		•							•	•		•	•						•	•	•				•	•	•	•		•		•	•	•		•		•	•	•
MOSS 17	•				•				•							•								•																•	•	•		•	•	•	•						•	•
MOSS 16	•				•				•							•							•	•									•		•					•	•	•	•	•		•			•	•		•	•	•
MOSS 15	•				•				•							•										•														•	•	•		•		•		•		•		•	•	•
MOSS 14									•							•							•	•					•											•		•				•		•		•			•	•
MOSS 13									•							•																			•					•	•	•		•	•	•	•			•	•		•	
MOSS 12	•		•		•				•					•	•	•							•	•											•					•	•	•		•	•	•	•			•	•		•	•
MOSS 11	•		•	•	•				•	•			•	•		•							•	•						•			•	•	•			•	•	•	•				•	•	•			•	•		•	
MOSS 10	•		•		•	•			•					•		•							•	•				•	•	•			•	•						•	•	•			•	•				•	•		•	•
MOSS 9									•							•						•	•			•							•												•									•
MOSS 8	•		•		•				•					•	•	•								•		•									•				•	•		•		•	•	•	•				•			•
MOSS 7	•				•				•							•						•	•	•		•		•	•	•					•				•	•					•									
MOSS 6					•	•			•		•			•		•						•	•	•		•			•				•		•							•												
MOSS 5			•						•							•						•		•		•		•		•			•		•			•		•				•	•	•					•			
MOSS 4									•							•						•				•	•			•					•					•					•	•	•	•				•	•	
MOSS 3					•				•					•	•							•	•	•				•	•				•		•				•	•	•	•			•	•								•
MOSS 2					•	•			•		•			•	•							•	•						•	•		•	•	•	•					•											•			•
MOSS 1	•				•	•					•				•							•	•	•		•		•	•	•		•	•		•				•	•					•						•			
PRV 8					•		•																																										•				•	•
PRV 7					•		•	•								•								•			•		•						•														•				•	•
PRV 6																																										•											•	
PRV 5																																															•		•			•	•	
PRV 4	•				•											•						•				•		•					•							•	•			•	•		•				•			
PRV 3									•		•		•		•	•										•		•		•										•	•				•							•		
PRV 2	•								•		•				•	•						•	•			•		•		•			•		•				•	•	•				•									
PRV 1	•	•				*					•				•	•	•	•			•		•			•				•				•	•				•														•	•
SG 11																•																			•					•					•	•	•				•			
SG 10							•									•			•					•									•							•														
SG 9							•					?														•				•					•						•				•									
SG 8							•								•	•						•						•							•			•	•	•	•				•									
SG 7	•						•									•				•				•	•								•							•	•	•												
SG 6	•						•									•								•	•									•	•				•						•						•	•	•	
SG 5									•							•												•				•			•						•			•	•		•				•	•		
SG 4						•					•	•				•						•						•	•			•	•		•				•	•	•													
SG 3																						•						•					•		•			•																
SG 2						•									•	•					•					•		•	•					•		•	•	•	•	•														
SG 1															•	•						•						•	•	•		•	•		•			•		•														

Tab. 1 - Distribution of the larger foraminifera in the Mossano (MOSS), Pederiva di Grancona (PRV) and San Germano dei Berici (SG) sections. The biozones recognized are reported in Fig. 2.

3) *N. fabianii* limestones (9 m);
2) silty and sandy limestones (5 m);
1) basaltic conglomerate (1 m or less).

The foraminifera recognized are listed in Tab. 2. The basaltic conglomerate is universally recognized as marking the beginning of the Priabonian marine transgression (Fabiani, 1915; Setiawan, 1983). The deepening continued during most of the succession sampled to reach open marine conditions (Setiawan, 1983). Little is known about the beds underlying the basaltic conglomerate. As reported by Piccoli & Massari Degasperi (1968) the area probably emerged near the end of the Middle Eocene, contemporary with a volcanic episode which affected the whole Lessini shelf (Piccoli & De Zanche, 1968).

E) Monte Cavro is a low hill just north of Verona, near the village of Quinzano. Our samples were taken on the south-eastern side of the hill, near the S. Rocchetto Monastery. The lithologic units recognized are, from top to bottom (Fig. 3b):

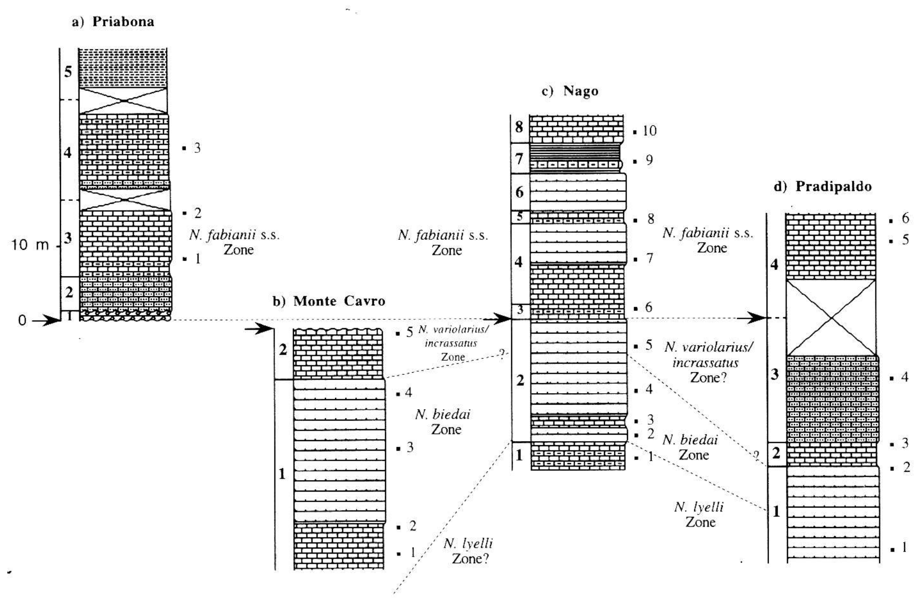


Fig. 3 - Correlation of the Priabona (a), Monte Cavro (b), Nago (c) and Pradipaldo (d) sections based on nummulite zones. Symbols as in Fig. 2.

2) limestones with small nummulites (7 m);
1) massive limestones with *N. biedai* (26 m).

The lower unit contains several robust or encrusting species (Tab. 2), indicating a high energy inner-shelf margin paleoenvironment. The overlaying limestones with small nummulites point to a relatively protected inner-platform paleoenvironment. This facies succession could be correlated with units 2 and 3 of the Mossano section (Fig. 2a). Therefore, the regressive trend observed in the previously described sections is confirmed.

3 - Monte Baldo and Bassano (Trentino and Veneto).

These areas were located on the north-western and eastern margins of the "Lessini shelf," respectively. We investigated and sampled two sections, the Nago section, in the Monte Baldo area, close to Lake Garda and the Pradipaldo section, near Bassano del Grappa (Fig. 1B).

F) The Nago section comprises Middle and Upper Eocene limestones and has recently been the subject of different studies. Luciani et al. (1988) recognized two large-scale and several minor depositionary cycles interpreted as related to sea-level changes.

Our samples were collected on the path that climbs towards the big pole that overhangs the village of Nago. The lithology presents a more or less regular alternation of pure limestones and marly limestones or marls. The units recognized are, from top to bottom (Fig. 3c):

8) bedded limestones with small nummulites (4 m);
7) marls with discocyclinids (4 m);
6) massive limestones with small nummulites (5 m);
5) marly limestones with discocyclinids (2 m);
4) massive and bedded limestones with calcareous algae and small nummulites (11 m);
3) limestones with corals and discocyclinids (2 m);
2) massive limestones with corals and calcareous algae (17 m);
1) marly limestones with discocyclinids (4 m).

Different from the other localities described to date, the paleoenvironment was here dominated by small coral reefs with abundant calcareous algae (Bosellini F.R. et al., 1988; Luciani, 1989). The larger foraminifera are less frequent in the fossil assemblage, but the general trend of regression-transgression in the two major cycles is clearly recognizable throughout the section. Unit 2 represents the top of the oldest major cycle. The assemblage (Tab. 2) indicates a relatively proximal environment, probably on the margin of the inner platform. The second cycle (comprising units 3-8) begins with probable fore-reef deposits (unit 3), where inner and outer platform species are mixed together. Then, the paleoenvironment shifts again towards a shallower facies with minor oscillations. The regressive-transgressive trend observed in the upper cycle is similar to and coeval with that observed in the Berici Mts.

G) The Pradipaldo section lies immediately south of the Asiago Plateau, on the eastern side of the Lessini shelf. It was studied by Frascari Ritondale Spano (1969) and more recently by Garavello & Ungaro (1984) and Ungaro & Garavello (1989). The section crops out a few km north-west of Bassano del Grappa. Our samples were collected from nearly vertical beds along the road from Bassano to Pradipaldo, on the left side of the Rio Lavacile. The lithologic units recognized are, from top to bottom (Fig. 3d):

4) bedded limestones with nummulites, pelecypods and echinoids (9 m);
- 11 m covered
3) sandy limestones (12 m);
2) bedded limestones with *Pachyperna laverdana* and miliolids (3 m);
1) massive limestones with *N. biedai* and *N.* cf. *dufrenoyi* (14 m).

