

## PLANKTIC FORAMINIFERAL CHANGES ACROSS THE K/T BOUNDARY IN THE CARPATHIAN TYPE UPPER CRETACEOUS AND PALEOCENE NEAR KLADORUB VILLAGE, VIDIN DISTRICT (NW BULGARIA)

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**ABSTRACT.** Three groups of planktic foraminiferal species from the Cretaceous/Tertiary boundary interval of the Carpathian type Upper Cretaceous and Paleocene near Kladorub Village could be divided: Cretaceous, survivors, and Paleocene ones. The uppermost 5 m of the Cretaceous section show considerable taxonomical diversity and uniform assemblage composition and structure. The assemblages are dominated by *Heterohelix* spp., *Pseudotextularia elegans*, *Globotruncana arca*, *Globotruncana stuartiformis*, *Planoglobulina* spp. The stratigraphical range of this part of the section comprises the uppermost part of *Abathomphalus mayaroensis* Zone. The survivors' group is represented by *Heterohelix* spp., *Muricohedbergella* spp., and *Guembelitra cretacea*. The renewal of the planktic assemblages in the beginning of the Paleocene starts with the abundant occurrence of *Parvulorugoglobigerina eugubina*, which dimensions are up to 125 µm. Later eoglobigerinids, represented mainly by *Eoglobigerina fringa*, *E. eobulloides*, *E. edita*, become dominating group. Subsidiary components of the assemblages are *Parasubbotina pseudobulloides* and rarely *Guembelitra cretacea*, *Chilloguembelina morsei*, *Woodringina claytonensis* etc. The stratigraphical range of the lowermost 5 m of the Paleocene section is from *Parvulorugoglobigerina eugubina* Zone to the lower part of *Parasubbotina pseudobulloides* Zone. The lowermost Paleocene *Guembelitra cretacea* Zone was not defined.

**Key words:** planktic foraminifera, K/T boundary, Carpathian type Upper Cretaceous and Paleocene, NW Bulgaria

## ПРОМЕНИ В ПЛАНКТОННАТА ФОРАМИНИФЕРНА ФАУНА НА ГРАНИЦАТА КРЕДА/ТЕРЦИЕР В КАРПАТСКИЯ ТИП ГОРНА КРЕДА И ПАЛЕОЦЕН ПРИ С. КЛАДОРУБ, ВИДИНСКО (СЗ БЪЛГАРИЯ)

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**РЕЗЮМЕ.** Планктонните фораминифери от граничния интервал Креда/Терциер в Карпатския тип Горна Креда и Палеоцен при с. Кладоруб могат да бъдат поделени на три групи видове: кредни, преживяващи и палеоценски. Най-горните 5 m от кредния разрез се характеризират със значително таксономично разнообразие и постоянен таксономичен състав и структура на фораминиферните асоциации. Доминиращи са *Heterohelix* spp., *Pseudotextularia elegans*, *Globotruncana arca*, *Globotruncana stuartiformis*, *Planoglobulina* spp. Стратиграфският обхват на тази част от разреза попада изцяло в най-горните нива на зона *Abathomphalus mayaroensis*. Групата на преживяващите видове включва основно *Heterohelix* spp., *Muricohedbergella* spp. и *Guembelitra cretacea*. Обновяването на асоциациите от планктонни фораминифери от началото на Палеоцена в изучавания разрез започва с масовата поява на *Parvulorugoglobigerina eugubina*, чийто размери не надвишават 125 µm. По-късно масово се развиват и преобладават еoglobигеринидите, представени най-вече от *Eoglobigerina fringa*, *E. eobulloides*, *E. edita*. В асоциацията участват още *Parasubbotina pseudobulloides* и по-рядко *Guembelitra cretacea*, *Chilloguembelina morsei*, *Woodringina claytonensis* и др. Стратиграфският обхват на първите 5 метра от палеоценския разрез включва зона *Parvulorugoglobigerina eugubina* и долната част от зона *Parasubbotina pseudobulloides*. Не е дефинирана най-долната палеоценска зона *Guembelitra cretacea*.

