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CAMPANIAN/MAASTRICHTIAN BOUNDARY IN TUNISIA[1]

(Fig. 1)

Abstract: Tunisian reference profiles of the Campanian-Maastrichtian on localities Kat ez Zerblia — El Haria (SW of El Kef) and Dj. Fguira Salah (El Fahs) were at first suggested as Upper Cretaceous neostratotypes of the Tethyan region (Salaj, 1973), later on as hypo- or parastratotypes in the course of the VI and VII African Colloquy on micropaleontology (Salaj, 1974 a, b, 1978, 1980; Donze, 1980). Specially is disscused the Campanian-Maastrichtian boundary. The new name *Archaeoglobitruncana* nov. gen. (Foraminiferida) is proposed too.

Резюме: Тунисские опорные разрезы границы кампана и маастрихта на местонахождениях Кат эз Зерблия — Эл Гария (на СЗ от г. Эл Кеф) и Дж. Фгуира Салах (Эл Фахс) были впервые предложены как неостратотипы верхнего мела тетидного региона (Салай, 1973) позднее как гипо- или парастратотипы в течение VI и VII Африканских коллоквиумов о микропалеонтологии (Салай, 1974 a, b, 1978, 1980; Донз, 1980). Особенно обсуждена граница кампана и маастрихта. Предложено и новое название *Archaeoglobitruncana* nov. gen. (Foraminiferida).

Introduction

For considering of detailed stratigraphy of Campanian-Maastrichtian sediments and of the question of the Campanian-Maastrichtian boundary connected with it the most suitable profile in Tunisia is situated in the area of El Kef (see Fig. 1, El Haria — Kat ez Zerblia). For its qualities (uncovering and completeness, rich in foraminifers, not only planktonic, also benthic, ostracodes, nannoplankton, inocerams, echinids and partly also ammonites) this profile was proposed for hypostratotypes or stratotypes for the Tethyan realm in pelagic facies (Salaj 1973, 1974 a, 1974 b, 1978 — see discussion also, 1980, 1983; Donze, 1980; Salaj — Maamouri, 1982).

Problem of Campanian-Maastrichtian boundary

The fact that between the stratotypes of the Campanian and Maastrichtian a considerable part of the bed sequence is missing has already been known since earlier (Hinte, 1965; Sissingh, 1977; Verbeek, 1977 a o.), but in spite of this fact the standard scale of zonal subdivision of the Campanian-Maas-

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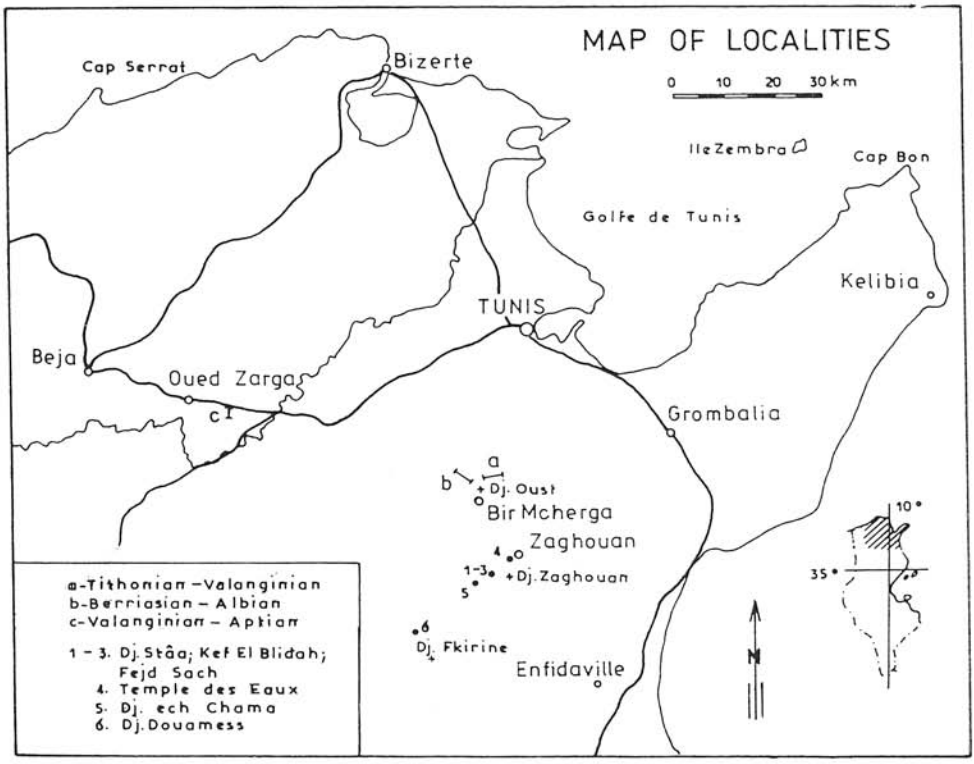

