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Diversity dynamics of Early Cretaceous brachiopods in the tectonic units of Serbia: regional versus global patterns

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ABSTRACT

The Danubian, Getic, and Vardar tectonic units of Serbia (northern Neo-Tethys) provide a rich palaeontological record permitting quantitative assessment of the Early Cretaceous brachiopod diversity dynamics. The compilation and the subsequent revision of the available information permit to document the stratigraphical ranges of 44 species, 26 genera, 15 families, and 11 superfamilies. Three diversity peaks (Late Valanginian, Early Barremian, and Early Albian) are established, as well as the Late Barremian–Late Aptian long-term diversity decline. Brachiopods were absent in the Berriasian–Early Valanginian, Late Hauterivian, and the Middle–Late Albian. It is established that the post-Early Barremian diversity decline occurred chiefly because of rare taxa appearances. The vulnerability of representatives of the superfamilies Terebratuloidea and Hemithiridoidea to external influences shaped the regional diversity dynamics of brachiopods. The amplitude of changes of the assemblage composition through the epoch was high. There were both similarities and dissimilarities between the regional and global diversity dynamics of brachiopods, and weak correspondence between the patterns is an evidence of heterogeneity of the Early Cretaceous brachiopod diversity changes in the global space. For instance, the Barremian radiation did not occur on the planetary scale. The interplay of the global factors (global diversity dynamics, eustatic changes, and oceanic anoxic events) and the regional factors (e.g., changing depositional environment) is proposed to explain the observed diversity patterns.

1. Introduction

The marine biota experienced significant changes through the Early Cretaceous (145.0–100.5 Ma). The long-term radiation through the epoch (Alroy et al., 2008; Purdy, 2008) was superimposed by the series of short-term biotic crises linked to the oceanic anoxic events (Hallam and Wignall, 1997; Sano, 2003; Takashima et al., 2006; Erba et al., 2015). However, the researchers have concentrated more on geochemical features of the Lower Cretaceous sequences permitting to judge the palaeoenvironmental context of the noted events than on the diversity dynamics of organisms. As the result, the Early Cretaceous changes in the number of taxa of various fossil groups are yet to be fully understood and interpreted on both regional and global scales.

Brachiopods were common invertebrates in the Early Cretaceous seas (Curry and Brunton, 2007). Their utility for stratigraphical, palaeogeographical, and palaeobiogeographical developments is significant (Gaspard, 1989, 1997, 1999; Lee, 2008; Jones, 2012), and, thus, this fossil group is almost ideal for investigation of the diversity dynamics. The global analysis of the latter was attempted by Curry and Brunton (2007), who demonstrated the stability through the epoch and the absence of significant radiations and extinctions. Regionally, the diversity dynamics of the Early Cretaceous brachiopods was examined by Ruban (2006, 2011, 2014) in the Caucasus, and the results, in contrast, indicate significant changes in the number of taxa with a diversity peak in the Barremian.

The Lower Cretaceous deposits of three tectonic units of Serbia representing the northern periphery of the Neo-Tethys Ocean (Fig. 1) bear significant number of brachiopods. These fossils have been studied for more than a century, particularly, by Petković (1911),Gočanin (1938), Sučić (1953), Andjelković (1973), Radulović (2000), and Radulović et al. (2007a). The regional record of brachiopods is well suitable for examination of their diversity

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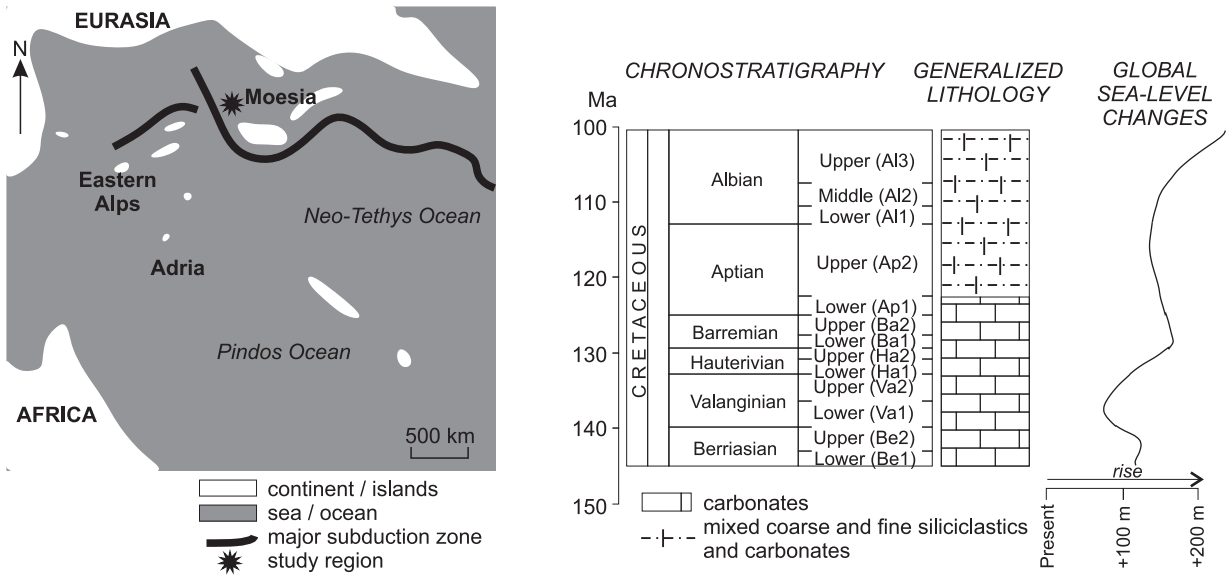