In units 1 and 2 the paleoenvironment shifts from an outer platform in a low-energy hydrodynamic regime to a very proximal, inner-platform setting with

Sample \ Species	Numm. beaumonti/discorbinus	N. biedai	N. chavannesi	N. cf. dufrenoyi	N. fabianii	N. cf. hormoensis	N. lyelli	N. stellatus	N. striatus	N. variolarius/incrassatus	Operculina sp.	O. alpina	O. aff. alpina	O. gomezi	O. schwageri	Heterostegina reticulata	Spiroclypeus carpaticus	Discocyclina sp.	D. augustae	D. discus	D. pratti	D. radians	Orbitoclypeus sp.	O. varians	Asterocyclina sp.	A. stella	A. stellata	Asterigerina sp.	Calcarina sp.	Fabiania sp.	Gypsina sp.	G. linearis	Haddonia heissigi	Halkyardia minima	Orbitolites sp.	Schlosserina asterites	Silvestriella tetraedra	Sphaerogypsina globula	Alveolinidae	Miliolidae	Rotaliidae indet.
PRB 3																			•																						•
PRB 2			•		•					•		•					•	•	•	•																		•			
PRB 1			•		•					•			•															•							•					•	
MC 5						•			•	•																		•			•	•						•			
MC 4										•													•					•				•					•			•	
MC 3		•				•			•	•			•			•				•	•			•	•			•					•				•				
MC 2		•	•			•		•	•	•			•			•				•	•			•	•	•		•		•		•	•				•	•			
MC 1						•				•						•							•					•	•		•	•	•							•	•
NG 10			•					•		•							•											•	•			•	•			•				•	
NG 9			•							•			•			•	•	•					•				•			•								•		•	
NG 8			•		•					•	•					•	•								•		•	•				•	•			•				•	
NG 7					•					•				•									•		•			•				•						•			•
NG 6					•					•							•			•			•	•				•				•	•	•						•	
NG 5									•								•						•		•					•		•						•		•	•
NG 4																														•								•		•	•
NG 3						•				•					•	•							•		•			•		•		•	•						•	•	
NG 2						•		•		•				•	•													•	•			•				•		•		•	•
NG 1						•				•													•					•	•	•		•	•						•	•	
PRD 6					•																							•		•		•	•				•			•	
PRD 5			•		•				•	•																		•				•	•		•		•			•	
PRD 4					?																																				
PRD 3										•																		•						•	•					•	
PRD 2	•	•	•				•		•	•					•	•						•			•			•		•	•			•						•	
PRD 1	•	•	•	•			•		•	•				•	•					•		•	•		•	•		•													

Tab. 2 - Distribution of the larger foraminifera in the Priabona (PRB), Monte Cavro (MC), Nago (NG) and Pradipaldo (PRD) sections. The biozones recognized are reported in Fig. 3.

an increase of the non-carbonate fraction towards the top of unit 2. In the overlaying unit 3 the fossils are absent or extremely fragmented. A paleoenvironmental interpretation of the latter sediments is difficult because of the lack of both fossil elements and sedimentary structures, but we can tentatively hypothesize a high-energy, very proximal environment, possibly a beach. In unit 4 the fossil assemblage (Tab. 2) points to an inner platform paleoenvironment, with high energy and without terrigenous influx. The acme of the regression was probably reached during the deposition of the barren arenaceous limestones, followed by a new deepening during the deposition of unit 4.

4 - Igualada and Vic (Cataluña, Spain).

We sampled two sections in the eastern part of the Ebro basin (Fig. 1A). The Eocene larger foraminifera from these areas were recently investigated by Ferrer (1967, 1971) and Calmbach (1987). Paleogeographically (Barnolas et al., 1981; Plaziat, 1981), the present-day Ebro basin was a wide gulf opened towards the Atlantic Ocean. Igualada was on a wide embayment west of the deltaic complexes of Montserrat and St. Llorenç del Munt, whereas Vic was located in the easternmost termination of the gulf.

H) The Eocene of Igualada includes several marine and continental formations (Ferrer, 1971). We will focus on the Sta. Maria Group (Collbas Fm., Igualada Fm., La Tossa Fm.) and the Artés Formation. The lithologic units recognized are, from top to bottom (Fig. 4a):

8) continental red beds (Artés Fm.; 5-10 m);
7) patch reefs (La Tossa Fm.; 18 m);
6) marls with discocyclinids (Igualada Fm.; 135 m);
5) patch reefs (Collbas Fm.; 40 m);

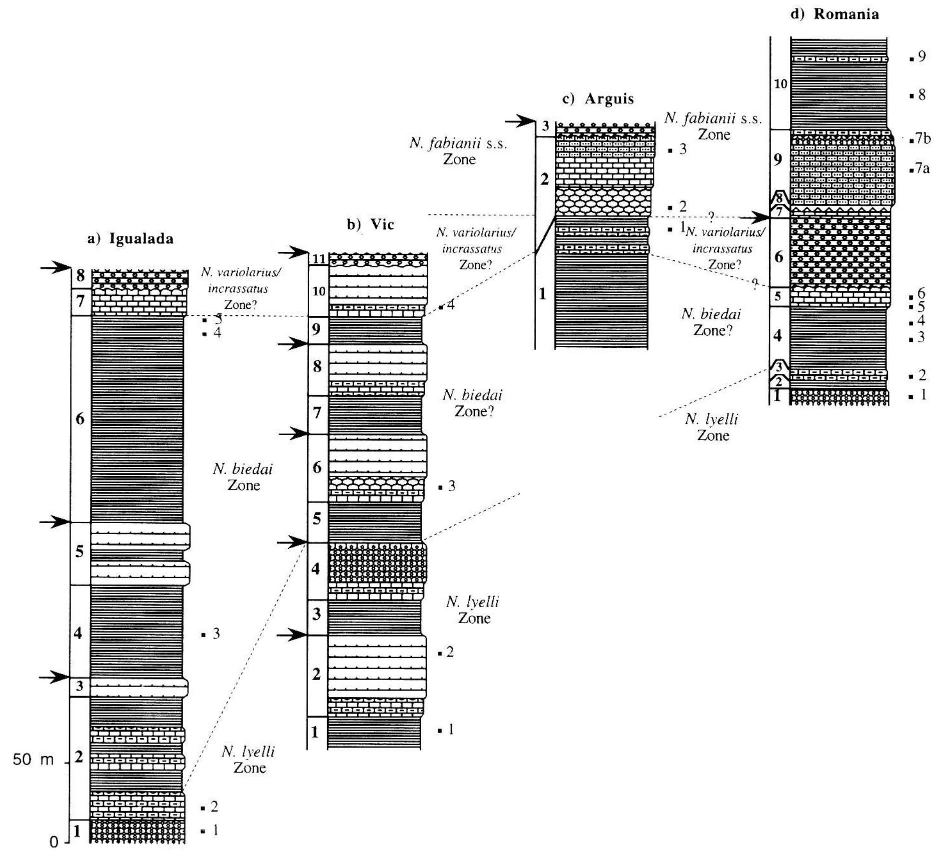


Fig. 4 - Correlation of the Igualada (a), Vic (b), Arguis (c) and Romania (d) sections based on nummulite zones. Symbols as in Fig. 2.

4) marls with *Pattalophyllia* (Collbas Fm.; 60 m);
3) patch reefs (Collbas Fm.; 12 m);
2) bioclastic limestones and marls (Collbas Fm.; 80 m);
1) *N. perforatus* bank (Collbas Fm.; 5-10 m).

The samples come from the section of Santa Maria de Miralles (Ferrer, 1971, fig. 4). Unit 1 is a nummulite-bank with prevailing A and B forms of *Nummulites perforatus* (de Montfort), but several other species are also present (Tab. 3). The inferred paleoenvironment for unit 1 is on the inner part of the platform. The overlaying alternation of marls and shallow biogenic limestones (usually patch reefs: units 2-5) suggests high-frequency oscillations of the sea-level. The marls with discocyclinids indicate a relatively deep paleoenvironment (outer platform). The patch reefs of unit 7 and the continental red beds of unit 8 represent a regressive phase closing the sedimentary cycle. This regressive trend is comparable with that observed in the Veneto area. The subsequent lack of marine sediments is probably consequent to the tectonic uplift related to the Pyrenaic orogenesis.

I) The lithologic units recognized in the Middle/Upper Eocene sediments of Vic (Marzo et al., 1989) are, from top to bottom (Fig. 4b):

11) continental red beds (Artés Fm.; 5-10 m);
10) reef limestones (St. Bartomeu; 32 m);
9) marls (Vespella Fm.; 18 m);
8) reef limestones (Sta. Perpetua; 32 m);
7) marls (Vespella Fm.; 22 m);
6) reef limestones (Can Cuspineda; 44 m);
5) marls (Vespella Fm.; 20 m);
4) limestones with nummulites (St. Martí Xic; 38 m);
3) marls (Vespella Fm.; 22 m);
2) reef limestones (La Trona; 54 m);
1) marls (Gurb Fm.; 20 m).