Fig. 1. Upper Cretaceous-Paleogene of the area of El Kef (after the geological map of Tunisia, El Kef); a – profile of the Campanian; b – profile of the Maastrichtian and Paleocene.

trichtian was established on the basis of various macrofaunas, microfaunas and nannoplankton.

When comparing the Campanian of the profile El Kef (S a l a j, 1980) on the basis of fauna and nannoplankton with the Campanian stratotype we may say that we can relate the uppermost layer of the Campanian stratotype (about 2 m) where *Quadrum trifidum* (STRADNER) appears for the first time (see V e r b e e k, 1977, p. 57, fig. 14) with the lowermost layers of the lower limestone barr of the Abiod formation. Here together with *Quadrum trifidum* (STRADNER), *Globotruncana arca rugosa* (MARIE) sensu S a l a j et S a m u e l appears, however, without *Globotruncana subspinosa* PESSAGNO, *Globotruncana ventricosa* (WHITE) and *Globotruncana calcarata* CUSHMAN. In this case the Campanian s. s. at the profile El Kef would have thickness of about 160 m.

The *Quadrum trifidum* Zone proper in the sense of S i s s i n g h (1977) is, however, at the profile El Kef about 280 m thick and corresponds the foraminifer zones: *Globotruncana arca rugosa*, *Globotruncana subspinosa* or *Globotruncana ventricosa* and *Globotruncana calcarata* (see S a l a j – M a a m o u r i, 1982, p. 464).

It is necessary to remark that in the *Bostrychoceras polyplocum* Zone at the profile El Kef (in upper layers of the lower barr of the Abiod limestone formation, see also Burollet 1956, p. 129) the species *Globotruncana subspinosa* PESSAGNO and *Globotruncana ventricosa* (WHITE) appear for the first time, thus representing the foraminifer *Globotruncana subspinosa* Zone. On the contrary, *Globotruncana calcarata* CUSHMAN (together with *Lambertiaster douvillei* GAUTHIER and *Inoceramus* dic. sp.) appears for the first time about 110 m higher up. It is, however, not excluded that with later investigation in the *Globotruncana calcarata* Zone, thickness of which is about 60 m, representatives of the *Bostrychoceras polyplocum* (ROEMER) could be found.

It is generally recognized that in the Tethyan realm the *Globotruncana calcarata* Zone belongs to the uppermost Campanian and its upper boundary connected with extinction of the species *Globotruncana calcarata* CUSHMAN also determines the Campanian-Maastrichtian boundary (see also results of the European Working-Group on planktonic foraminifera, Robaszynski, 1983).

Extinction of the species *Globotruncana calcarata* CUSHMAN is considered as an important mark for determination not only of the boundary of the uppermost Campanian in the Tethyan realm (see Bellier et al., 1983) (in the Boreal realm, however, the species *Globotruncana calcarata* has neither been found in the Campanian, nor in the Maastrichtian) but with determination of the Campanian-Maastrichtian boundary we have problems.

