



Berriasian–Valanginian boundary in Bulgaria

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Границата Бериас–Валанжин в България

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Резюме. Дефиницията на границата Бериаски–Валанжински етаж в България е претърпяла значителни промени през последните 40 години. Тази статия разглежда еволюцията на възгледите за границата Бериас–Валанжин, основани на разпространението и събитията на първа поява на калпионелидите и амонитите. Разгледани са нови данни по амонити, корелирани с по-рано установени микрофосилни зони по калпионелиди и варовити диноцисти в разреза Бърля (Западна Стара планина), както и нови данни по три микрофосилни групи (калпионелиди, варовити диноцисти и фораминифери) в разреза Чавчи камък (Западно Средногорие). Новите резултати позволиха да се уточни позицията на границата Бериаски–Валанжински етаж в тези разрези съгласно съвременните критерии – по първата поява на калпионелидния вид *Calpionellites darderi* и на амонитния вид *Thurmanniceras pertransiens*. Данни за паралелното ветрикално разпространение на различни варовити микрофосили показват още две събития на първа поява на тази граница – на варовития диноцист *Colomisphaera conferta* и на фораминиферния вид *Meandrospira favrei*, които могат да се използват като допълнителни критерии за определяне на основата на Валанжинския етаж в пелагични карбонати и в преходни фациеси към карбонатната платформа.

Ключови думи: граница Бериаски–Валанжински етаж, калпионелиди, амонити, България.

Abstract. The definition of the Berriasian–Valanginian boundary in Bulgaria was a subject of considerable changes during the last forty years. This paper reviews the evolution of concepts based on the vertical ranges and bioevents such as the first occurrence of certain ammonite and calpionellid species. New data are herein presented of direct correlation between ammonites and previously defined microfossil bioevents and biozonations on calpionellids and calcareous dinocysts at Barlya Section in the Western Balkan Mountains, as well as joint microfossil bioevents (on calpionellids, calcareous dinocysts and foraminifers) at Chavchi Kamak Section in the Western Srednogorie. These data allowed a precise placing of the Berriasian–Valanginian boundary in the sections studied according to modern and widely accepted criteria, i.e. the first occurrences of the calpionellid *Calpionellites darderi* and/or the ammonite *Thurmanniceras pertransiens*. Parallel microfossil biostratigraphy in pelagic limestones and transitional platform-to-basin facies evidences two auxiliary microfossil bioevents which are to be used for recognition of the base of Valanginian. These are the first occurrences of the calcareous dinocyst *Colomisphaera conferta* and the foraminifer *Meandrospira favrei*.

Key words: Berriasian–Valanginian boundary, calpionellids, ammonites, calcareous dinocysts, foraminifers, Bulgaria.

Introduction

The concepts of definition of the Berriasian–Valanginian boundary in Bulgaria changed significantly during the last four decades. The base of Valanginian was mostly defined on the basis of ammonites (Nikolov, 1965b, 1987; Mandov, 1967, 1971; Nikolov, Sapunov, 1977; Nikolov et al., 1998, 2007). Data on other fossil groups were tied to ammonite occurrences more or less tentatively. Extensive microfossil studies on different groups across the Berriasian–Valanginian boundary during the last fifteen years (Lakova, Stoyanova, 1997; Lakova et al., 1999; Ivanova, 1999; Ivanova et al., 2000, 2002, 2008; Lakova, Petrova, 2009), new ammonite data (Petrova, 2009), joint studies and correlations between ammonites and microfossils (here described), as well as the

change of criteria accepted for the base of Valanginian on global scale, all these are reasons to re-consider the definition and bioevents as criteria to place this boundary in Bulgaria.

Biostratigraphic results

Definition of the base of Valanginian

The lower boundary of the Valanginian Stage is defined at the first occurrence (FO) of the calpionellid species *Calpionellites darderi* (the base of calpionellid E Zone) as recommended by the Brussels Symposium in 1995 (Bulot et al., 1996). The IUGS Subcommission on Cretaceous Stratigraphy (Rawson, 2004) and the International Geological Congress in

Florence, 2004, accepted this recommendation. The advantage of this criterion for the base of Valanginian is that *Calpionellites darderi* is of wide geographic occurrence and commonly recorded from various facies (Bulut et al., 1996; Aguado et al., 2000). An auxiliary criterion is the first occurrence of the ammonite species *Thurmanniceras pertransiens*, which coincides with the base of calpionellid E Zone (Blanc et al., 1994; Aguado et al., 2000).