The samples were collected in Sta Cecília de Voltrega (Serra-Kiel & Reguant, 1991), St. Martí Xic, St. Bartomeu del Grau (Barnolas et al., 1981; Barnolas et al., 1985; Barnolas et al., 1988), all near Vic. The stratigraphic column is a composite section reconstructed with the available data from the literature. Unit 1 contains a larger foraminiferal assemblage (Tab. 3) which suggests an outer platform, relatively deep paleoenvironment. In the overlaying reef complexes (units 2, 4, 6, 8, 10) the assemblages usually lack discocyclinids and contain species typical of an inner platform paleoenvironment. The interpretation of the five oscillations of the relative sea-level is difficult because of the possible contemporaneous tectonic movements related to the Pyrenaic orogenesis possibly associated with some short term eustatic variations. However, the general trend is the same as in Igualada.

5 - Arguis (Aragona, Spain).

J) Arguis (Fig. 1A) is in the southernmost part of the pre-pyrenaic belt and belongs to the "outer Sierras" or "marginal Sierras," bordering the northern side

Sample \ Species	*Numm. beaumonti/discorbinus*	*?N. budensis*	*N. chavannesi*	*N. colomi*	*N. cyrenaicus*	*N. fabianii*	*N. garnieri garnieri*	*N. garnieri sturi*	*N. gizehensis*	*N. cf. hormoensis*	*N. perforatus*	*N. pulchellus*	*N. striatus*	*N. variolarius/incrassatus*	*Operculina* sp.	*O. alpina*	*O. aff. alpina*	*O. gomezi*	*O. schwageri*	*Heterostegina reticulata*	*Spiroclypeus carpaticus*	*Discocyclina* sp.	*D. augustae*	*D. discus*	*D. pratti*	*D. radians*	*Orbitoclypeus daguini*	*O. varians*	*Asterocyclina* sp.	*A. stellata*	*Asterigerina* sp.	*Calcarina* sp.	*C. cf. lecalvezae*	*Dictyoconus* sp.	*Fabiania* sp.	*Gypsina* sp.	*Haddonia heissigi*	*Halkyardia minima*	*Linderina cf. buranensis*	*Orbitolites* sp.	*Sphaerogypsina globula*	Alveolinidae	Miliolidae	Rotaliidae indet.
IG 5			•					•		•				•			•	•				•								•	•													
IG 4			•														•	•		•			•	•		•			•	•														•
IG 3	•		•					•					•						•			•																						•
IG 2	•			•	•			•	•		•			•					•												•		•	•	•				•		•	•		•
IG 1	•			•				•			•		•						•														•						•	•	•	•	•	
VIC 4			?	•											•							•								•	•										•		•	
VIC 3			•					•		•								•	•									•	•		•							•			•			
VIC 2			•							•									•	•			•						•															
VIC 1			•															•	•				•			•	•		•														•	•
ARG 3				•									•			•													•						•		•						•	
ARG 2			•	•			•						•	•			•	•							•					•													•	
ARG 1			•	•									•		•		•	•				•							•															
R 9			•			•																																					•	
R 8		•	•												•																													•
R 7b						•						•		•	•	•					•										•										•			
R 7a												•																				•				•							•	•
R 6																																					•					•	•	•
R 5																																											•	•
R 4																																												
R 3										•					•																													
R 2	•								•		•																															•		
R 1	•										•																																•	

Tab. 3 - Distribution of the larger foraminifera in the Igualada (IG), Vic (VIC), Arguis (ARG) and Romania (R) sections. The biozones recognized are reported in Fig. 4.

of the Ebro basin. The Middle to Upper Eocene marine sediments crop out on the southern side of the Guarga syncline (Canudo et al., 1988). The lithologic units recognized are, from top to bottom (Fig. 4c):

3) continental beds (Campodarbe Fm.; 5-10 m);
2) limestones and sandy limestones (Belsué-Atarés Fm.; 50-75 m);
1) marls (Arguis Fm.; 60-85 m).

The Arguis marls are devoid of larger foraminifera except in their uppermost part. The transition to the Belsué-Atarés Fm. is gradual and often heteropic. In the latter formation the larger foraminifera (Tab. 3) indicate an outer platform paleoenvironment, passing to an inner platform, probably under a low-energy regime as indicated by a few species such as *Haddonia heissigi* Hagn and *Fabiania* sp. The rapid transition from deeper to shallower environment suggests that the ramp was characterized by a steep slope and the platform was narrow. The marine sediments are once again capped by continental beds. The regressive trend is correlatable with the last cycle observed in the other Spanish localities examined. Also here regression is not followed by a transgression.

6 - Cluj-Napoca (Transylvania, Romania).

K) The neighbourhood of Cluj-Napoca (Fig. 1C) are very interesting for the study of the Middle to Upper Eocene transition. During the Eocene this area was covered by a shallow epicontinental sea; there, the carbonate platform deposits are well-developed and often intercalated with evaporites and continental beds. Two sedimentary cycles are recognizable, separated by thick continental deposits (Bombita, 1984). The stratigraphic succession was reconstructed from several separate localities (Leghìa, Mera and Cluj; see Bombita & Moisescu, 1968, fig. 1). The lithologic units recognized are, from top to bottom (Fig. 4d):

10) marls with nummulites (Brebi marls; 60 m);
9) limestones with *N. fabianii* (Cluj limestone; 48 m);
8) evaporites (upper gypsum; 4-5 m);
7) bedded limestones with miliolids; 4-5 m;

6) continental beds (Nadasului Fm.; 45 m);
5) bedded limestones with alveolinids (Leghìa limestone; 10 m);
4) marls (Mortanusa Marls; 40 m);
3) limy marls with *Velates* (5-6 m);
2) marls with pelecypods (4-5 m);
1) *N. perforatus* bank (5-10 m).

The lower part of the lowermost cycle (unit 1) crops out near Leghìa, the type-locality of the species *Nummulites perforatus* (de Montfort). The bank is almost exclusively composed by A and B forms of *N. perforatus* along with very rare specimen of *N. beaumonti* d'Archiac & Haime (Tab. 3). The most impressive feature of unit 1 is the extensive bioerosion of the tests (especially in the B forms of *N. perforatus*), largely bored by lithophagous pelecypods and serpuloid worms. Similar extensive bioerosion were reported in deposits of almost the same age by Serra-Kiel & Reguant (1984) and Carbone et al. (1980) from Ebro basin (Spain) and Liguria (northern Italy), respectively. The inferred paleoenvironment for this unit is shallow water inner platform under relatively high energy regime. The overlaying units 2 and 3 are still of shallow water inner platform environment, whereas the Mortanusa Marls (unit 4), devoid of macrofauna, suggest a deeper environment on an outer platform setting, possibly below the photic zone. The transition from unit 4 to unit 5 is marked by a lag with bivalves and an important detrital non-carbonate fraction, indicating a probable very shallow paleoenvironment. Unit 5 contains species characteristic of a moderate-energy, "lagoonal" paleoenvironment. The sediments of the second cycle (units 7-10) crop out near the town of Cluj and in the vicinity of Mera. After the continental episode represented by unit 6, units 7-8 indicate a marine paleoenvironment, probably in an inner platform setting. In the Baciu quarry (near Cluj) the Cluj limestone (unit 9) is completely exposed. The lower part of unit 9 contains very rare larger foraminifera again suggesting a relatively inner platform paleoenvironment. *Nummulites fabianii* (Prever) appears only in the highest levels of the formation, just below the nummulite-bank facies. The bank contains A and B forms of *N. fabianii*, often associated with *N. pulchellus* Hantken, *N.* cf. *incrassatus* de la Harpe, operculinids, etc. (Tab. 3). The inferred paleoenvironment is near the transition between the inner and outer platform setting, under a relatively low energy regime. On the whole, the upper part of the first cycle and the lower part of the second one could be compared with the regressive-transgressive trend observed in Veneto.

Nummulite biozones and correlations.

The Mossano section, which is apparently continuous throughout the Middle/Upper Eocene boundary, seems suitable to reconstruct the biozonal succession. This section can be helpful to recognize the stratigraphic position of the base of the type-section of Priabona.

To correlate these sections, we have to bear in mind that:

a) in the type-section of Priabona the only biozone recognizable is the *Nummulites fabianii* s.s. Zone;

b) the base of the type-Priabonian is marked by a marine transgression.