**Ключови думи:** планктонни фораминифери, граница Креда/Терциер, Карпатски тип Горна Креда и Палеоцен, СЗ България

## Introduction

Since the advent of the impact theory (Alvarez et al., 1980) the K/T boundary has been investigated worldwide in several aspects – stratigraphical, paleontological, sedimentological, mineralogical, geochemical, etc. Detailed study of this interval in Bulgaria started at the end of the 80s of the 20<sup>th</sup> century. Continuous sequences in several facial types have been established (see Sinnyovsky et al., 2002; Sinnyovsky, 2003). Five of them (including the section near Kladorub Village) were proposed for protected geosites (Sinnyovsky, 2003). Integrated stratigraphical, sedimentological and mineralogical-geochemical study was made in 7 sections across the K/T boundary in Bulgaria (Стойкова et al., 2000). In

paleontological aspect the K/T boundary interval in all studied sections have been investigated mainly by means of calcareous nannofossils (Stoykova, Ivanov, 1992; Preisinger et al., 1993a, b; Ivanov, Stoykova, 1994, 1995; Sinnyovsky, Sultanov, 1994; Sinnyovsky, Stoykova, 1995; Rögl et al., 1996; Стойкова, Иванов, 1996; Sinnyovsky, Vangelov, 1997; Синьовски, 1999; Вангелов, Синьовски, 2000; Sinnyovsky, Petrov, 2000; Sinnyovsky, 2001; Sinnyovsky et al., 2002; Stoykova, Ivanov, 2002, 2004; Sinnyovsky, 2004a, b; Stoykova et al., 2004). Macrofossils like ammonites and echinoids have been used in two sections - S of Moravitsa Village (ammonites and echinoids - Стойкова et al., 2000) and near Byala Town (ammonites – Ivanov, 1993; Ivanov, Stoykova, 1994, Иванов, 1995; Стойкова, Иванов, 1996; echinoids – Илиева, 1998,

lieva, 2000), while the planktic (Rögl et al., 1996; Adatte et al., 2002; Stoykova et al., 2004) and benthic foraminifera (Вълчев, 2001) have been studied only in the sections near Byala Town.

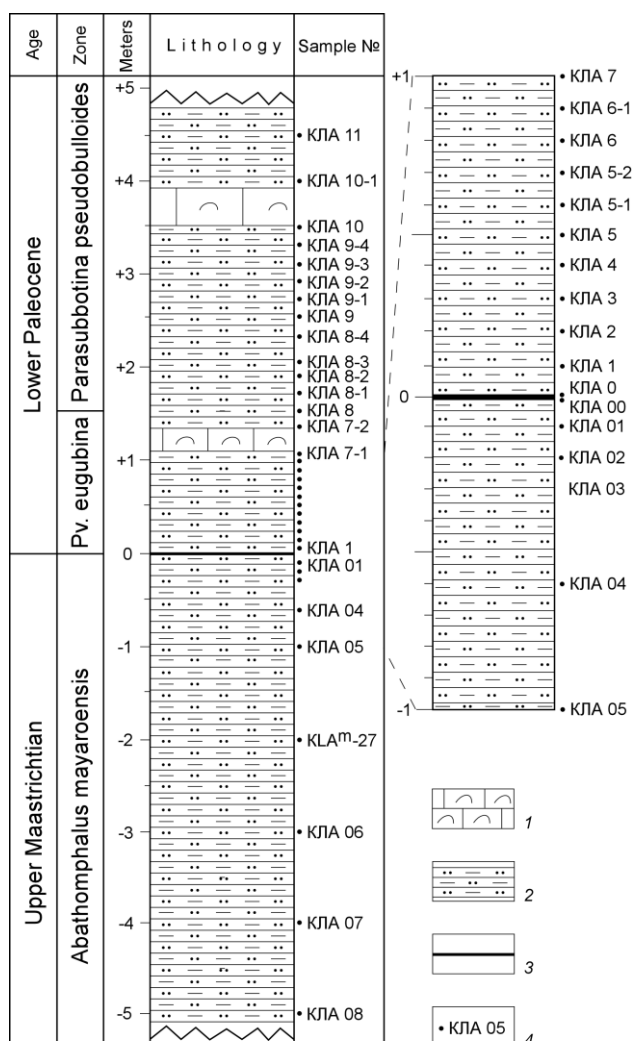


Fig. 1. Column section across the K/T boundary in the Kladorub Formation: 1 – bioclastic limestones; 2 – siltstones and marls; 3 – K/T boundary dark clay layer; 4 – sample

The aim of this article is to elucidate the taxonomical changes in the planktic foraminiferal assemblages across the Cretaceous/Paleocene transition in the fine-grained terrigenous sequence of the Kladorub Formation (“Sinaya Cretaceous” – Бончев, 1923; “Carpathian type Cretaceous” – Ц. Цанков, 1961, 1963; В. Цанков, 1968; “Kladorub Complex” – Tzankov, 1972; “Kladorub Formation” – Дечева et al., 1990; Филипов et al., 1995).

We chose the section SE of Kladorub Village, Vidin District for detailed study of planktic foraminiferal changes across the K/T boundary because of the following reasons: 1) the boundary interval is well exposed and can be easily sampled; 2) clarified lithology (Sinnyovsky et al., 2002); 3) detailed biostratigraphical subdivision based on calcareous nannoplankton of the whole Upper Campanian – Paleocene section (Sinnyovsky, 2004b). The geological map with the location of the studied section was published by Sinnyovsky et al. (2002).

