Project: Ve 146/1 „Riffbildung vor und nach dem Kreide-Tertiär-Event: Korallen-Algen-Riffe des obersten Maastrichtium bis Thanetium der Montagna della Maiella, Italien", Project Leader: A. Vecsei (Freiburg)

Paleocene Reef Evolution on the Maiella Carbonate Platform (Italy)

Adam Vecsei, Esmail Moussavian & Dragica Turnšek

Area of Study: Central Italy
Environment: Platform margin
Stratigraphy: Paleocene
Organisms: Corals, algae
Depositional Setting: Patch reefs
Constructive Processes: Framework growth and binding
Destructive Processes: Physical erosion
Preservation: Redeposited blocks
Research Topic: Reef evolution

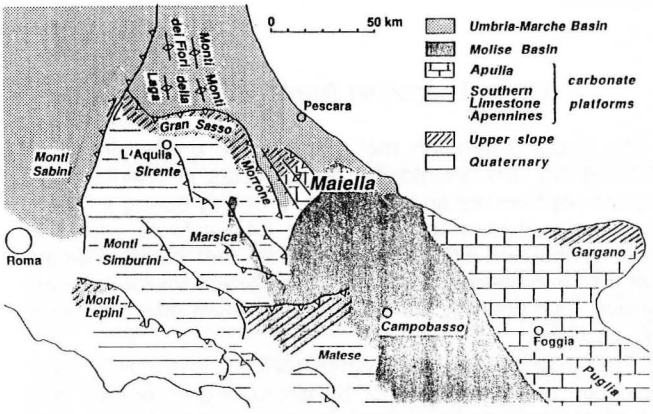

Fig. 1: Location of the Maiella carbonate platform, probably a fragment of the Apulian platform, in the external Apennines.

Abstract

The Maiella platform provides an example of the innovation and evolution of coral-algal reefs during the Paleocene. After the disappearance of rudist-dominated reefs around the Cretaceous/Tertiary (K/T) boundary, coral-algal reefs grew along the platform margin and top during two subsequent sealevel highstands in the Danian-Early Thanetian and Late Thanetian. The Danian-Early Thanetian reef communities are more diverse, and the constructional types more evolved than those previously known from this time. The Danian-Early Thanetian coral association differs from the Upper Thanetian association and from Upper Cretaceous coral faunas, indicating that it represents a distinct evolutionary phase. Repeated emergence of the Danian-Early Thanetian reefs resulted in a complex diagenetic history. All these Paleocene reefs were displaced by gravitative redeposition.

1 Introduction

The common conception that the Paleocene was a time of reorganization in the reef community, based on the absence of reefs or the small number and size of reefs until the Late Thanetian (e.g. FAGERSTROM 1987), has been modified by the increasing evidence for reef growth during the Early Paleocene (Danian) and the Early Thanetian (MOUSSAVIAN 1992, JAMES & BOURQUE 1992). These reefs are dominated by corals and red algae, although little is known about the associations of reef biota. The Paleocene reef occurrences along the northern margins of the Mediterranean Tethys include the fragment of an isolated carbonate platform margin exposed in the central Italian Montagna della Maiella (Maiella platform, EBERLI et al. 1993, Fig. 1). The study of these reefs gives insights into how the reef community was affected by environmental stresses during a global biogenic crisis, and how it recovered and reorganized.

The K/T boundary is documented in the Maiella by a deep, partly subaerial truncation surface cut into Upper Cretaceous platform sediments during a low sealevel stand (VECSEI 1991). The Paleocene reefs grew along the platform margin during two particular age intervals (dated by benthic and some planktonic foraminifera): Danian-Early Thanetian and Late Thanetian (MOUSSAVIAN & VECSEI 1995). The reef sediments were, shortly after their formation, gravitationally redeposited within a series of slope limestones, and within shallow channels cut into the platform top.

2 Danian-Early Thanetian Reef Sediments

The Danian-Early Thanetian reef blocks (up to 400 m long and 15 m high) on the upper slope are relics of formerly larger structures, probably patch-reefs, that grew during a phase of high relative sealevel. We distinguished four facies types within the reefs (MOUSSAVIAN & VECSEI 1995):

1) Massive framestones dominated by dendroid, massive, encrusting, and bulbous corals and by red algae.
2) Massive to thick-bedded bindstones dominated by successions of encrusting to massive corals and red algae.
3) Packstones and bindstones, in which fragments of the reef organisms are partly encrusted and bound together by coral-algal associations.
4) Bafflestones with dendroid corals.