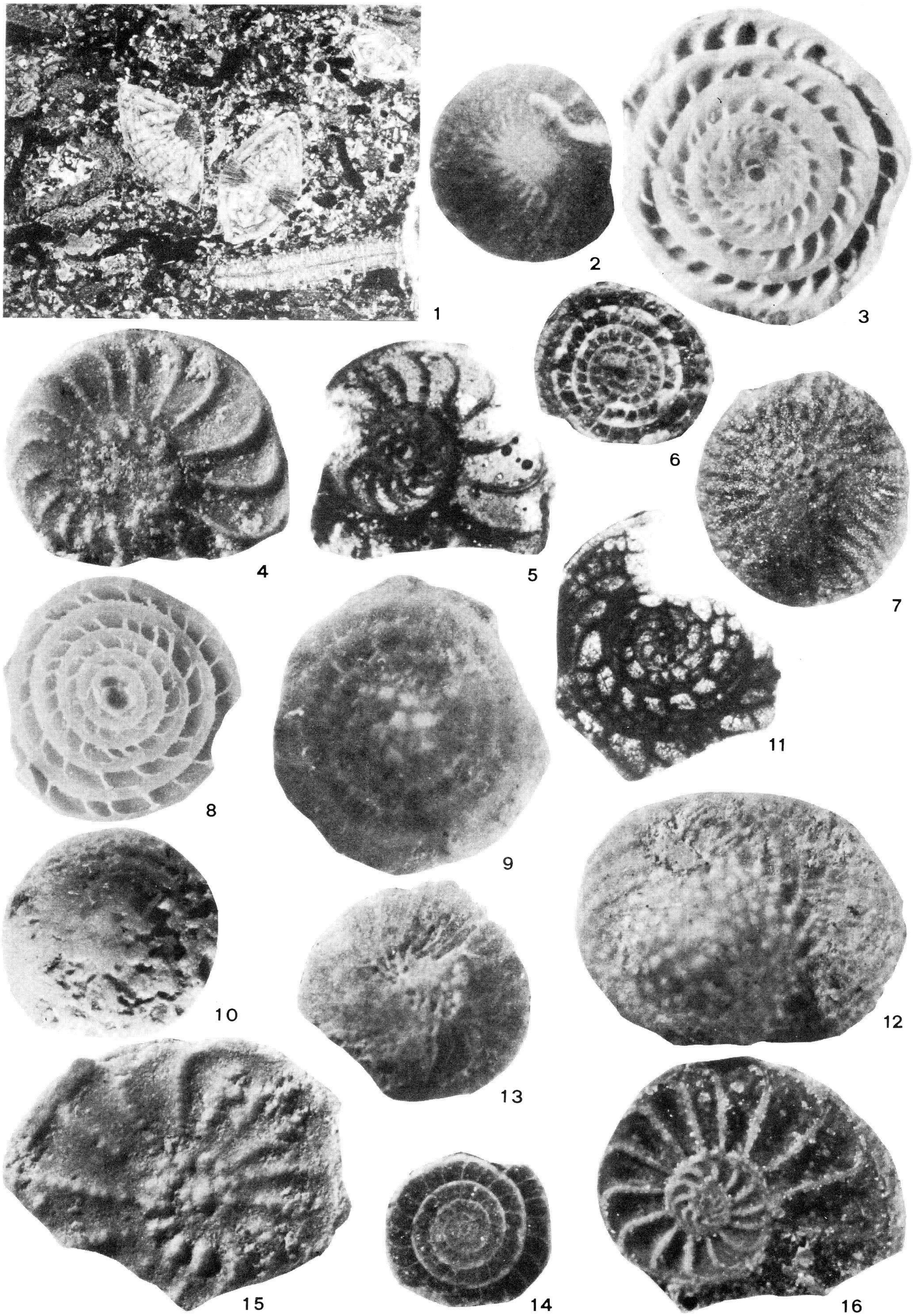
In the Mossano section the marls and marly limestones of the uppermost tract (unit 4, Fig. 2a) are surely attributable to the *N. fabianii* s.s. Zone (Pl. 2, fig. 8-16), for the presence of *Nummulites fabianii* (Prever), *N. stellatus* Roveda, *Operculina alpina* Dou-

---

PLATE 1

Fig. 1-8 : Species of the *Nummulites lyelli* Zone.
Fig. 1 - Microfacies of the nummulite bank of Pederiva, with *Nummulites lyelli* d'Archiac & Haime, A form (top left) and *N. biarritzensis* d'Archiac (top right). Sample PRV 1; x 10.
Fig. 2 - *Nummulites lyelli* d'Archiac & Haime, B form: equatorial section. Sample PRV 1; x 2.5.
Fig. 3 - *Operculina bericensis* Oppenheim: external view. Sample PRV 1; x 15.
Fig. 4 - *Operculina bericensis* Oppenheim, A form: equatorial section. Sample SG 2; x 15.
Fig. 5 - *Nummulites* cf. *dufrenoyi* d'Archiac & Haime, B form: external view and part of the equatorial section. Specimen stored in the museum of the "Istituto di Paleontologia (Università di Modena)" coming from the nummulite bank of Pederiva (Veneto); x 1.
Fig. 6 - *Nummulites* cf. *dufrenoyi* d'Archiac & Haime, A form: equatorial section. Sample SG 2; x 10.
Fig. 7 - *Nummulites perforatus* (de Montfort), B form: equatorial section. Sample R 1, nummulite bank of Leghìa (Romania); x 2.5.
Fig. 8 - *Nummulites perforatus* (de Montfort), A form: equatorial section. Sample R 1, nummulite bank of Leghìa (Romania); x 10.

Fig. 9-16: Species of the *Nummulites biedai* Zone.
Fig. 9 - *Nummulites beaumonti* d'Archiac & Haime, A form: equatorial section. Sample IG 1; x 10.
Fig. 10 - *Nummulites beaumonti* d'Archiac & Haime, A form: external view. Sample IG 1, same specimen as fig. 9; x 10.
Fig. 11 - *Nummulites* cf. *hormoensis* Nuttall & Brighton, A form: equatorial section. Sample MC 2; x 15.
Fig. 12 - *Nummulites* cf. *hormoensis* Nuttall & Brighton, A form: external view. Sample MOSS 11; x 15.
Fig. 13 - *Nummulites discorbinus* (Schlotheim), A form: external view. Sample IG 2; x 10.
Fig. 14 - *Nummulites discorbinus* (Schlotheim), A form: equatorial section. Sample MOSS 11; x 15.
Fig. 15 - *Nummulites biedai* Schaub, A form: equatorial section. Sample MC 2; x 10.
Fig. 16 - *Nummulites biedai* Schaub, B form: equatorial section. Sample MOSS 11; x 2.5.

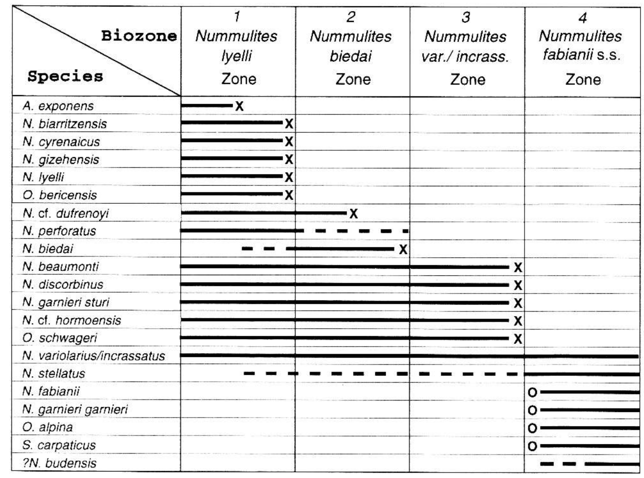

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16

villé, *Spiroclypeus carpaticus* (Uhlig). Moreover, these sediments are transgressive, just as those at the base of the type-Priabonian. Accordingly, unit 4 (marls) of Mossano can be correlated with the lowermost portion of the Priabona section (Fig. 3a).

Some other important biostratigraphic considerations are possible on the former section. Moreover, the lower part of the shallow-water sediments (units 1-2, Fig. 2a) at Mossano is of late Middle Eocene age based on the presence of *Nummulites biedai* Schaub, *N. discorbinus* (Schlotheim), *N.* cf. *dufrenoyi* d'Archiac & Haime, *N. lyelli* d'Archiac & Haime, *N.* cf. *hormoensis* Nuttall & Brighton, *Operculina schwageri* Silvestri. According to the current biozonation scheme (Schaub, 1981) unit 1 and 2 can be attributed as a whole to the *Nummulites brongniarti* Zone (="Biarritzian") (Tab. 6). Relying on the data from the Mossano section this zone, and consequently the "Biarritzian," can be subdivided in two subsequent concurrent-range biozones characterized by discrete larger foraminiferal assemblages (Pl. 1):

I) a lower *Nummulites lyelli* Zone (Tab. 4), characterized by the presence of the named species (Pl. 1, fig. 1, 2), *N. beaumonti* d'Archiac & Haime, *N. discorbinus* (Schlotheim), *N.* cf. *dufrenoyi* d'Archiac & Haime (Pl. 1, fig. 5, 6), *N.* cf. *hormoensis* Nuttall & Brighton and *Operculina schwageri* Silvestri. In other localities such as Pederiva di Grancona, San Germano dei Berici, Igualada, Vic and Leghìa, the *N. lyelli* Zone was found also to contain *N. biarritzensis* d'Archiac (Pl. 1, fig. 1), *N. cyrenaicus* Schaub, *N. garnieri sturi* Vanova, *N. gizehensis* (Forskål), *N. perforatus* (de Montfort) (Pl. 1, fig. 7, 8), *Operculina bericensis* Oppenheim (Pl. 1, fig. 3, 4) and *Assilina* spp.