Thurmanniceras pertransiens is a commonly occurring species in the Mediterranean Realm, mainly in paleogeic facies. In platform environments it is scarce and is normally replaced by coeval ammonites such as *Neocomites premolicus*, *Sarasinella eucyta* and *Thurmanniceras gratianopolitense* (Ettachfini et al., 1998; Wippich, 2003). The lower boundaries of the *Calpionellites* and *Thurmanniceras pertransiens* coincide as it was documented in Berriasian–Valanginian boundary strata in Spain (Aguado et al., 2000) and France (Blanc et al., 1994). This coincidence reflects significant contemporaneous evolutionary changes in calpionellids and ammonites.

Calpionellids at the Berriasian–Valanginian boundary in Bulgaria

The Berriasian–Valanginian boundary in Bulgaria was first traced on calpionellids in 70s of the last century following widely accepted criteria based on calpionellid ranges in the Mediterranean Realm. Bakalova (Bakalova in: Nikolov, Sapunov, 1977) placed the base of Valanginian in the upper part of *Calpionellopsis* Zone according to the concept by Allemann et al. (1971). Later, Lakova and Stoyanova (1997) and Lakova et al. (1999) considered the base of Valanginian as coinciding with the FO of *Praecalpionellites murgeanui*, i.e. the base of *Praecalpionellites murgeanui* Zone by Pop (1994).

Recently, Lakova and Petrova (2009), Petrova (2009) and Petrova et al. (2010) followed the concept of Bulut et al. (1996) of drawing the Berriasian–Valanginian boundary at the FO of *Calpionellites darderi*.

Lakova et al. (1999) even tracing the base of Valanginian at the FO of *Praecalpionellites murgeanui* assumed that the base of *Calpionellites* Zone (*Calpionellites darderi* Subzone), coinciding with the base of calcareous dinocyst *Colomisphaera conferta* Zone, could be another candidate for the Berriasian–Valanginian boundary. Pop (1994) was the first to make this suggestion mentioning that the FO of *Calpionellites darderi* is related to a significant filetic event in the calpionellid evolution.

The FO of *Calpionellites darderi* is an applicable bioevent for tracing the base of Valanginian in Bulgaria as it was widely reported from various facial zones in many areas of this country. This species was recorded from the subsurface of the Western and Central Fore-Balkan (Bakalova, 1977a), in the Eastern Fore-Balkan and Moesian Platform (Nikolov, 1987; Ivanova et al., 2002), as well as in numerous outcrop sections in the Western Fore-Balkan (Lakova, Stoyanova, 1997), Western Balkan Mountains (Bakalova, 1977b; Bakalova in: Nikolov, Sapunov, 1977; Lakova et al., 1999; Lakova, Petrova, 2009) and the Western Srednogie (Petrova et al., 2010).

Ammonites at the Berriasian–Valanginian boundary in Bulgaria

This boundary was mainly defined on ammonites in Bulgaria. The criteria for definition the base of Valanginian changed during the years always respecting the progress in the ammonite biostratigraphy for this time interval in the Mediterranean Realm.

The Berriasian–Valanginian boundary was first defined in this country by Nikolov (1965b) at the

SYSTEM	SERIES	STAGE	Substage	Age (Ma) Ogg et al. (2004)	Ammonite Zones				
					Nikolov (1965a, b) Mandov (1967,1971)	Nikolov et al.(2007)	Petrova (2009)		
CRETACEOUS	Lower	Valanginian	Lower	140,2±3,0	Valanginian Lower	Roubaudiana	Lower	Busnardoites campylotoxus	Busnardoites campylotoxus
								Thurmanniceras pertransiens	Thurmanniceras pertransiens
	Thurmanniceras otopeta								
	Berriasian Upper		Boissieri		Upper	Fauriella boissieri	Subthurmannia boissieri		

Fig. 1. Correlation between ammonite zonations proposed for the Upper Berriasian and Lower Valanginian in Bulgaria