It results from detailed analysis of paleontological data obtained at the studied profile that the upper boundary of the Campanian on the basis of *Bostrychoceras polyplocum* (ROEMER) should be placed in immediate overlier of the first limestone barr of the Abiod formation, thus essentially lower (by 170 m) in relation with extinction of the species *Globotruncana calcarata* CUSHMAN. The fauna and flora, however, shows that its character is Campanian also still after extinction of the species *Globotruncana calcarata*. Moreover, many species of them have never been found at the stratotype of the Maastrichtian s. l.

We proposed in agreement with Lambert (1980) and Remack-Petitot (1969) to place the boundary between the Campanian and Maastrichtian in the area of El Kef (Salaj, 1973, 1974 a, 1974 b, 1980; Salaj – Maamouri, 1982, p. 464) in the lower part of upper barr of the Abiod limestone formation (40 m) above the level with *Stegaster altus* SEUNES. The reasons were as follows:

a) The 80 m thick passage of marls and marly limestones (upper part of middle alternation) corresponds to the *Globotruncana stephensoni* Subzone[1] (= lower part of the *Globotruncanella havanensis* Zone sensu Bellier et al., 1983); further, the uppermost part of the sequence belonging to the middle alternation with *Pseudocossmaticeras brandti* (found immediately below the II nd limestone barr, determined by Prof. Dr. J. Wiedmann, in Salaj, 1980, p. 101), as well as the lower part of the II nd limestone barr of the Abiod formation with *Stegaster altus* SEUNES correspond to the "*Rugotruncana*" *kefiana* Subzone defined by Bellier, Caron, Donze, Herm, Maamouri et Salaj,

[1] Originally defined as the *Globotruncana orientalis* Subzone (see Salaj, 1983).

1983 (upper part of the *Globotruncanella havanensis* Zone sensu Bellier et al., 1983).

The species *Rugotruncana kefiana* SALAJ et MAAMOURI, 1982 (p. 468–9, Pl. 1, Figs. 10–12) is here designated as the type-species of Archaeoglobitruncana nov. gen. of the family *Globotruncanidae* BROTZEN, 1942 (the composed name is derived from abreviations of the genus *Archaeoglobigerina – Archaeoglobi –;* and *Globotruncana – truncana).* This nov. gen. is evolved from one species of the genus *Archaeoglobigerina* PESSAGNO 1967, and is characterized by wall-structure typical of the genus *Archaeoglobigerina* and by spines arranged in two lines which are typical of *Archaeoglobitruncana* nov. gen.

The *Globotruncana stephensoni* Subzone as well as the lower part of the *archaeoglobitruncana kefiana* Subzone with *Stegaster altus* SEUNES correspond to the nannoplankton zone *Tranolithus phacelosus* de Sissingh (1977), already beginning in the uppermost layers of the *Globotruncana calcarata* Zone.

The so proposed Campanian-Maastrichtian boundary would also be in agreement with the proposal of Verbeek (1977), who studied nannoplankton at this profile.

The upper part of the II nd limestone barr (the last 12 m contain *Stegaster* cf. *heberti;* but this level is not present at the Maastrichtian stratotype), still within the *Globotruncanella havanensis* Zone (upper part *Archaeoglobitruncana kefiana Subzone)* would already belong to the Maastrichtian s. l. For simplification of the problem, regarding to lithology, it would be better to include this part also in the Campanian s. l. In this level with *Stegaster* cf. *heberti* we do not found the species *Globotruncana falsostuarti* SIGAL.

For completeness of the problem it is still necessary to mention that at this locality it is not correct to relate the II nd Abiod limestone barr with the *Globotruncana gansseri* Zone as carried out by Sissingh (1977, p. 47, Fig. 9). The first apparition of the species *Globotruncana gansseri* is essentially higher up, from sample 220 (in Sissingh, 1977, p. 47, Fig. 9) or sample 8/1968 and 10/1968 (cf. Salaj, 1980, p. 184, Fig. 62; Salaj et Maamouri, 1982, p. 465, Fig. 2; Bellier et al., 1983, p. 609, Tab. 1). For this reason we also understand the nannoplankton *Reinhardtites levis* P. R. Z. as Lower Maastrichtian in age (see Sissingh, 1977, Fig. 9). The *Lithraphidites quadratus* Zone in the sense of Verbeek (1977, p. 24) begins in the uppermost layers of the II nd limestone barr of the Abiod formation and thus where the species *Globotruncana* cf. *falsostuarti* SIGAL begins to appear (studied in thin section only), as index species of the zone of equel name.