REITNER, J., NEUWEILER, F. & GUNKEL, F. (eds., 1996): Global and Regional Controls on Biogenic Sedimentation. I. Reef Evolution. Research Reports. – Göttinger Arb. Geol. Paläont., **Sb2**, 175-178, Göttingen

In facies type 2, eight coral species were determined (Tab. 1): Actinacidids, goniopors, and dendrophylliids are most frequent. The dominant encrusters are red algae (corallinaceans and peyssonneliaceans) and corals (e.g., actinacidids and gonioporids). Facies types 1 and 2 represent the reef cores, facies types 3 and 4 the reef margins.

The Danian-Lower Thanetian reef limestones reveal a complex diagenetic history, indicated by early vadose and phreatic and late phreatic cements. Karstification found in one reef block indicates emersion during and thus a sealevel lowstand between the Late Danian-Early Thanetian and (at the latest) the early Late Thanetian. Silicification and pervasive neomorphism probably also occurred during this emersion.

3 Late Thanetian Reef Sediments

The Upper Thanetian reef blocks were eroded from the platform top and redeposited as breccias in channels cut into the platform top and the slope, probably during a Paleocene sealevel lowstand. The large total volume and wide areal distribution of Upper Thanetian reef clasts indicate that the reefs were volumetrically important and areally extensive. Two main facies were distinguished (MOUSSAVIAN & VECSEI 1995):

1) Framestones and bindstones built by encrusting, massive, and bulbous corals or by encrusting coral-algal and red algal-dominated associations represent reef cores. The red algal assemblages are more diverse than in the older Paleocene flora.

2) Well-cemented peri-reef grainstones are dominated by small benthic foraminifera.

In facies type 1, the eight determined coral taxa (Tab. 1) indicate that the scleractinian species are different from those in the Danian-Lower Thanetian reefs. Larger benthic foraminifera (e.g., discocyclinids and *Ranikothalia* sp.) appear.

Early and late phreatic cements characterize the Upper Thanetian reefs. Geopetal micrite and silt occur in larger interparticle and intraparticle pores.

4 Reefs and the K/T Boundary

The K/T boundary events caused a profound change in reef communities and reef types wherever they are known to occur, including the Maiella platform (cf. KAUFFMAN 1984, MOUSSAVIAN 1992). Although this is qualitatively well established, assessment of survival rates across the K/T boundary, of radiation thereafter, and of paleogeographic distributions in the benthic community are as yet impossible owing to the scarcity of taxonomic data. The reef evolution on the Maiella platform after disappearance of the rudists as reef builders at the end of the Cretaceous is qualitatively well established and suggests incipient radiation in the Danian-Early Thanetian and further radiation by the Late Thanetian