Фиг. 1. Корелация между амонитните зонални схеми за Горния Берриас и Долния Валанжин в България

lower boundary of the ammonite *Roubaudiana* Zone (Fig. 1). This was made in agreement with the decisions of Lyon Colloquium in 1963. Prior to that time in Bulgaria the Berriasian was considered as a substage of the Valanginian Stage (Sapunov, 1957; Nikolov, 1960, 1965a). Mandov (1967, 1971) mentioned that the base of Valanginian, i.e. the boundary between the ammonite *Boissieri* and *Roubaudiana* ammonite zones, should be traced at the last occurrences of species of the genera *Subthurmannia*, *Berriasella* and *Himalaytes* and the FOs of ammonites of the genera *Thurmanniceras*, *Kilianella*, *Olcostephanus* and *Neocomites*. Later on, Nikolov (in: Nikolov, Sapunov, 1977) introduced *Thurmanniceras pertransiens* Subzone in the lower part of *Roubaudiana* Zone, thus accepting a zonation by Le Hégarat (1971) made in Southeastern France.

The index species *Thurmanniceras pertransiens* was documented from outcrop sections in the Eastern Fore-Balkan. Nikolov (1987) noted that the base of Valanginian in Bulgaria is to be traced at the FO of *Thurmanniceras pertransiens*. Later, however, Nikolov et al. (1998, 2007) accepted the standard Mediterranean ammonite zonation proposed by Hoedemaeker et al. (1993) and traced the Berriasian–Valanginian boundary between the ammonite *Boissieri* and *Otopeta* zones (Fig. 1). This suggestion was earlier made at the Copenhagen Cretaceous Symposium (Birkelund et al., 1984).

Petrova (2009) accepted the proposal by Bulot et al. (1996) and further developed by Hoedemaeker et al. (2003), Rawson (2004) and Ogg et al. (2004) of tracing the base of Valanginian at the FO of *Thurmanniceras pertransiens*, which coincides with the FO of *Calpionellites darderi*. These two parallel bioevents were documented in the hemipelagic limestone-marl succession of the Salash Formation at Barlya section, Western Balkan Mountains (Figs. 2 and 3).

Thurmanniceras pertransiens was reported in Bulgaria from outcrop sections in the Eastern and

Central Fore-Balkan (Sapunov, 1957; Nikolov, 1960; Mandov, 1967; Nikolov, Sapunov, 1977; Nikolov et al., 1998) and Western Balkan Mountains (Petrova, 2009). Compared to the calpionellid species *Calpionellites darderi*, *Thurmanniceras pertransiens* was less commonly reported but its FO is applicable for determination of the Berriasian–Valanginian boundary in this country.

Calcareous dinocysts and bethic foraminifers at the Berriasian–Valanginian boundary

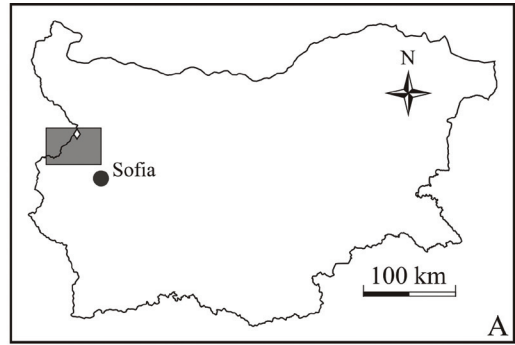
The ammonite vertical ranges and zonation of the Valanginian at Barlya Section (Petrova, 2009) were directly correlated to previous joint microfossil zonations on calpionellids, calcareous dinocysts and calcareous nannoplankton by Lakova et al. (1999). This correlation has confirmed the results on coeval ammonite and calpionellid bioevents at the Berriasian–Valanginian boundary reported from Southeastern France (Blanc et al., 1994) and Southeastern Spain (Aguado et al., 2000). At Barlya Section the coeval FOs of *Calpionellites darderi* and *Thurmanniceras pertransiens* are registered at 30 m above the base of Salash Formation (sample 338) together with the FO of the calcareous dinocyst *Colomisphaera conferta* (Fig. 3). Thus, the base of Valanginian is to be traced parallel on three fossil groups at the bases of *Thurmanniceras pertransiens* ammonite zone, *Calpionellites* Zone and *Colomisphaera conferta* Zone (Fig. 2).

The Chavchi Kamak Section in the Western Srednogorie, on the other hand, represents a transition from the carbonate platform sediments of the Slivnitsa Formation to hemipelagic clayey limestones of the Salash Formation. In this section, the FO of *Calpionellites darderi* was documented at 0.40 m below the top of Slivnitsa Formation (sample Ch 6) together with the FO of the foraminiferal species *Meandrosphaera favrei* (Fig. 4).