## Material and methods

The studied samples were derived from the outcrop section along the Tsiganskiya Dol from 5 m below up to 5 m above the 3-4 cm dark clay layer (Fig. 1). After crushing and treating by  $\text{Na}_2\text{SO}_4$  the samples were sieved through 310  $\mu\text{m}$ , 200  $\mu\text{m}$ , 125  $\mu\text{m}$ , and 63  $\mu\text{m}$ . Planktic foraminiferal remains from all the residues were investigated.

## Planktic foraminiferal assemblages

Three groups of planktic foraminifers were established in the K/T boundary interval near Kladorub village according to their stratigraphical range: Cretaceous, survivors, and Paleocene ones.

### Cretaceous forms

The uppermost 5 m below the boundary clay layer are characterized by high taxonomical diversity – over 30 species (Fig. 2), and uniform taxonomical composition and structure. The assemblages are composed of various heterohelicids, globotruncanids, and rugoglobigerinids. The dominating taxa include *Heterohelix punctulata* (Cushman), *H. striata* (Ehrenberg), *Planoglobulina acervulinoides* (Egger), *P. brazoensis* Martin, *Pseudotextularia elegans* (Rzehak), *Globotruncana arca* (Cushman), *G. falsostuarti* Sigal, *Globotruncanita stuartiformis* (Dalbiez), *Rugoglobigerina rugosa* (Plummer). Common species are *Heterohelix globulosa* (Ehrenberg), *Laeviheterohelix dentata* (Stenestad), *Racemiguembelina fruticosa* (Egger), *Globotruncana roseta* (Carsey), *Globotruncanita stuarti* (de Lapparent), *Abathomphalus mayaroensis* (Bolli). Rare or single contributors like *Heterohelix rajagopalani* (Govindan), *Planoglobulina carseyae* (Plummer), *Pseudotextularia intermedia* de Klsz, *Pseudoguembelina palpebra* Brönnimann and Brown, *Contusotruncana contusa* (Cushman), *Globotruncana aegyptiaca* Nakkady, *Globotruncanita conica* (White), *Globotruncanella citae* (Bolli), *G. havanensis* (Voorwijk), *G. petaloidea* (Gandolfi), *Rugoglobigerina hexacamerata* Brönnimann, *R. macrocephala* Brönnimann also occur. All of the above listed species disappear at a level of +3 cm which corresponds to the upper limit of the K/T boundary clay layer.

### Survivors

A total 7 Cretaceous species may be considered as possible survivors. The most characteristic amongst them are *Heterohelix navaroensis* Loeblich, *H. planata* (Cushman), *Laeviheterohelix glabrans* (Cushman), and *L. pulchra* (Brotzen), which were found in the whole studied 10 m long interval. They are comparatively abundant in the Cretaceous part of the section, while above the boundary layer they become rare or single. Another two Cretaceous forms – *Muricohedbergella holmdelensis* (Olson) and *M. monmouthensis* (Olson) could be referred to the group of survivors. They are rare in the Cretaceous samples and rare or single in the Paleocene. Their representatives disappear at a level of +3.0 m.



*Eoglobigerina fringa* (Subbotina), *Eo. eobulloides* (Morozova), *Eo. edita* (Subbotina), *Eo. simplicissima* (Blow). Together with these species, the first occurrence of *Chilloguembelina midwayensis* (Cushman) was noted. The diversity of the assemblages at the higher levels continues to increase with the occurrence of *Globanomalina archaeocompressa* (Blow) and *Parasubbotina pseudobulloides* (Plummer), as the occurrence of the first taxon precedes the occurrence of the second one. At the level of the first occurrence of *Parasubbotina pseudobulloides* (Plummer) (+1,5 m) the sizes of all planktic foraminifers are smaller than 125 µm. This crisis in planktic foraminiferal sizes was observed up to the top of the studied section (+5,0 m). At the base of the same interval, changes in the assemblage composition were observed. On one hand, parvulorugoglobigerinids disappear, and on the other hand the biserial and triserial planktic foraminifers become dominating component. In the larger size fractions (>200 µm) we found Upper Cretaceous taxa only, probably reworked. In the upper part of the interval between +3,5 and +5,0 m FAD of species such as, *Parasubbotina varianta* (Subbotina), *Globanomalina planocompressa* (Shutskaya), *Eoglobigerina spiralis* (Bolli), *Praemurica inconstans* (Subbotina) and single *Globoconusa daubjergensis* (Broennimann) was noted. At the top of the 5 m Paleocene interval, FAD of *Subbotina triloculinoides* (Plummer) was found.