II) An upper *Nummulites biedai* Zone (Tab. 4), characterized by the abundance of the named species



Tab. 4 - Distribution of the age-diagnostic larger foraminifera with respect to the discussed nummulite biozones. O) Appearance; X) disappearance; dashed line) presence uncertain.

(Pl. 1, fig. 15, 16) sometimes associated with *N. beaumonti* d'Archiac & Haime (Pl. 1, fig. 9, 10), *N. discorbinus* (Schlotheim) (Pl. 1, fig. 13, 14), *N.* cf. *hormoensis* Nuttall & Brighton (Pl. 1, fig. 11, 12), *Operculina schwageri* Silvestri.

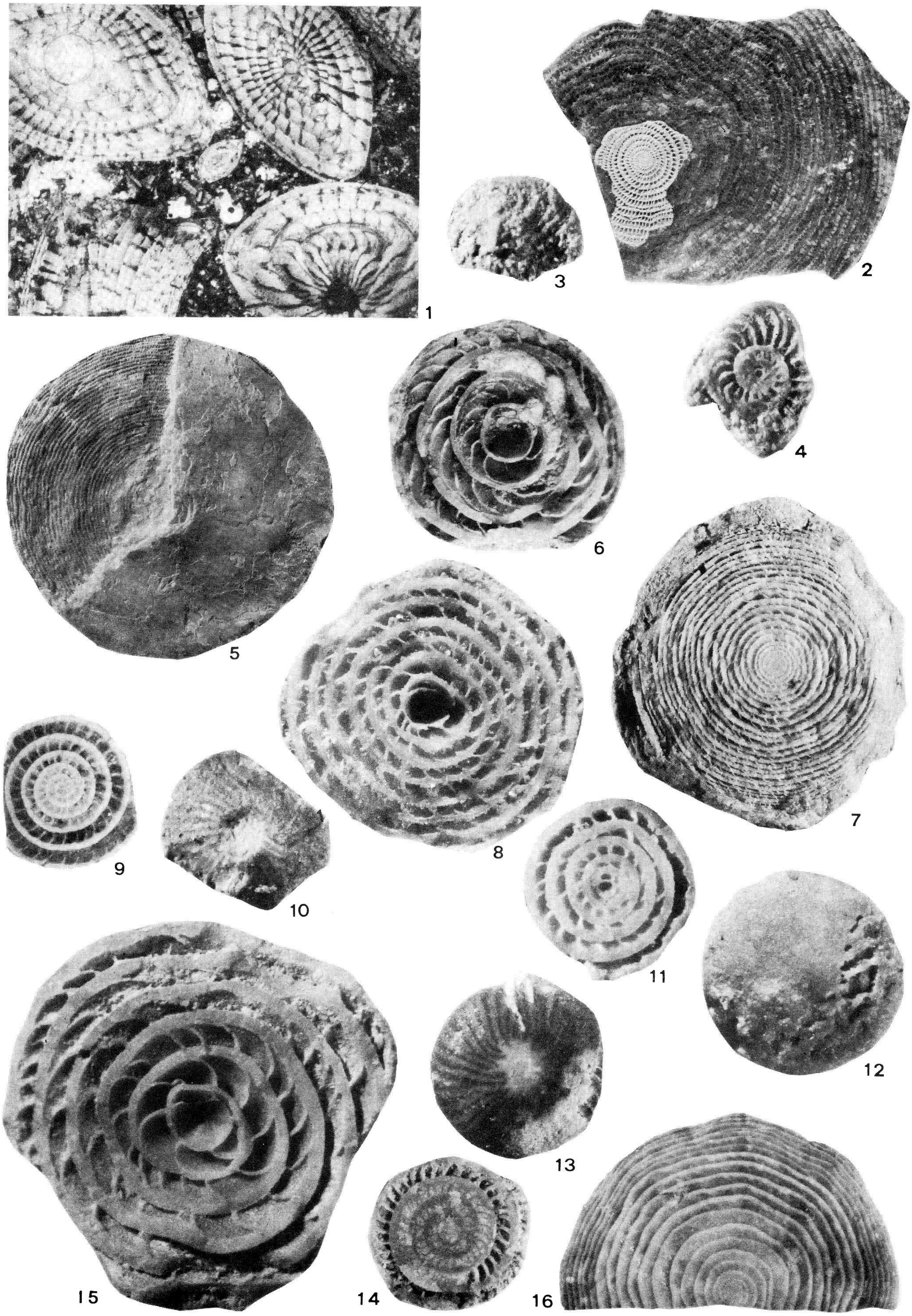
Accordingly, unit 1 from the Mossano section is attributable to the *N. lyelli* Zone and unit 2 to the *N. biedai* Zone.

Unit 3 is difficult to date because it contains low-diversity larger foraminiferal fauna with a few stratigraphically significant species. In this unit (Tab. 1) *O. schwageri* and *N. beaumonti/discorbinus*, of Middle Eocene age are associated with primitive *N. fabianii*, *N. stellatus*, *N. variolarius/incrassatus* (Pl. 2, fig. 1-3), *Heterostegina reticulata* Rütimeyer, *Operculina schwageri* Silvestri (Pl. 2, fig. 4, 5). This assemblage, that in Igualada and Vic contains also *N. garnieri sturi* Vanova (Pl. 2, fig. 6, 7), would indicate the *N.* aff.

PLATE 2

Fig. 1-7 : Species of the *N. variolarius/incrassatus* Zone.
Fig. 1 - Microfacies with *Nummulites variolarius/incrassatus* (centre and centre left), discocyclinid (bottom right) and *Fabiania* sp. (centre left). Sample SG 5; x 10.
Fig. 2 - *Nummulites incrassatus* de la Harpe, A form: external view. Sample IG 2; x 15.
Fig. 3 - *Nummulites incrassatus* de la Harpe, A form: equatorial section. Sample MC 2; x 15.
Fig. 4 - *Operculina schwageri* Silvestri, A form: external view. Sample IG 3; x 15.
Fig. 5 - *Operculina schwageri* Silvestri, A form: equatorial section. Sample MOSS 11; x 20.
Fig. 6 - *Nummulites garnieri sturi* Vanova, A form: equatorial section. Sample IG 3; x 20.
Fig. 7 - *Nummulites garnieri sturi* Vanova, A form: external view. Sample IG 2; x 20.

Fig. 8-16: Species of the *Nummulites fabianii* s.s. Zone.
Fig. 8 - *Nummulites fabianii* (Prever), A form: equatorial section. Sample R 7b; x 15.
Fig. 9 - *Nummulites fabianii* (Prever), A form: external view. Sample R 7b; x 15.
Fig. 10 - *Nummulites fabianii* (Prever), A form: external view. Sample PRV 7; x 15.
Fig. 11 - *Spiroclypeus carpaticus* (Uhlig): equatorial section. Sample MOSS 21; x 20.
Fig. 12 - *Spiroclypeus carpaticus* (Uhlig): external view. Sample MOSS 21; x 15.
Fig. 13 - *Nummulites garnieri garnieri* de la Harpe, A form: external view. Sample ARG 2; x 20.
Fig. 14 - *Nummulites garnieri garnieri* de la Harpe, A form: equatorial section. Sample ARG 2; x 20.
Fig. 15 - *Operculina alpina* Douvillé: external view. Sample R 7b; x 15.
Fig. 16 - *Operculina alpina* Douvillé: equatorial section. Sample R 7b, same specimen as fig. 15; x 15.


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16

fabianii Zone (Cita, 1969). Because in our opinion, *N.* aff. *fabianii* is unsatisfactory defined (Herb & Hekel, 1973), we prefer to rename the *N.* aff. *fabianii* Zone as *Nummulites variolarius/incrassatus* Zone, after the name of the most abundant taxa. It can be defined as the interval-zone between the disappearance of the larger nummulites (*N. biedai* in the investigated sections) and the appearance of the species distinctive of the *N. fabianii* s.s. Zone. It is worth mentioning that absence of taxa appearing or restricted to this interval creates some difficulties in reliably identify this zone. Conversely, the following *N. fabianii* s.s. Zone is well-characterized by the appearance of several species such as *N. fabianii* (Prever) (Pl. 2, fig. 8-10), *N. garnieri garnieri* de la Harpe (Pl. 2, fig. 13, 14), *Operculina alpina* Douvillé (Pl. 2, fig. 15, 16) and *Spiroclypeus carpaticus* (Uhlig) (Pl. 2, fig. 11, 12).

The genus *Orbitolites* has been usually regarded as restricted to the Middle Eocene (Hottinger et al., 1964; Beckmann et al., 1981; Loeblich & Tappan, 1988), but we found it in some samples from Pederiva, Priabona and Pradipaldo (Tab. 1, 2) into the *N. fabianii* s.s. Zone, in agreement with Barbin (1986), who reported *Orbitolites* from the Priabonian stratotype.

Discussion.