Fig. 1. Location of the study region in the Early Cretaceous (base palaeomap is simplified from Golonka, 2004), chronostratigraphical framework (based on Gradstein et al., 2012; see updates at stratigraphy.org), and global sea-level changes (adapted from Haq, 2014).

dynamics, which is an objective of the present paper. Of special interest is the comparison of the regional and global diversity patterns, which can offer some keys for further understanding of spatial heterogeneity of the biotic evolution in the Early Cretaceous.

2. Geological setting

Geographically, the study region corresponds to central and eastern Serbia. The regional geology and, particularly, the Lower Cretaceous stratigraphy, are characterized by Grubić and Jankičević (1972), Andjelković (1973, 1980), Andjelković and Nikolić (1974), and Andjelković et al. (1996), Radulović et al. (2007b), and Vašíček et al. (2009). From the tectonic point of view, the study region corresponds to three tectonic units (zones), namely the Danubian Unit, the Getic Unit, and the Vardar (Shumadia) Unit; two former belong to the Carpatho-Balkanides (Krstić et al., 1996; Kräutner and Krstić, 2003). The Lower Cretaceous deposits are relative widespread there. The Berriasian–Lower Aptian sedimentary complex is dominated by carbonates (limestones), and the Middle Aptian–Albian sedimentary complex consists of a mixed assemblage of lithologies, including coarse and fine siliciclatics (sandstones and shales) and carbonates (limestones and marlstones) (Fig. 1). It should be added that the so-called "Urgonian facies" are typical for the Barremian–Aptian interval (Andjelković, 1973; Jankičević, 1978). The age is established precisely on the basis of ammonites, belemnites, brachiopods, foraminifers, and other fossils (e.g., Radulović, 2000; Radulović and Radulović, 2002; Radulović et al., 2007b; Vašíček et al., 2009). These deposits are exposed in many sections, the most representative of which are Vladikina Ploča in the Danubian tectonic unit, Bežište, Crnoljevica, and Prekonozi in the Getic tectonic unit, and Belgrade in the Vardar tectonic unit.

In the Early Cretaceous, the study region was located on the northern periphery of the Neo-Tethys Ocean and, more exactly between Moesia and the major subduction zone (Fig. 1). In other words, it occupied a transitional position between the stable tectonic blocks of Eurasian affinity and the highly active continental margin experienced multiple and highly-complex tectonic re-organizations documented by the modern reconstructions (Stampfli and Borel, 2002; Golonka, 2004; Seton et al., 2012). A broad spectrum of facies is established there (Andjelković, 1973, 1980; Andjelković and Nikolić, 1974; Andjelković et al., 1996). In general, the Danubian tectonic unit is represented by deep-marine facies, the Getic tectonic unit is represented by shallow-marine facies, and the Vardar tectonic unit is represented by a mix of shallow- and deep-marine facies. Among the other interesting features are the mid-Early Cretaceous reefs and the presence of glaucony (especially in the upper part of the Lower Cretaceous sequence). Grubić and Jankičević (1972) pointed the development of carbonate platform on the part of the study region since the Late Jurassic.

The Lower Cretaceous deposits of Serbia are very rich in various fossils, including ammonites, belemnites, bivalves, brachiopods, echinoids, foraminifers, etc. Brachiopods are numerous and occur chiefly in shallow-marine facies, except for the Lower Hauterivian where they occur in deep-marine facies. According to Westermann (2000), the global palaeobiogeographical differentiation was strong in the beginning of the Cretaceous and weakened toward the end of its early epoch. The study region was located close to the transition between the Boreal and Tethyan biochores, although the exact affinity of its faunas is yet to be investigated.

3. Material and methods

The stratigraphical ranges of brachiopod species have been compiled from the works of Petković (1911), Gočanin (1938), Sučić (1953), Andjelković (1973), Radulović (2000, 2003), Radulović and Radulović (2002), Radulović et al. (2002), Polavder and Radulović (2005), and Radulović et al. (2006, 2007a,b). These data characterize the Early Cretaceous brachiopod record of the Danubian, Getic, and Vardar tectonic units distinguished on the territory of eastern and central Serbia. The compiled information has been examined critically with regard to the systematics to avoid errors and subsequent under- or overestimations of the taxonomic diversity. Decades-long involvement of two of the authors of the present paper into the Mesozoic brachiopod research in Serbia has facilitated this revision substantially. The suprageneric taxonomy follows the present edition of "Treatise on Invertebrate Palaeontology" (Kaesler, 1997–2007). The resulting