New biostatigraphic data, based on inoceramid bivalves, palynomorphs and calcareous nannofossils from the Kosharevo Formation, Kyunetsa section, Western Srednogorie (Western Bulgaria)

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Upper Cretaceous volcano-sedimentary sequences in Western Srednogorie Zone (sensu Ivanov, 2017) formed NW-SE strips, spanning the Turonian–Maastrichtian interval and overlying with unconformity different Upper Jurassic–Lower Cretaceous carbonate sediments. Ivanov (2017) recognized in the range of Western Srednogorie Zone four tectonic units as follows: Svoge, Sofia, Lyubash and Melove Tectonic Unit (Fig. 1A).

The Melove Tectonic Unit is narrow NW-SE strip located closed to the border area of the Western Srednogorie Zone, close to the Kraiste Tectonic Zone. The unit is best exposed along the Melove Hill, west from the village of Kosharevo and between the villages of Gabrov Dol and Baniste (Ivanov, 2017). The first detail stratigraphic and paleontological study of the sediments exposed in the Melove Hill, was carried out by Jolkičev and Karaguleva (1962). The formal lithostratigraphic scheme about the Upper Cretaceous sequences exposed in Melove Hill and the entire Western Srednogorie Zone was proposed by Sinnyovsky et al. (2012, 2013).

The best continuous Upper Cretaceous sedimentary record in Melove Hill is exposed in Kyunetsa section located 2.5 km northwest from the village of Kosharevo. According to Sinnyovsky et al. (2012) the exposed in Kunetsa section sediments fall into four formations in superposition as follows: Paramun Formation (lower–middle Turonian), Izvor Formation (middle Turonian–Coniacian), Melove Formation (type-section, Coniacian–lowermost Campanian) and Kosharevo Formation (lower Campanian) (Fig. 1B).

Recently, in references to define Late Cretaceous boundary events the Kyunetsa section was described in detail. The main goal of the present study is an integrated research and calibration of the macro- and microfossil record obtained from the Kosharevo Formation, and especially assessment of their value for definition the Santonian/Campanian boundary within the formation. First Jolkičev and Karaguleva (1962) reported fossil fauna from the Kosharevo Formation represented by Inoceramus reguaris d’Orbigny, Inoceramus balticus Böhm, Inoceramus gandjaensis Aliev, Hamites simplex d’Orbigny, Lytoceras sp. indet, Micraster sp. and diverse microfauna represented by foraminifers. Based on this fossil record the authors define Maastrichtian age for the sediments combined in Kosharevo formation. Subsequently Sinnyovsky et al. (2012) revised the stratigraphic interval proposed by Jolkičev and Karaguleva (1962) on lower Campanian using nannofossil data.

The lower boundary of the formation is with the thin-bedded white to grey limestones of the Melove Formation. The base of the formation is composed of thin-bedded white to pink limestones and bioturbated red marls. Upward marls predominate whereas limestones are presented as thin-bedded interbeds or in irregular alternation with the marls. In some levels medium-bedded, cobble-to pebble size conglomerates are observed. The top
of the formation is marl dominated with thin bedded limestone’s layers.

From the thin-bedded, white limestones, cropping-out in the lower part of the Kosharevo Formation (bed 11), relatively abundant inoceramid fauna was obtained (Fig. 1C). The inoceramid bivalves are represented by very well preserved medium to large sized specimens from single valves. The inoceramid assemblage is a monotypic and presented by *Cordiceramus pseudoregularis* (Sornay, 1962).

This taxon was described firstly by Sornay (1962, Pl. 7, Fig. 1) and subsequently by Sornay (1968, Pl. D, Figs 1, 2) from the lower part of the middle Campanian in Madagascar. This species is not common in the Bulgarian inoceramid record, and is recorded for the first time in Bulgaria. Although the unclear relationships with other morphologically very close codiciceramids such as *C. recklingensis*, *C. paraheberti* and *C. heberti* (Walaszczyk, Cobban, 2006), the mass occurrence of this species, indicates early Campanian age for the fossiliferous sediments cropping out in the upper part of bed 11.

Palynomorphs were obtained from sample Ku-11A (upper part of bed 11). The palynological assemblage is represented mainly by spores and pollen from the Normapolles group. It comprises the following species: *Vacuopollis percentus* Pflug, 1953, *Oculopollis orbicularis* Goczan, 1967, *Subtrudopollis* spp., *Deltoidospora* *ordinata* Brelic, 1964 and *Cicatricosisporites* spp. Representatives of the *Oculopollis* genus dominate the Santonian and Campanian palynofloras in the Normapolles province of Europe and the consistent occurrence of *O. orbicularis* is documented up to the lower Campanian (Pavlishina, 1999, 2004). The palynofacies

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**Fig. 1.** A, tectonic sketch map of Bulgaria (according to Ivanov, 2017) with the position of the studied area; B, Melove Tectonic Unit – part of the Western Sredngorie Zone (Sinnoysky et al., 2012); C, lithological column and chronostratigraphical assessment of the Kyunetsa section, with zoomed Kosharevo Formation located in middle and upper part of the section. The position of the nannofossils and palinological samples are pointed with the location of the inoceramid specimens.
pattern shows predomination of small opaque phytoclasts and high value of the opaque to translucent phytoclast ratio (OP/TR ratio). Generally, this ratio increases basin-ward due to fractionation processes and the higher preservation potential of opaque particles (Tyson, 1993). Such ratio is characteristic for distal shelf deposits. The C/M ratio (continental to marine elements) is very high, thus suggesting high continental input in the basin.

Sample Ku-10A in the section is already above the Santonian/Campanian boundary according to calcareous nannofossil data. The nannofossil assemblage of Ku-10A includes the zonal marker *Broinsonia parca parca*, which FO indicates UC14a and CC18a of early Campanian age. Besides the zonal marker, the following nannofossil marker species are present: *Arkhangelskiella cymbiformis*, *Calculites obscurus*, *Lithastrinus grillii*, *Micula staurophora*, *Prediscosphaera grandis*, *Reinhardtites anthophorus*. Higher up in the section, in sample KU11B, *Broinsonia parca constricta* indicates zone UC14b.

The obtained integrated biostratigraphic data, based on inoceramid bivalves, calcareous nannofossils and palynomorphs, define early Campanian age for the lower part of the Kosharevo Formation (up to bed 11). Further research and detailed sampling will specify the stratigraphic range of its middle and upper parts, and, if possible will locate the Santonian/Campanian and the lower/upper Campanian boundaries in the section.

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**References**