A comparison of the Mossano data with those from the other sections investigated reveals a striking resemblance in both the succession of larger foraminiferal assemblages and the regressive-transgressive trends. The biozonation scheme here proposed from Mossano and partially from Priabona (Tab. 4) applies to all the other localities investigated.

In both Pederiva and S. Germano (Veneto) the *N. lyelli*, *N. biedai* and *N. fabianii* s.s. Zones are easily recognizable. The *N. variolarius/incrassatus* Zone is more difficult to identify owing to the very shallow paleoenvironment which was unsuitable for nummulites. However, the sea-level changes show the same trends at Pederiva and S. Germano and are contemporaneous with those observed at Mossano.

At Monte Cavro (Verona) were recognized the *N. biedai* and *N. variolarius/incrassatus* Zones and the succession evolved with the same regressive trend as in Mossano.

In the western Lessini shelf (Nago) the paucity of significant larger foraminifera and the absence of larger nummulites makes it difficult to recognize the *N. lyelli*, *N. biedai* and *N. variolarius/incrassatus* Zones, whereas the *N. fabianii* s.s. Zone is well represented during a rise in sea level.

In the Pradipaldo section (eastern Lessini shelf) the *N. lyelli*, *N. biedai* and *N. fabianii* s.s. Zones are present, whereas the *N. variolarius/incrassatus* Zone is probably represented by nearshore deposits with rare nummulites. Nevertheless, the regressive-transgressive trend is here completely represented.

In Igualada, the uppermost marine sediments (La Tossa Fm.) contain rare planktonic foraminifera attributed by Ferrer (1971) to the P15 Zone, i.e. the lowermost Priabonian. In Arguis, Canudo et al. (1988) found planktonic foraminifera of P15 Zone in the uppermost beds of the Arguis Fm. According to our observations, in Igualada (unit 7; Fig. 4a) and Vic (unit 10; Fig. 4b) the larger foraminiferal assemblages from the younger sediments are attributable to the *N. variolarius/incrassatus* Zone, whereas the species distinctive of the *N. fabianii* s.s. Zone are lacking. On the other hand, at Arguis we found *N. garnieri garnieri* in unit 2 (Fig. 4c), suggesting that at this locality the uppermost marine sediments are of Late Eocene age, in agreement with planktonic foraminiferal data. The relative changes of sea-level are here quite difficult to correlate with the Veneto area because of the tectonic movements of the Pyrenaic orogenesis which mask the eustatic changes. The regressive trend in the upper Middle Eocene is, however, confirmed, but at least at Arguis it also continues in the Priabonian.

In Romania units 1-3 (Fig. 4d) correlate with the *N. lyelli* Zone. On the other hand, most of the overlaying sediments (unit 4) do not contain larger foraminifera. According to Bombita (pers. comm.) unit 4 straddles the Middle/Upper Eocene boundary on the basis of the calcareous nannofossils (NP 17/18 boundary); the Leghìa limestone (unit 5) is devoid of nummulites and cannot objectively be attributed to any nummulite biozone. Comparing the regressive trend observed in Romania with that from the Veneto area we can tentatively suggest that Mortanusa Marls, Leghìa limestone, and probably the overlaying continental Nadasului Fm. ("Napocian", Bombita, 1984), are time-equivalent of the *N. biedai* and *N. variolarius/incrassatus* Zones. The middle-upper part of the Cluj limestone (unit 9) yielded specimens of *Nummulites fabianii* at a medium stage of evolution. Consequently, the lower Cluj limestone (without larger foraminifera) could be attributable to the lower part of the Upper Eocene. The transgressive episode represented by units 9-10 correlates with the marine ingression recognized in Veneto at the beginning of the Priabonian stratotype.

Conclusions.

To clarify the stratigraphic position of the lower part of the type-Priabonian we tentatively correlate the nummulite zones with the planktonic foraminifera and calcareous nannofossil zones. We have to stress

Lithologic Units	Nummulite Zones	Calcareous Nannofossil Zones	Dinoflagellate Cyst Zones
Bryozoa beds		NP 20	Adi, Gse
Asterocyclina beds	*Nummulites fabianii* s.s.	NP 20	Gse
Nodular limestone	*Nummulites fabianii* s.s.	NP 20	Aal, Cfu
Blue claystone	*Nummulites fabianii* s.s.	NP 20	Ssp
Discocyclina beds	*Nummulites fabianii* s.s.	NP 19	Ssp, Mps
Nummulites fabianii beds	*Nummulites fabianii* s.s.		Mps
Silty & sandy limestone			Mps
Basaltic conglomerate			

Tab. 5 - Biozonation of the Priabona section. Nummulite Zones after Cita (1969); calcareous nannofossil Zones after Jossen (1982) and Verhallen & Romein (1983); dinoflagellate cyst Zones after Brinkhuis (1994).

Stages	Nummulite Zones (Cita, 1969)	Nummulite Zones (this work)	Calcareous Nannofossil Zones	Planktonic Foraminifera Zones
PRIABONIAN	*N. fabianii* s.s.	*N. fabianii* s.s.	NP 21	P 17
PRIABONIAN	*N. fabianii* s.s.	*N. fabianii* s.s.	NP 19/20	P 16
PRIABONIAN (2)	*N. fabianii* s.s.	*N. fabianii* s.s.	NP 18	P 15
(1)	*N.* aff. *fabianii*	*N. variolarius/incrassatus*	NP 18	P 15
MIDDLE EOCENE (BARTONIAN or "BIARRITZIAN")	*N. brongniarti*	*N. biedai*	NP 18	P 14
MIDDLE EOCENE (BARTONIAN or "BIARRITZIAN")	*N. brongniarti*	*N. lyelli*	NP 17	P 13

Tab. 6 - Tentative correlation between nummulite biozonation and calcareous nannofossils/planktonic foraminifera biozonations. Correlation between NP and P zones after Proto Decima et al. (1975), Nocchi et al. (1986) and Parisi et al. (1988). The base of the Priabonian could be traced (1) at the base of the *N. variolarius/incrassatus* Zone (=P14/P15 boundary) or (2) at the base of the *N. fabianii* s.s. Zone (=base of the type-Priabonian); for the discussion see the text.

that planktonic foraminifera and calcareous nannofossils are normally uncommon in carbonate platform facies, so direct correlations between nummulite zones and P/NP zones are difficult to obtain.

According to Cavelier & Pomerol (1976) and Aubry (1985, 1986), the Upper Barton Beds (top of the type-Bartonian) belong to the NP17 Zone, whereas the lowermost type-Priabonian sediments should belong to the NP18 Zone. This interpretation is agreed by Berggren et al. (1985) and Harland et al. (1990), who also reported the Bartonian/Priabonian boundary as corresponding to the P14-P15 transition (=NP17/ NP18 boundary).

At Possagno, one of the hypostratotypes of the Priabonian, both planktonic foraminifera and calcareous nannofossils are present, allowing a direct correlation between the two plankton scales: there the P14/P15 boundary falls within the NP18 Zone (Proto Decima et al., 1975, fig. 3) and does not correspond to the NP17/NP18 zonal boundary. More recently, Nocchi et al. (1986, fig. 1) and Parisi et al. (1988, fig. 2) found the same correlation in different sections from central Italy.

Our proposal of correlation between nummulite and P/NP zones relies on data from the type-section of Priabona (Tab. 5). Jossen (1982) and Verhallen & Romein (1983) found in Priabona only the NP19 (partim)-NP20 biozones, but they could not analyze the lowermost portion of the succession, which was assigned by Brinkhuis (1994) to the Mps Zone on the basis of dinoflagellate cysts. In central Italy this zone correlates with NP18 and NP19/20 (Brinkhuis & Biffi, 1993), so we hypothesize that at least a part of the NP18 Zone is present in the lowermost beds at Priabona (Tab. 6).

In Egypt, on the southern side of the Eocene Tethys, a direct correlation between the nummulite zones and P/NP zones has been reported by Strougo (1992, tab. 1), who found the lowermost part of P15 Zone correlatable with the *Nummulites ptukhiani* Zone. This correlation supports our interpretation, because the *N. ptukhiani* Zone here does not correspond to the *N. brongniarti* Zone of Schaub (1981) but to the *N.* aff. *fabianii* Zone (=*N. variolarius/incrassatus* Zone).

A careful study of the *N. fabianii* lineage at different levels of the Middle and Upper Eocene is needed in order to obtain biostratigraphic informations, which could improve the potentiality to distinguish the *N. fabianii* s.s. Zone from the *N. variolarius/incrassatus* Zone.

As pointed out by Strougo (1992), there are two interpretations of the Priabonian Stage: one regards the Priabonian sensu stricto, referring to the Priabona stratotype, the other follows the Propositions of the Colloque sur l'Éocène extending the Priabonian to the *N.* aff. *fabianii* Zone (=*N. variolarius/incrassatus* Zone).

According to these interpretations, the Middle/Upper Eocene boundary could be traced either at the base of the *N. fabianii* s.s. Zone or at the base of the *N. variolarius/incrassatus* Zone (Tab. 6). Anyway, the type-section of Priabona is not suitable for a GSSP, lacking the continuity with the underlying Middle Eocene sediments; there the type-Priabonian begins with the *N. fabianii* s.s. Zone and the *N. variolarius/incrassatus* Zone is missing. Conversely, the succession is apparently continuous throughout the Middle/Upper Eocene boundary in the Mossano section, which is therefore a potential GSSP stratotype for the base of the Priabonian.