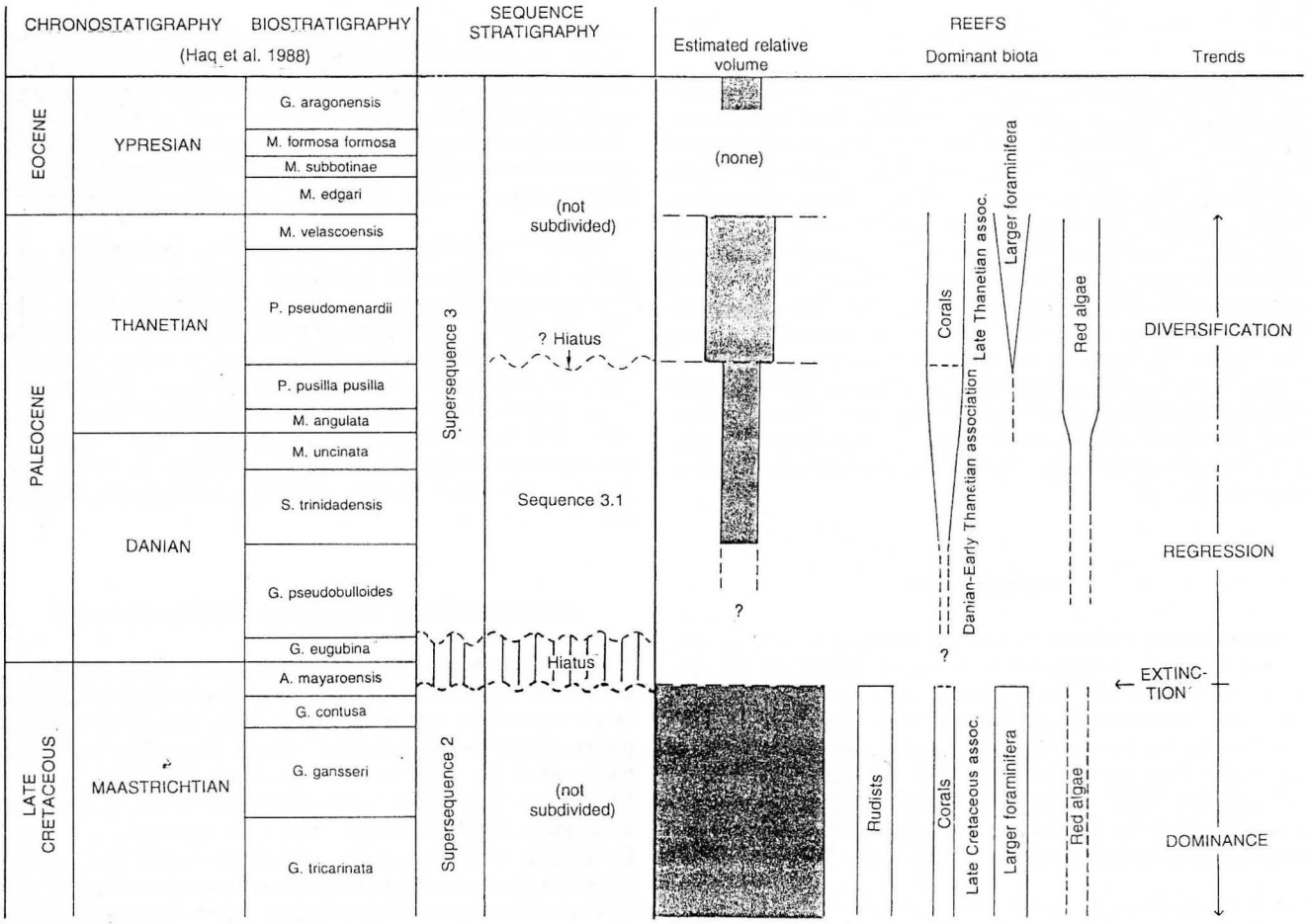

Fig. 2: Ages of Maastrichtian-Ypresian slope sequences and reef sediments, distribution of important reef biota, and trends in reef evolution on the Maiella platform. Note three distinct coral associations. Ages are well constrained in the Cretaceous and in the Late Thanetian; in the Paleocene before the appearance of complex larger foraminifera, maximal sedimentation intervals and minimal hiatus durations are indicated. Modified after MOUSSAVIAN & VECSEI (1995).

Maiella coral species	World distribution
Danian-Lower Thanetian	
Rhabdophylliopsis alloiteaui (ALLOITEAU & TISSIER 1958)	Danian; Spain
Dendrophyllia candelabrum HENNIG 1902	Danian; Denmark, Sweden, Greenland
Goniopora elegans (LEYMERIE 1846)	Danian-Thanetian-Eocene; Slovenia, Ucraina, Bosnia, France
Actinacis sp.	—
?*Porites* sp.	—
Stylocoenia montium (OPPENHEIM 1912)	Danian-Thanetian-?Eocene; Bosnia, Ucraina, Slovenia
Rhizangia sp.	Danian; Slovenia
Agathiphyllia sp.	—
Upper Thanetian	
Placocoeniopsis katzi KUSMICHEVA 1975	Danian; Crimea
Stylocoenia neutra BARTA-CALMUS 1973	Thanetian-Eocene; Slovenia, France
Actinacis barretti WELLS 1934	Eocene; Mexico, Jamaica
Cladocora sp.	—
"*Acropora*" *esperanza* FROST & LANGENHEIM 1974	Eocene, Mexico
Alveopora sp.	—
Polytremacis sp.	—
Rhizangia sp.	Thanetian; Slovenia

Tab. 1: Danian-Lower Thanetian and Late Thanetian coral taxa from Maiella carbonate platform reef sediments and their known world distribution.

(Fig. 2). The groups that survived into the Paleocene, especially corals and "modern" red algae, already formed small reefs in the Danian-Early Thanetian.

Some detailed information exists for the rudists (that disappeared; e.g., KAUFFMAN 1984) and corals (that were severely decimated; e.g., NEWELL 1971) around the K/T boundary, although available data on corals are insufficient for a detailed assessment of the taxonomic change (ROSEN & TURNŠEK 1989). Corals did not disappear from reefs for a long period, if at all, around the K/T boundary. We determined 16 hermatypic Paleocene coral taxa from the Maiella platform, which probably built patch reefs of unknown size. Although the determined taxa probably do not represent the complete community, the taxonomic distribution reveals important differences between the Danian-Lower Thanetian and the Upper Thanetian associations. Some of the Paleocene genera (e.g., *Actinacis* and *Polytremacis*) are known also from the Cretaceous outside the Maiella, but the species are different. The definitive evaluation of the significance of these coral associations should await the development and application of higher-resolution bio- and chronostratigraphic methods (e.g., in elaboration by the IGCP 286 group; HOTTINGER, pers. comm.).