SYSTEM	SERIES	STAGE	Substage	Age (Ma) Ogg et al. (2004)	Ammonite Zones	Calpionellid Zones and Subzones	Calcareous dinocysts Zones	Foraminiferal Events Ivanova, Kolodziej, 2004; Ivanova et al., 2000, 2008		
					Petrova (2009)	(Lakova et al., 1999)				
CRETACEOUS	Lower	Valanginian	Lower	140,2±3,0	Lower	Busnardoites campylotoxus	Calpionellites	Calpionellites major	Colomisphaera conferta	FO Meandrosphaera favrei
					Thurmanniceras pertransiens	Calpionellites darderi				
	Upper	Berriasian	Upper	Upper	Subthurmannia boissieri	Calpionellopsis	Praecalpionellites murgeanui	Stomiosphaera wanneri	Stomiosphaera proxima	
							Calpionellopsis oblonga	Calpionellopsis simplex		

Fig. 2. Correlation between ammonite, calpionellid and calcareous dinocyst zonations and foraminiferal FO event for the Upper Berriasian and Lower Valanginian in Bulgaria.

Фиг. 2. Корелация на зоналните схеми по амонити, калпионелиди и варовити диноцисти за Горния Берриас и Долния Валанжин в България



Barlya section

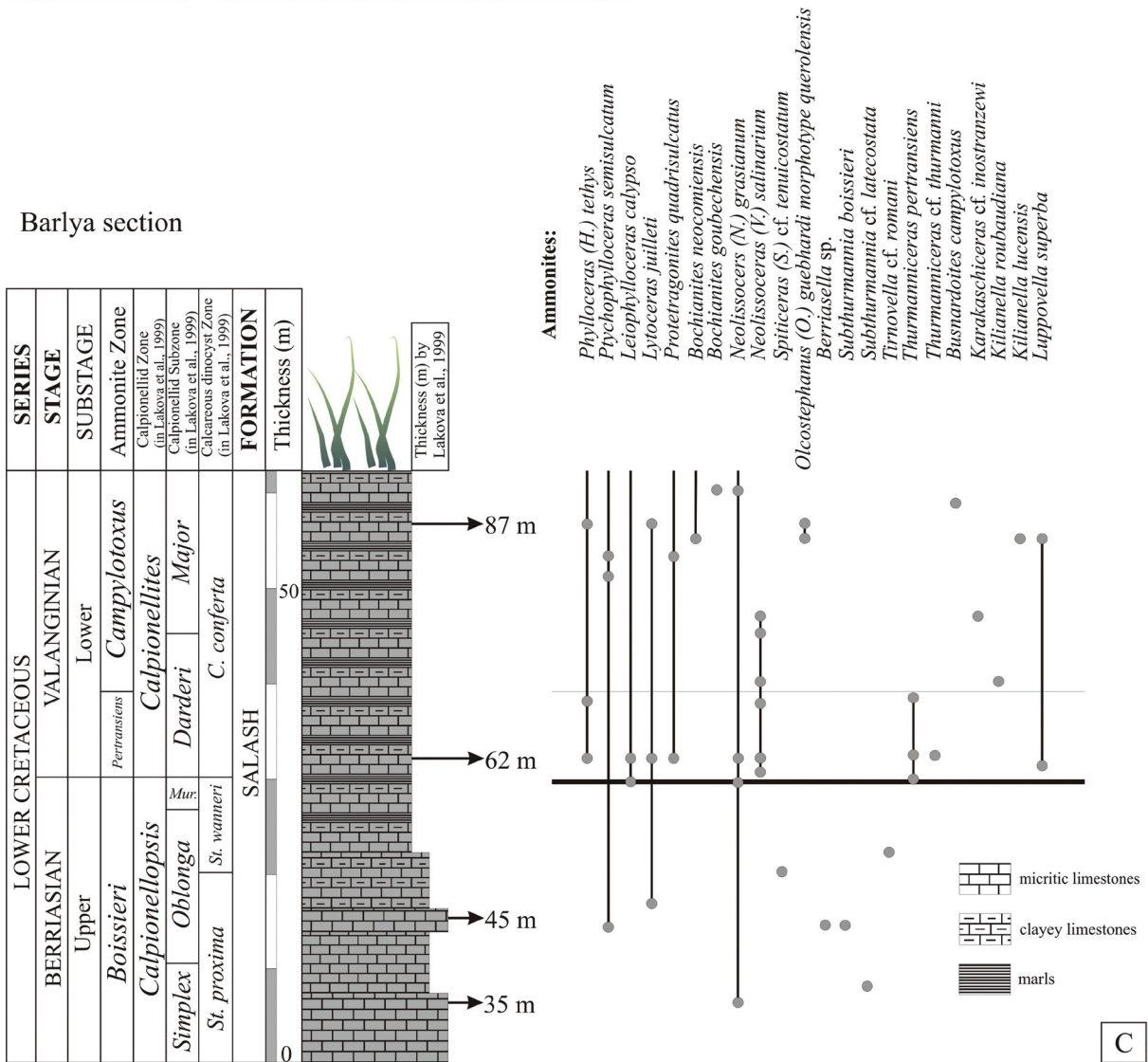
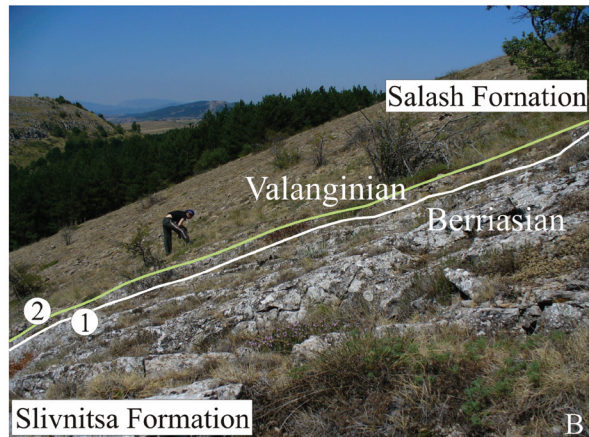
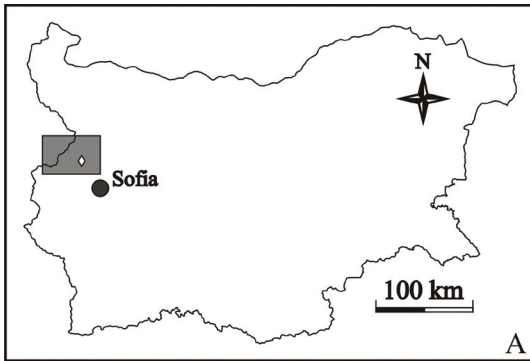