Acknowledgements.

The authors are greatly indebted to Prof. J. Serra-Kiel (Barcelona Univ.), G. Less (Hungarian Geol. Surv.), J. Petrescu (Cluj Univ.) and G. Bombita (Bucuresti Univ.), for the kind field assistance and helpful discussions in Spain, Hungary and Romania respectively. Thanks to Prof. L. Hottinger (Basel Univ.) for the helpful debates in Rome (September 1992).

Thanks are due to Prof. I. Premoli-Silva (Milano Univ.) and Prof. K. Drobne (Ljubljana Univ.) for the critical reading and the useful advices for the improvement of the manuscript.

This research was financially supported by M.U.R.S.T. 60% grant to A. Sirotti.

REFERENCES

Arni P. (1965) - L'évolution des *Nummulitinae* en tant que facteur de modification des dépots littoraux. *Mém. B.R.G.M.*, v. 32, pp. 7-20, Paris.

Aubry M.-P. (1985) - Northwestern European Paleogene magnetostratigraphy, biostratigraphy and paleogeography: Calcareous nannofossil evidence. *Geology*, v. 13, pp. 198-202, Boulder.

Aubry M.-P. (1986) - Paleogene calcareous nannoplankton biostratigraphy of northwestern Europe. *Palaeogeogr., Palaeoclimatol., Palaeoecol.*, v. 55, pp. 267-334, Amsterdam.

Barbin V. (1986) - Présence d'*Alveolina* et d'*Orbitolites* (Foraminifères) dans le Priabonien stratotypique (Vicentin, Italie du Nord). *11ème Réun. (Ann.) Sc. Terre, Clermont-Ferrand, Soc. Géol. Fr. éd.*, p. 10, Paris.

Barnolas A., Busquets P. & Serra-Kiel J. (1981) - Características sedimentológicas de la terminación del ciclo marino del Eoceno superior en el sector oriental de la Depresión del Ebro (Catalunya, N.E. de España). *Acta Geol. Hisp.*, v. 16, n. 4, pp. 215-221, Barcelona.

Barnolas A., Samso J.M., Serra-Kiel J. & Tosquella J. (1985) - The Sant Martí Xic deltaic-reef complex in the Pyrenean margin of the southern Pyrenean basin. *6th Europ. Reg. Meeting I.A.S., Poster & Abstracts*, pp. 504-507, Lleida.

Barnolas A., Samso J., Serra-Kiel J. & Tosquella J. (1988) - Estructura interna del sistema deposicional de Sant Martí Xic. *Geogaceta*, v. 5, pp. 69-71, Madrid.

Beckmann J.P., Bolli H.M., Perch-Nielsen K., Proto Decima F., Saunders J.B. & Toumarkine M. (1981) - Major calcareous nannofossil and foraminiferal events between the Middle Eocene and Early Miocene. *Palaeogeogr., Palaeoclimatol., Palaeoecol.*, v. 36, pp. 155-190, Amsterdam.

Berggren W.A., Kent D.V. & Flynn J.J. (1985) - Jurassic to Paleogene. Pt. 2. Paleogene geochronology and chronostratigraphy. In Snelling N.J. (Ed.) - The Chronology of the Geological Record. *Blackwell Sc. Publ., Geol. Soc. Mem.*, n. 10, pp. 141-195, Oxford.

Bombita G. (1964) - Observations et propositions concernant la nouvelle division de l'Éocène. *Mém. B.R.G.M.*, v. 28, n. 2, pp. 941-948, Paris.

Bombita G. (1984) - Le Napocien, vingt ans après sa définition. *Rev. Paléobiol.*, v. 3, n. 2, pp. 209-217, Genève.

Bombita G. & Moisescu V. (1968) - Données actuelles sur le Nummulitique de Transylvanie. *Mém. B.R.G.M.*, v. 58, pp. 693-729, Paris.

Bosellini F.R., Luciani V., Russo A. & Sirotti A. (1988) - Emendamenti alla stratigrafia paleogenica del Monte Baldo (Alpi meridionali, Italia). *Boll. Soc. Paleont. Ital.*, v. 27, n. 3, pp. 361-366, Modena.

Brinkhuis H. (1994) - Late Eocene to Early Oligocene dinoflagellate cysts from the Priabonian type-area (Northeast Italy): biostratigraphy and paleoenvironmental interpretation. *Palaeogeogr., Palaeoclimatol., Palaeoecol.*, v. 107, pp. 121-163, Amsterdam.

Brinkhuis H. & Biffi U. (1993) - Dinoflagellate cyst stratigraphy of the Eocene/Oligocene transition in central Italy. *Mar. Micropaleont.*, v. 22, pp. 131-183, Amsterdam.

Calmbach L. (1987) - Der Eocäne Golf von Igualada (Katalonien) - Stratigraphie, Fazies und Microfauna der marinen Sedimente. *Thesis* (unpublished), Univ. of Basel.

Canudo J.I., Molina E., Riveline J., Serra-Kiel J. & Sucunza M. (1988) - Les événements biostratigraphiques de la zone prépyrénéenne d'Aragon (Espagne), de l'Éocène moyen à l'Oligocène inférieur. *Rev. Micropaléont.*, v. 31, n. 1, pp. 15-29, Paris.

Carbone F., Stani G., Matteucci R., Schiavinotto F. & Russo A. (1980) - Ricostruzione paleoambientale dell'affioramento nummulitico di Capo Mortola (Liguria occidentale). *Ann. Univ. Ferrara*, n.s., sez. IX, n. 6, supplem., pp. 231-268, Ferrara.

Castellarin A. & Cita M.B. (1969) - Étude de quelques coupes priaboniennes dans le Monte Baldo (Prov. Verona et Trento, Italie) et discussion des limites de l'étage. *Mém. B.R.G.M.*, v. 69, pp. 119-143, Paris.

Cavelier C. & Pomerol C. (1976) - Les rapports entre le Bartonien et le Priabonien. Incidence sur la position de la limite Éocène moyen-Éocène supérieur. *Bull. Soc. Géol. France, C.R.*, v. 18, n. 2, pp. 49-51, Paris.

Cita M.B. (1969) - Le Paléocène et l'Éocène de l'Italie du Nord. *Mém. B.R.G.M.*, v. 69, pp. 417-429, Paris.

Colloque sur l'Éocène (1969) - Propositions. *Mém. B.R.G.M.*, v. 69, pp. 459-470, Paris.

Cowie J.W., Ziegler W., Boucot A.J., Basset M.G. & Remane J. (1986) - Guidelines and Statutes of the International Commission on Stratigraphy. *Cour. Forsch.-Inst. Senckenberg*, n. 83, pp. 1-14, Frankfurt a. M.

Fabiani R. (1915) - Il Paleogene del Veneto. *Mem. Ist. Geol. Univ. Padova*, v. 3, pp. 1-336, Padova.

Ferrer J. (1967) - Le Paléocène et l'Éocène des Cordillères côtières de la Catalogne (Espagne). *Ecl. Geol. Helv.*, v. 60, n. 2, pp. 567-575, Basel.

Ferrer J. (1971) - El Paleoceno y Eoceno del borde sur-oriental de la depresión del Ebro (Cataluña). *Schweiz. Palaeont. Abh.*, v. 90, pp. 1-70, Basel.

Flügel E. (1982) - Microfacies Analysis of Limestones. V. of 633 pp., Springer-Verlag, Berlin.

Frascari Ritondale Spano F. (1969) - Serie paleogeniche nell'area pedemontana a Sud dell'altopiano di Asiago. *Mém. B.R.G.M*, v. 69, pp. 173-181, Paris.

Garavello A. M. & Ungaro S. (1984) - Studio biostratigrafico e paleoecologico della serie eocenica di Pradipaldo nella zona pedemontana meridionale dell'altipiano di Asiago. *Geol. Romana*, v. 21, pp. 655-675, Roma.

Hallock P. & Glenn E.C. (1986) - Larger Foraminifera: A Tool for Paleoenvironmental Analysis of Cenozoic Carbonate Depositional Facies. *Palaios*, v. 1, n. 1, pp. 55-64, Tulsa.

Hardenbol J. (1968) - The "Priabonian" type section (a preliminary note). *Mém. B.R.G.M.*, v. 58, pp. 629-635, Paris.

Harland W.B., Armstrong R.L., Cox A.V., Craig L.E., Smith A.G. & Smith D.G. (1990) - A geologic time scale 1989. V. of 263 pp., Cambridge Univ. Press, Cambridge.

Hedberg H.D. (1976) - International Stratigraphic Guide. V. of 200 pp., John Wiley & Sons, New York.

Herb R. & Hekel H. (1973) - Biostratigraphy, variability and facies relations of some Upper Eocene Nummulites from Northern Italy. *Ecl. Geol. Helv.*, v. 66, n. 2, pp. 419-445, Basel.