The species *Globotruncana falsostuarti* SIGAL, as is in the last time generally interpreted, begins to appear later than is the extinction of the species *Globotrucana calcarata* CUSHMAN (sample K-6; Bellier et al., 1983, p. 609, Tab. 1; see also Robaszynski 1983, p. 687, Fig. 3). The *Globotruncana falsostuarti* Interval Zone defined by Salaj et Samuel (1966) is related with the Lower Maastrichtian, but the base of this zone is higher than is the toop of the *Globotruncana calcarata* T. R. Z.

Regarding, to the fact the species *Lithraphidites quadratus* BRAMLETTE et MARTINI not only according to Sissingh (1977) but also according to Verbeek (1977) has its apparition much later than the species *Globotruncana falsostuarti* SIGAL, it begins to appear from the base of the *Globotruncana*

ganseri Zone. Therefore it is necessary to shif also the base of the *Lithraphidites quadratus* Zone at the profile El Kef higher and thus it cannot be correlated with the *Globotruncana falsostuarti* Zone. The *Lithraphidites quadratus* Zone is also present in the upper part of the Gulpen Formation (Lanaye; Lixhe; Čepek et Moorkens 1979), and in the last time in the lower part of the Gulpen Fm. Verbeek (1983) found the *Quadrum trifidum* and *Quadrum gothicum* Zones, corresponding to the uppermost Campanian.

The *Globotruncana falsostuarti* Zone, generally interpreted as Lower Maastrichtian, is not present at stratotype of the Maastrichtian s. l.

Verbeek (1983) assigns to the Lower Maastrichtian the middle members of the Gulpen Fm. (Vyjlen, Lixhe Mts.) in the stratotype area of the Maastrichtian. These, according to him, correspond to the nannoplankton *Arkhangelskiella cymbiformis* Zone immediately overlying the *Quadrum trifidum* Zone and underlying the *Lithraphidites quadratus* Zone. According to Verbeek (1983, p. 198): "In the Limburg area the Campanian-Maastrichtian boundary may be placed at the extincion level of *Quadrum trifidum*. Consequently this boundary coincides with the boundary between the Beutenaken Chalk Member and the Wijlen Chalk Member within the lower part of the Gulpen Formation".

When compared with planktic foraminifers, disappearance of *Quadrum trifidum* (STRADNER) in the area of El Kef is much later than disappearance of the species *Globotruncana calcarata* CUSHMAN Moreover, it is necessary to stress that minimum the upper part of the *Tranolithus phacelosus* Zone (= *Archaeoglobitruncana kefiana* Subzone) and the whole *Reinhardtites levis* Zone (= *Globotruncana falsostuarti* Zone) defined in the area of El Kef by Sissingh (1977) have not been proved in the area of the Maastrichtian stratotype. They are zones, which in the standard biostratigraphic scheme (see Sissingh 1977, Pearch-Nielsen 1983) are underlying the *Arkhangielskiella cymbiformis* Zone (the *Lithraphidites quadratus* Zone included in the latter represents the upper part of the 25 C Zone only – see Pearch--Nielsen 1983, p. 154, Fig. 1) and overlying the *Quadrum trifidum* Zone, from which the *Reinhardtites levis* Zone is unambiguously assigned to the Maastrichtian.

So it is evident from these correlating considerations that the sequence at the profile El Kef occurring in overlier of the level with *Stegaster altus* SEUNES and in underlier of the *Globotruncana gansseri* Zone, which is assignet to the Maastrichtian hypostratotype, is about 100 m thick; from this the *Globotruncana falsostuarti* Zone is about 60 m thick.