Fig. 3. Geographic position of Barlya Section (A), outcrop view of the base of Valanginian in the section, Salash Formation (B) and lithological log with ammonite occurrence and ranges in Barlya Section correlated with calpionellid and calcareous dinocyst zones and subzones in Lakova et al. (1999) (C)

Фиг. 3. Географска позиция на разрез Бърля (А), изглед на най-долната част на Валанжинския етаж в разрез Бърля, Салашка свита (В) и литоложка колонка с появата и разпространението на амонитите в разрез Бърля, корелирани с калпionenелидните и диноцистните зони и подзони по Lakova et al. (1999) (С)



Chavchi kamak section

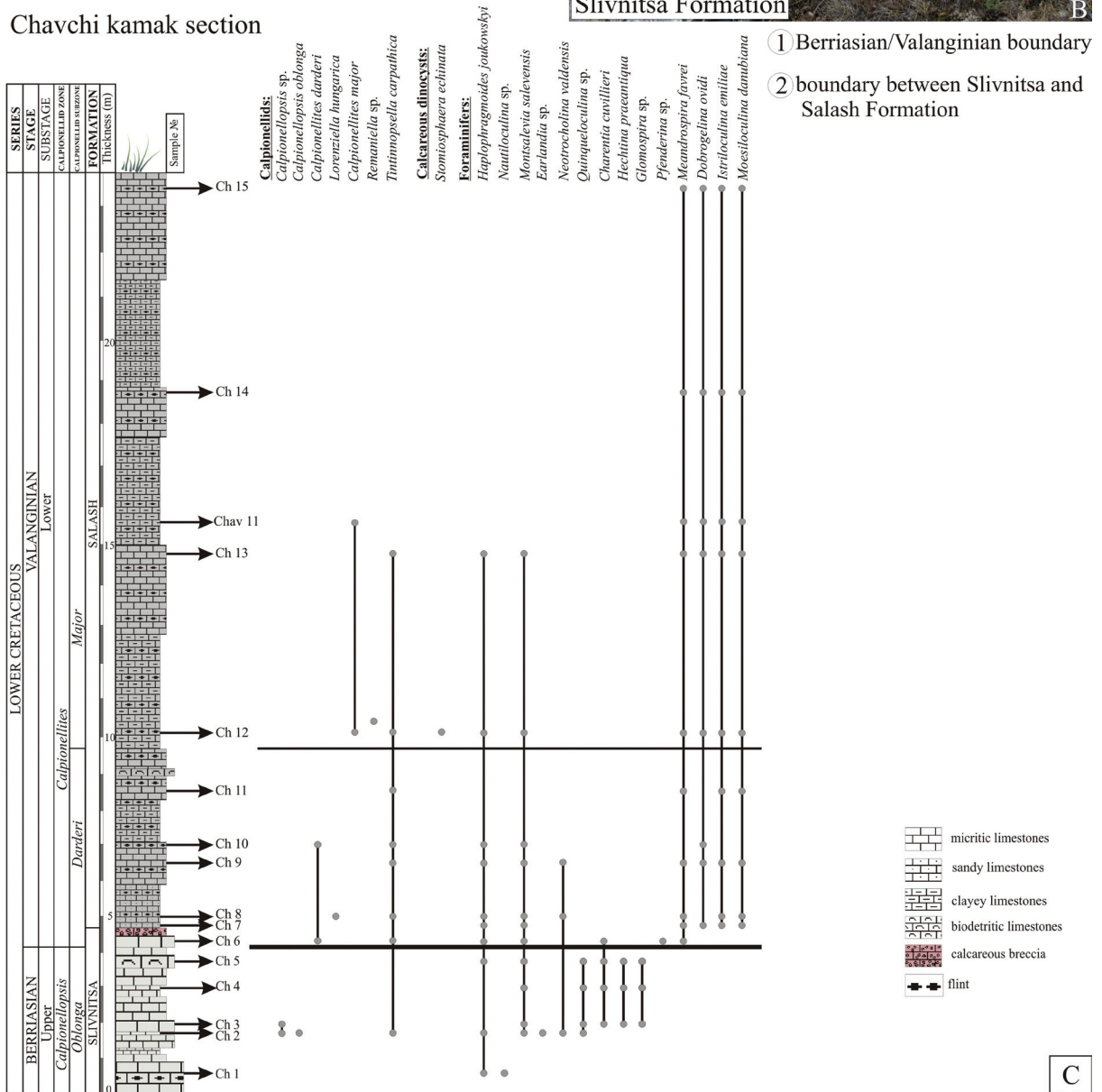


Fig. 4. Geographic position of Chavchi Kamak Section (A), outcrop view of the Berriasian–Valanginian boundary in the top of Slivnitsa Formation (B) and lithological log with calpionellid, calcareous dinocyst, and foraminiferal occurrence and ranges from the Chavchi Kamak locality (C)

Фиг. 4. Географска позиция на разрез Чавчи камък (А), изглед на границата Берриас/Валанжин в най-горната част на Сливнишката свита (В) и литоложка колонка с появата и разпространението на калпионелидите, варовитите диноцисти и фораминиферите в разрез Чавчи камък (С)

Ivanova (in: Ivanova et al., 2000, 2002, 2008; Ivanova, Kolodziej, 2004) used *Meandrospira favrei* as a main criterion for tracing the base of Valanginian in shallow-water carbonates rich in foraminifera. Ivanova (in: Ivanova, Kolodziej, 2004) stressed that *Meandrospira favrei* is of wide ecological tolerance, commonly occurring in both carbonate platform and pelagical/hemipelagical sediments.

The Berriasian–Valanginian boundary at Chavchi Kamak Section is drawn at the FOs of *Calpionellites darderi* and *Meandrospira favrei*, i.e. at the lower boundaries of zones named after these index species.

Conclusion

The Berriasian–Valanginian boundary in Bulgaria could be traced on the basis of four different macro-

and microfossil groups. The joint studies on ammonites, calpionellids, calcareous dinocyst and small benthic foraminifera has revealed that together with the two main criteria for the base of Valanginian (the FOs of *Calpionellites darderi* и *Thurmanniceras pertransiens*), the FOs of *Colomisphaera conferta* and *Meandrospira favrei* are also reliable bioevents to be used as auxiliary markers or independently in carbonate platform and transitional facies. Further study on calcareous dinocysts and benthic foraminifera across the Berriasian–Valanginian boundary in the Mediterranean Realm could confirm the results from Bulgaria.

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