Stresses owing to environmental deterioration are cited by most authors as the main causes for mass extinction around the K/T boundary. In many reef-bearing sequences, as in the Maiella, only the two stress factors sealevel fluctuation (e.g., living space reduction during lowstands) and long-term climate change (e.g., lower temperatures) are easily deciphered (VECSEI 1991). Short-term temperature reduction, and changes in ocean chemistry and trophic level can only be surmised from their apparent global character to have played a role.

5 Conclusions

The Paleocene coral-algal reefs from the Maiella carbonate platform show that small, partly framework-supported reefs already existed shortly after the K/T boundary in the Danian-Early Thanetian. These reefs were taxonomically relatively diverse and mark a distinct evolutionary period. The innovation of the same reef communities in several areas of the Tethys in the Early Paleocene may indicate the relatively high environmental tolerance of this newly innovated reef type. The complex diagenetic history observed in the Danian-Lower Thanetian reefs appears to be common in reefs that grew under the influence of strongly fluctuating sealevel in the Early Paleocene. The coral-algal reefs diversified taxonomically and probably increased further in volume by the Late Thanetian. The Danian-Lower Thanetian coral fauna therefore marks a distinct, albeit short, period in coral evolution. The definitive evaluation of the significance of the Paleocene coral associations on the Maiella platform should await the development of higher-resolution bio- and chronostratigraphic methods.

Many aspects of the evolution of reef organisms around the K/T boundary remain uncertain. The rudists and (in the peri-reef) the larger hyaline foraminifera disappeared at the end of the Cretaceous. There are strong indications that the coral taxa were severely decimated around the K/T boundary, but we do not know to what degree they and the other members of the reef community declined in numbers and in taxa. The appearance of new larger foraminiferal lineages during the Thanetian is well established in the Maiella.

For the reefs on the Maiella platform, it is the repeated relative sealevel lowstands around the K/T boundary and during the Paleocene that are the most easily demonstrated sources of environmental stress.

Acknowledgements

We thank the Deutsche Forschungsgemeinschaft for supporting this study (DFG-project Ve 146/1).

References

EBERLI, G.P., BERNOULLI, D., SANDERS, D. & VECSEI, A. (1993): From aggradation to progradation: The Maiella platform (Abruzzi, Italy). – In: SIMO, T., SCOTT, R.W. & MASSE, J.P. (eds.). – Amer. Assoc. Petroleum Geol. Mem., **56**, 213-232, Tulsa

FAGERSTROM, J.A. (1987): The Evolution of Reef Communities. – 600 pp., New York (Wiley)

JAMES, N.P. & BOURQUE, P.-A. (1992): Reefs and mounds. – In: WALKER, R.G. & JAMES, N.P. (eds.): Facies Models. Response to Sea Level Change. – 323-347, Toronto (Geol. Assoc. Canada)

KAUFFMAN, E.G. (1984): The fabric of Cretaceous marine extinctions. – In: BERGGREN, W.A. & VAN COUVERING, J.A. (eds.): Catastrophes in Earth History. – 151-246, Princeton (Princeton Univ. Press)

MOUSSAVIAN, E. (1992): On Cretaceous bioconstructions: Composition and evolutionary trends of crust-building associations. –

Facies, **26**, 117-144, Erlangen

MOUSSAVIAN, E. & VECSEI, A. (1995): Paleocene reef sediments from the Maiella carbonate platform, Italy. – Facies, **32**, 213-222, Erlangen

NEWELL, N.D. (1971): An outline history of tropical organic reefs. – Amer. Museum Nov., **2465**, 37 pp., New York

ROSEN, B.R. & TURNŠEK, D. (1989): Extinction patterns and bio geography of scleractinian corals across the Cretaceous/Tertiary boundary. – In: JELL, P.A. & PICKETT, J.W. (eds.): Fossil Cnidaria 5. – Mem. Assoc. Australasian Palaeont., **8**, 355-370, Brisbane

VECSEI, A. (1991): Aggradation und Progradation eines Karbonat-plattform-Randes: Kreide bis mittleres Tertiär der Montagna della Maiella, Abruzzen. – Mitt. Geol. Inst. Eidg. Techn. Hochschule Univ. Zürich N.F., **294**, 169 pp., Zürich