We studied the question of the Campanian-Maastrichtian boundary also at the profile Dj. Fguira Salah. As a consequence of partial condensation, Campanian-Maastrichtian sediments are of less thickness here. Overlying the *Globotruncana calcarata* Zone, which reaches the basal part of the second limestone barr of the Abiod Formation, the *Globotruncanella havanensis* Zone with the *Globotruncana stephensoni* and *Archaeoglobitruncana kefiana subzones* occurs. The later subzone, as a consequence of condensation, is about 50 cm thick. The species *Archaeoglobitruncana kefiana* SALAJ et MAAMOURI was found in one sample only (No. 56). The condensed sedimentation persisted throughout the Maastrichtian, thickness of which is several tens of metres only. This type of the Maastrichtian is insuitable for more detailed studies. So far as detailed microbiostratigraphical studies of the Campanian and Maastrichtian are con-

cerned, we refer to the works of Salaj (1980, 1983); Salaj – Maamouri (1982) and Bellier, Caron, Donze, Herm, Maamouri et Salaj (1983).

Conclusion

On the basis of biostratigraphical studies the reference profile of the Campanian-Maastrichtian in the area El Kef (NW Tunisia) permits in relation to the Campanian and Maastrichtian stratotypes to establish relatively precisely the passage, which is missing between them. The essential part of this passage may be assignet to the Campanian, the smaller part to the Maastrichtian. Both stages, in the function of hypostratotypes, as naturally, are subordinate to stratotypes. Regarding to their completeness as well as to gradual transition to the underlier (Santonian) and overlier (Danian) we propose them at the same time as stratotypes of the Campanian-Maastrichtian in pelagic development for the Tethyan realm. There is also the eventual possibility to establish a new stage or substage, the Kefian (cf. Salaj, 1980), which in the frame of the Campanian s. l. would represent its upper part.

This time section would essentially correspond also to distinct tectonic processes and distinct paleogeographical changes, which were taking place in the Tethys and Boreal realms of that time; emersion and erosion of many areas, condensed sedimentation, regressions and transgressions were taking place. Frequent stratigraphic hiatuses in bed sequences at the Campanian-Maastrichtian boundary were just a consequent of it. We propose for this section of time, in which these significant tectonic processes were taking place, to introduce the name praelaramicde Kefian phase of folding.

For the reason that at the studied profile in the area of El Kef the stratigraphy for the Campanian-Maastrichtian is worked out in detaile we propose to establish also the stratotype boundaries:

1. Between the Santonian – Campanian (in marls), on the basis of appearance of the species *Globotruncana arca* (CUSHMAN) (foraminifers) and *Aspidolithus parcus* (STRADNER) (nannoplankton), which appear synchronously (the same situation is at the section of Dj. Fguira Salah, see Salaj 1980, p. 102; sample 2 d in which the species *Aspidolithus parcus* (STRADNER) was also found).

2. Between the Cmpanian s. 1. (Kefian included) and Maastrichtian, on the basis of appearance of *Globotruncana falsostuarti* SIGAL (base of the marly sequence overlying the second limestone barr of the Abiod formation, samples 1 (IV, K-6): It would be also in agreement with the opinion of Sigal (1952, 1977), who mentions the species *Globotruncana falsostuarti* from the Maastrichtian only.

Remark: It is, however, necessary to stress that the micropaleontologists consider the boundary of extinction of the species *Globotruncana calcarata* CUSHMAN as the top of the Campanian. In this case, when this opinion is accepted also in the area of El Kef (see proposition of Bellier et al.), then we must assign to the Maastrichtian s. l. (i. e. up to appearance of the species *Globotruncana falsostuarti*) still about 280 m of the sequence.

3. Most correct for this passage will be acceptance of the new stage (= Kefien of Salaj, 1980), inserted between the Campanian and Maastrichtian. Its boun-

daries and relations to the Campanian and Maastrichtian will be defined by the International Stratigraphical Commission.

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