#### Biostratigraphical notes

Three zones were defined in the 10 m Upper Cretaceous-Paleocene studied section (Figs. 1, 2): *Abathomphalus mayaroensis*, *Parvulorugoglobigerina eugubina* and *Parasubbotina pseudobulloides*.

#### *Abathomphalus mayaroensis* Interval Zone

**Definition.** The interval from FAD of *Abathomphalus mayaroensis* (Bolli) to the extinction of most of Cretaceous taxa.

**Remarks.** The zone corresponds to the zone of the same name of Premoli Silva, Verga (2004). In Tsiganskiya Dol section we distinguished the upper part of the zone, as it comprises the whole 5 m studied Cretaceous interval.

#### *Parvulorugoglobigerina eugubina* Interval Zone

**Definition.** The interval from FAD of *Parvulorugoglobigerina eugubina* (Luterbacher & Premoli Silva) to FAD of *Parasubbotina pseudobulloides* (Plummer).

**Remarks.** The zone corresponds to the zone of the same name in El Kef section (Arenillas, et al., 2000) and with P£ Zone of Blow (1979), but it differs from the P£ Zone of Berggren et al. (1995). In Tsiganskiya Dol section, the zone includes the interval from 0 to +1,5 m above the K/T boundary.

#### *Parasubbotina pseudobulloides* Interval Zone

**Definition.** The interval from FAD of *Parasubbotina pseudobulloides* (Plummer) to FAD of *Globanomalina compressa* (Plummer).

**Remarks.** The zone corresponds to *Parasubbotina pseudobulloides* Zone (Arenillas, et al., 2000, 2004), *Globigerina pseudobulloides* Zone (Bolli, 1966) and P1a Zone (Blow, 1979). In the studied 5 m Paleocene interval in Tsiganskiya Dol section we found out the lower part of the zone, covering the interval between +1,5 and +5,0 above the

K/T boundary. This interval corresponds to *Eoglobigerina trivialis* Subzone (Arenillas et al., 2004). It was distinguished between two distinct events – FAD of *Parasubbotina pseudobulloides* (Plummer) and FAD of *Subbotina triloculinoides* (Plummer).

## Conclusions

The Cretaceous/Tertiary boundary interval in Tsiganskiya Dol SE of Kladorub Village (Vidin District) was investigated from planktic foraminiferal point of view. The well-exposed Upper Cretaceous-Paleocene sequence contains well preserved planktic foraminiferal assemblages which allowed us to elucidate the taxonomical changes in this interval.

Rich and diverse Upper Cretaceous assemblages (over 30 species), showing uniform taxonomical composition and structure, were established in the 5 m interval below the K/T boundary layer. About of 80% of them become extinct at the K/T boundary. 7 taxa only could be considered as survivors. We ignored the presence of Cretaceous specimens, larger than 200 µm, found in single samples above the boundary layer. They were assumed to have been reworked and hence were not listed as survivors on Fig. 2.

The Paleocene planktic foraminiferal assemblages in the upper 5 m of the studied section are of relatively low diversity – 17 typical Paleocene species have been established. Only two of them – *Parvulorugoglobigerina eugubina* (Luterbacher & Premoli Silva) and *Pv. sabina* (Luterbacher & Premoli Silva) disappear in the studied interval, while the other ones continue their development in the upper levels of the section.

The Paleocene section in Tsiganskiya Dol started with *Parvulorugoglobigerina eugubina* Zone. *Guembelitra cretacea* Zone cannot be discerned here like in other deep sea sections (Olsson, Liu, 1993). Unique in a certain sense is the change in the size of the typical Paleocene foraminifers. Most frequently, at the base of the Paleocene, the test sizes are below 125 µ – for example Byala section, Goritsa section, etc. (Adatte et al., 2002; Stoykova et al., 2004). In Tsiganskiya Dol section the crisis in test sizes was observed in the upper levels of *Parvulorugoglobigerina eugubina* Zone and lower levels of *Parasubbotina pseudobulloides* Zone.

The first appearance of *Parasubbotina pseudobulloides* (Plummer) is an event which precedes the extinction of *Parvulorugoglobigerina eugubina* (Luterbacher & Premoli Silva). The appearance of *Parasubbotina pseudobulloides* (Plummer) is clearly discernible event and it can be used more successfully as a datum level. Therefore, we define the first Paleocene planktic foraminiferal zone as an interval zone unlike the cases, when *Pv. eugubina* Zone was defined as Total Range zone and its upper boundary is marked by the index taxon extinction (Berggren et al., 1995). By finding the FAD of *Parasubbotina pseudobulloides* (Plummer) and *Subbotina triloculinoides* (Plummer) it is proved that this part of the section belongs to the lower part of *Parasubbotina pseudobulloides* Zone.

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