Hottinger L., Lehmann R. & Schaub H. (1964) - Données actuelles sur la biostratigraphie du nummulitique méditerranéen. *Mém. B.R.G.M.*, v. 28, n. 2, pp. 611-652, Paris.

Hottinger L. & Schaub H. (1960) - Zur Stufeneinteilung des Paleocaens und des Eocaens. Einfürung der Stufen Ilerdien und Biarritzien. *Ecl. Geol. Helv.*, v. 53, n. 1, pp. 453-479, Basel.

Hottinger L., Schaub H. & Vonderschmitt L. (1956) - Zur Stratigraphie des Lutétien im Adour-Becken. *Ecl. Geol. Helv.*, v. 49, n. 2, pp. 453- 468, Basel.

Jenkins D.G. & Luterbacher H.P. (1992) - Paleogene stages and their boundaries (Introductory remarks). *N. Jb. Geol. Paläont. Abh.*, v. 186, n. 1-2, pp. 1-5, Stuttgart.

Jossen J.-A. (1982) - Les nannofossiles calcaires de Priabona. *Rev. Paléobiol.*, v. 1, n. 1, pp. 39-51, Genève.

Loeblich A.R.Jr. & Tappan H. (1988) - Foraminiferal genera and their classification. 2 v. of 970 pp. and 212 pp., Van Nostrand Reinhold Co., New York.

Luciani V. (1989) - Stratigrafia sequenziale del Terziario nella catena del Monte Baldo (provincie di Verona e Trento). *Mem. Sc. Geol. Univ. Padova*, v. 41, pp. 263-351, Padova.

Luciani V., Barbujani C. & Bosellini A. (1988) - Facies e cicli del Calcare di Nago (Eocene superiore, Trentino meridionale). *Ann. Univ. Ferrara*, n.s., v. 1, n. 4, pp. 47-62, Ferrara.

Marzo M., Muñoz J.A., Puigdefàbregas C. & Serra-Kiel J. (1989) - The south pyrenean foreland basin - eastern sector. Pars II & IV. Area of Igualada & area of Vic. *Int. Rep. Univ. Barcelona*, pp. 3-8, 30-43, Barcelona.

Mathelin J.-C. & Sztràkos K. (1993) - L'Eocène de Biarritz (Pyrénées Atlantiques, SW France). Stratigraphie et paléoenvironnement. Monographie des foraminifères. *Cah. Micropaléont.*, n.s., v. 8, n. 1, pp. 5-181, Paris.

Munier-Chalmas E. & Lapparent A. de (1893) - Note sur la nomenclature des terrains sédimentaires. *Bull. Soc. Géol. France*, s. 3, v. 21, pp. 438-488, Paris.

Nocchi M., Parisi G., Monaco P., Monechi S., Madile M., Napoleone G., Ripepe M., Orlando M., Premoli Silva I. & Bice D.M. (1986) - The Eocene-Oligocene boundary in the Umbrian pelagic sequences, Italy. In Pomerol C. & Premoli-Silva I. (Eds.) - Terminal Eocene events. *Dev. Palaeont. Strat.*, n. 9, pp. 25-40, Elsevier, Amsterdam.

Papazzoni C.A. (1993) - Macroforaminiferi di piattaforma del margine settentrionale della Tetide al limite Eocene medio-Eocene superiore. *Ph. D. Thesis* (unpublished), v. of 240 pp., Modena.

Papazzoni C.A. (1994) - Macroforaminifera and paleoenvironments near the Middle-Upper Eocene boundary in the Mossano section (Berici Mts., Vicenza, northern Italy). In Matteucci R. et al. (Eds.) - Studies on Ecólogy and Paleoecology of Benthic Communities. *Boll. Soc. Paleont. Ital.*, spec. v. 2, pp. 203-212, Modena.

Papazzoni C.A. & Sirotti A. (1993) - Stratigraphic occurrence and evolution of *Heterostegina reticulata* Rütimeyer, 1850 in the Mossano section (Middle-Upper Eocene, Berici Mts., N Italy). *Boll. Mus. Civ. St. Nat. Verona*, v. 17 (1990), pp. 525-540, Verona.

Parisi G., Guerrera F., Madile M., Magnoni G., Monaco P., Monechi S. & Nocchi M. (1988) - Middle Eocene to Early Oligocene calcareous nannofossil and foraminiferal biostratigraphy in the Monte Cagnero section, Piobbico (Italy). In Premoli Silva I., Coccioni R. & Montanari A. (Eds.) - The Eocene-Oligocene boundary in the Marche-Umbria basin (Italy). *Int. Subcomm. Paleog. Strat.*, spec. publ., pp. 119-135, Ancona.

Piccoli G. & De Zanche V. (1968) - Rapporti tra vulcanismo e sedimentazione nel Paleogene del Veneto (Italia nordorientale). *XXIII Int. Geol. Congr.*, v. 2, pp. 49-60, Prague.

Piccoli G. & Massari Degasperi G. (1968) - I molluschi dello stratotipo del Priaboniano e il loro significato paleoecologico. *Mém. B.R.G.M.*, v. 58, pp. 242-252, Paris.

Plaziat J.-C. (1981) - Late Cretaceous to Late Eocene palaeogeographic evolution of Southwestern Europe. *Palaeogeogr., Palaeoclimatol., Palaeoecol.*, v. 36, pp. 263-320, Amsterdam.

Pomerol C. (1964) - Le Bartonien du bassin de Paris: interprétation stratigraphique et essai de corrélation avec le bassin de Belgique et du Hampshire. *Mém. B.R.G.M.*, v. 28, n. 1, pp. 153-168, Paris.

Proto Decima F., Roth P.H. & Todesco L. (1975) - Nannoplancton Calcareo del Paleocene e dell'Eocene della Sezione di Possagno. *Schweiz. Palaeont. Abh.*, v. 97, pp. 35-55, Basel.

Roveda V. (1961) - Contributo allo studio di alcuni macroforaminiferi di Priabona. *Riv. It. Paleont. Strat.*, v. 67, n. 2, pp. 153-224, Milano.

Salvador A. (1994) - International Stratigraphic Guide: A Guide to Stratigraphic Classification, Terminology, and Procedure (2nd edition). V. of 220 pp., GSA & IUGS, Boulder.

Schaub H. (1968) - A propos de quelques étages du Paléocène et de l'Éocène du bassin de Paris et leur corrélation avec les étages de la Téthys. *Mém. B.R.G.M.*, v. 58, pp. 643-653, Paris.

Schaub H. (1981) - Nummulites et Assilines de la Téthys Paléogène. Taxinomie, phylogénèse et biostratigraphie. *Schweiz. Palaeont. Abh.*, v. 104-106, pp. 1-236, Basel.

Schweighauser J. (1953) - Mikropaläontologische und stratigraphische Untersuchungen im Paleocaen und Eocaen des Vicentin (Norditalien). *Schweiz. Palaeont. Abh.*, v. 70, pp. 1-97, Basel.

Serra-Kiel J. & Reguant S. (1984) - Paleoecological conditions and morphological variation in monospecific banks of *Nummulites*: an example. *Benthos '83; 2nd Int. Symp. Benthic Foraminifera (Pau, April 1983)*, pp. 557-563, Pau & Bordeaux.

Serra-Kiel J. & Reguant S. (1991) - Biofaciès de plate-forme aphotique silico-clastique avec bryozoaires et spongiaires (Éocène moyen, secteur oriental du bassin sud-Pyrénéen). *Géobios*, v. 24, n. 1, pp. 33-40, Lyon.

Setiawan J.R. (1983) - Foraminifera and microfacies of the type Priabonian. *Utrecht Micropaleont. Bull.*, v. 29, pp. 1-161, Utrecht.

Sirotti A. (1978) - Discocyclinidae from the Priabonian type-section (Lessini Mountains, Vicenza, Northern Italy). *Boll. Soc. Paleont. Ital.*, v. 17, n. 1, pp. 49-67, Modena.

Strougo A. (1992) - The Middle Eocene/Upper Eocene transition in Egypt reconsidered. *N. Jb. Geol. Paläont. Abh.*, v. 186, n. 1-2, pp. 71-89, Stuttgart.

Ungaro S. (1969) - Étude micropaléontologique et stratigraphique de l'Éocène supérieur (Priabonien) de Mossano (Colli Berici). *Mém. B.R.G.M.*, v. 69, pp. 267-280, Paris.

Ungaro S. & Garavello A. (1989) - Biostratigrafia e paleoambienti del Paleogene nella zona pedemontana meridionale dell'altipiano di Asiago (Vicenza). *Atti 3° Simp. Ecol. Paleoecol. Com. Bent.*, pp. 773-801, Catania.

Verhallen P.J.J.M. & Romein A.J.T. (1983) - Calcareous nannofossils from the Priabonian stratotype and correlations with the parastratotypes. *Utrecht Micropaleont. Bull.*, v. 29, pp. 163-173, Utrecht.

Wilson J.L. (1975) - Carbonate Facies in Geologic History. V. of 471 pp., Springer-Verlag, New York.

Received November 2, 1994; accepted April 19, 1995