Calcareous nannofossil extinction pattern across the Cretaceous/Tertiary boundary in the Tethyan Realm

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This paper presents detailed calcareous nannofossil investigations carried out across the K/T boundary interval in sections from the Tethyan Realm (Caravaca from the Betic Cordilleras, SE Spain, and Pietroşiţa from the southern part of the Eastern Carpathians, Romania). The Caravaca section was the object of one of the first detailed calcareous nannoplankton investigations for the K/T boundary interval (Romein, 1977), as well as of more recent micropaleontological (foraminiferal and nannofloral) and isotope studies (Kaiho & Lamolda, 1999; Lamolda *et al*., 2005). In the Pietroşiţa section, isotope measurements and fluctuations were recently published (Bojar *et al*., accepted).

In the studied sections, calcareous nannofossil events are similar to those recorded everywhere in the Tethyan Realm across the K/T boundary (Aguado, 1993; Pospichal, 1995; Melinte, 1999; Gardin, 2002; Tantawy, 2003, among many others). Namely, the successive first occurrences (FOs) of *Micula murus*, *Nephrolithus frequens* and *M. prinsii*, followed by the extinction of most Cretaceous nannoplankton, as well as by 'blooms' of the calcareous dinoflagellate *Thoracosphaera operculata* and of the nannofossil *Braarudosphaera bigelowii*.

The oldest observed step in the decline of Upper Cretaceous nannofloras, both in terms of species richness (number of taxa per sample) and abundance (number of specimens per field of view), was identified in the Spanish and Romanian sections below the 'fallout' lamina of the K/T boundary, above the FO of *M. prinsii*. This decline is expressed by a decrease of 15-20% in species richness and up to 30% in abundance. Taking into account the sedimentation rate for each investigated section, the first nannofloral decline took place around 4.5 kyr prior to the K/T event. A second nannofloral decline (approximately 2 kyr prior to the K/T event) is recorded in the two studied sections, and is marked by an abundance decrease of 60-70%, while species richness has no relevant changes. We may assume that these two Upper Maastrichtian steps in nannofloral decline observed in both Tethyan sections mirror paleoenvironmental changes that took place contemporaneously in the two investigated regions, and therefore indicate a stepwise extinction. Alternatively, this pattern may be an artifact of preservation and/or of local palaeoecological conditions (the Signor-Lipps effect, a false extinction) reported also by Gardin (2002) around the K/T boundary at Elles, Tunisia.

At the K/T boundary, around 80% of Cretaceous nannofossils disappeared. The survivors (Cretaceous taxa which are believed to cross the K/T boundary, having a consistent and continuous occurrence in the Tertiary nannofossil assemblages) are *B. bigelowii*, *B. alta*, *Chiastozygus ultimus*, *Cyclagelosphaera reinhardtii*, *Markalius inversus*, *Neocrepidolithus neocrassus*, *Octolithus multiplus* and *Zeugrhabdotus sigmoides*. In both the studied sections, *Biantholithus sparsus* sporadically occurs from the topmost Maastrichtian.

Just above the K/T boundary (the Ir 'layer'), *T. operculata* significantly increases in abundance from 0.5% up to 5% and a 'bloom' of *Markalius inversus* occurred. The dominant components of the basal Paleocene nannofloral assemblages are *Watznaueria barnesiae* and *Micula decussata*, which together account for up to 80% of the total nannofloras. Notably, both taxa are the dominant components of Upper Maastrichtian nannofloras, representing together around 40-50% of the total assemblage, but they show a continuous decrease towards the top of the analyzed sections (in the lowermost Paleocene).

Within the basal Paleocene of the Spanish and Romanian sections, successive 'blooms' of *T. operculata* (up to 60%) and *B. bigelowii* (up to 25-30%) were observed. The isotope data show a negative correlation with the *Thoracosphaera* 'blooms' and a positive correlation with the *B. bigelowii* 'bloom' in the Romanian succession.

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