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NOTES ON THE STRATIGRAPHY AND MICROFACIES OF TITHONIAN AND BERRIASIAN CARBONATE SEQUENCE AROUND DRAGOVISHTITSA VILLAGE (WESTERN SREDNOGORIE, BULGARIA)

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Abstract

In the eastern part of the Western Srednogorie Unit, a specific succession of Gintsi and Glozhene–Slivnitsa formations has provided micropalaeontological evidence of late Tithonian (*Chitinoidella* and *Praetintinnopsella* zones) and mid-Berriasian (Elliptica Subzone of the *Calpionella* Zone) age on the basis of 38 chitinoidellid and calpionellid species. A significant stratigraphic hiatus has been documented within the Glozhene–Slivnitsa Formation since the *Crassicollaria* Zone, as well as the Alpina+Remaniella subzones of *Calpionella* Zone, are absent from the section. The conformably overlaying Salash Formation is of mid-Berriasian age (Elliptica Subzone) and is locally characterized by presence of calcareous sandstones. Seven carbonate microfacies have been determined, which suggest that the carbonates were deposited in carbonate ramp rather than under pelagic conditions. Indeed, the upper part of the sections studied has revealed an upward-deepening trend.

Key words: Tithonian, Berriasian, microfacies, carbonate platform, stratigraphy, calpionellids, Western Srednogorie, Bulgaria

Introduction. The Upper Jurassic and Lower Cretaceous carbonate sediments in the Western Srednogorie tectonic unit are mainly represented by the massive biogenic limestones of the Slivnitsa Formation depoisited under conditions of a long-lived platform. These are of Callovian to Valanginian age [1, 2]. In

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the westernmost part of this tectonic unit (in Dragoman area), the Slivnitsa Formation is unconformably covered by the hemipelagic limestones and marlstones of the Salash Formation of Valanginian and Hauterivian age [3–6].

It is only in the eastern part of the Western Srednogorie Unit where Upper Jurassic and Berriasian carbonate successions of Yavorets, Gintsi and Glozhene formations were described [7].

The study area attracted the interest of the present authors for the following reasons: 1) occurrence of unique carbonate development with pelagic microfossils (calpionellids) in the Western Srednogorie Unit; 2) complex relationships and fast facial transitions between shallow- and deeper-water depositional settings; 3) lack of previous carbonate microfacies examinations; 4) scarcity so far of abundant palaeontological data for age determination of strata younger than Kimmeridgian; 5) new results gained during the recent geological mapping of the area on scale 1:50 000.

This paper presents description of Tithonian and Berriasian carbonate and siliciclastic-carbonate sections in the Western Srednogorie north of Dragovishtitsa Village (Fig. 1A), namely the calpionellid distribution and precise dating, regional stratigraphy, carbonate microfacies and reconstruction of depositional settings at the end of Jurassic and beginning of Cretaceous.

Material and methods. A total of 43 thin-sections have been studied for calpionellids under transmitted light Jenaval microscope. Microfacies analysis is based on detailed microscopic study of 38 thin-sections observed under standard petrographic microscope. Microfacies types have been identified following the textural classification proposed by DUNHAM [8] and the diagnostic microfacies criteria of FLÜGEL [9]. The field observations, calpionellid biostratigraphy and depositional settings interpretation have been made jointly with Daniela Reháková and Jozef Michalík. The subzonal index-species along with characteristic chitinoidellid and calpionelled species are presented in Fig. 1B. The examined materials are hosted at the Geological Institute, Bulgarian Academy of Sciences, Sofia.

Previous studies. The work of SAPUNOV et al. [7] on the lithostratigraphy, biostratigraphy and regional distribution of the Upper Jurassic and Berriasian carbonate sediments in the area of the Mezhdina Summit north of Dragovishtitsa was the first and is still the most comprehensive study. Those authors described two sections on the southern slope of the summit. The lithostratigraphic succession recognized from base upwards is as follows: Polaten, Yavorets, Gintsi, Glozhene, Slivnitsa and Salash formations. Calpionellid data by Bakalova [7] suggested then the presence of the Elliptica Subzone in the Salash Formation. On the northern slope of Mezhdina Summit, Sapunov et al. [7] described a succession consisting of the Polaten and Slivnitsa formations. Apart from the reported new regional stratigraphic and biostratigraphic data, the cited authors pointed out the unique nature of Dragovishtitsa area, where sediments of different depositional settings (carbonate platform transition to deeper-water pelagic environment) occured over restricted area.

In the eastern part of the Western Srednogorie Unit, the Polaten Formation underlays all carbonate Callovian and Upper Jurassic sediments. Starting from the Callovian–Oxfordian, the uniform widespread sediments of the Polaten Formation (mainly gray allochemic sandy limestones) are disconformably covered by formations of two differentiated facial types: the carbonate-platform massive biogenic limestones of the Slivnitsa Formation to the north and west, and the "pelagic" limestones of the West Balkan Carbonate Group (Yavorets+Gintsi+ Glozhene formations) to the south-east. The Glozhene Formation is covered by an irregular alternation of thin-bedded clayey limestones and calcareous sandstones. This alternation was described and referred to as the Salash Formation by Sapunov et al. [7]. Nikolov [10] used the name Salash–Cherni Osam Formation for a fairly different lithological body of rhythmic three-component alternation that crops out easterly in the active Balsha Quarry (Fig. 1A).

Subject of this study are the Gintsi and Glozhene–Slivnitsa formations, and the Salash Formation at Dragovishtitsa 1 and 2 sections (Fig. 1A). The field appearance of the formations studied herein is presented in Fig. 2.

Descriptions of sections and biostratigraphy. Calpionellid zones and subzones have been determined following the definitions and zonal schemes by Pop [11]; Reháková and Michalík [12]; Lakova and Petrova [13]. The Tithonian *Chitinoidella* and *Praetintinnopsella* zones and the lower Berriasian Elliptica Subzone of the *Calpionella* Zone have been documented in this study. It is noteworthy that the uppermost Tithonian *Crassicollaria* Zone and lower Berriasian Alpina and Remaniella subzones are absent from Dragovishtitsa 1. Successions of chitinoidellids known from other parts of the Tethys have been taken into account, such as the Carpathians of Romania and Slovakia (Pop [14], Reháková [15]).

Dragovishtitsa 1 Section (Fig. 3). Gintsi Formation. The gray to pinkish gray nodular limestones are medium-bedded with chert nodules. The measured thickness is 26 m (in this work are studied only the uppermost 8 m). The age determined on ammonites [7] is late Oxfordian to early Kimmeridgian. The uppermost part at Dragovishtitsa 1 Section has been herein proved to be of early late Tithonian age based on calpionellids (Boneti Subzone).

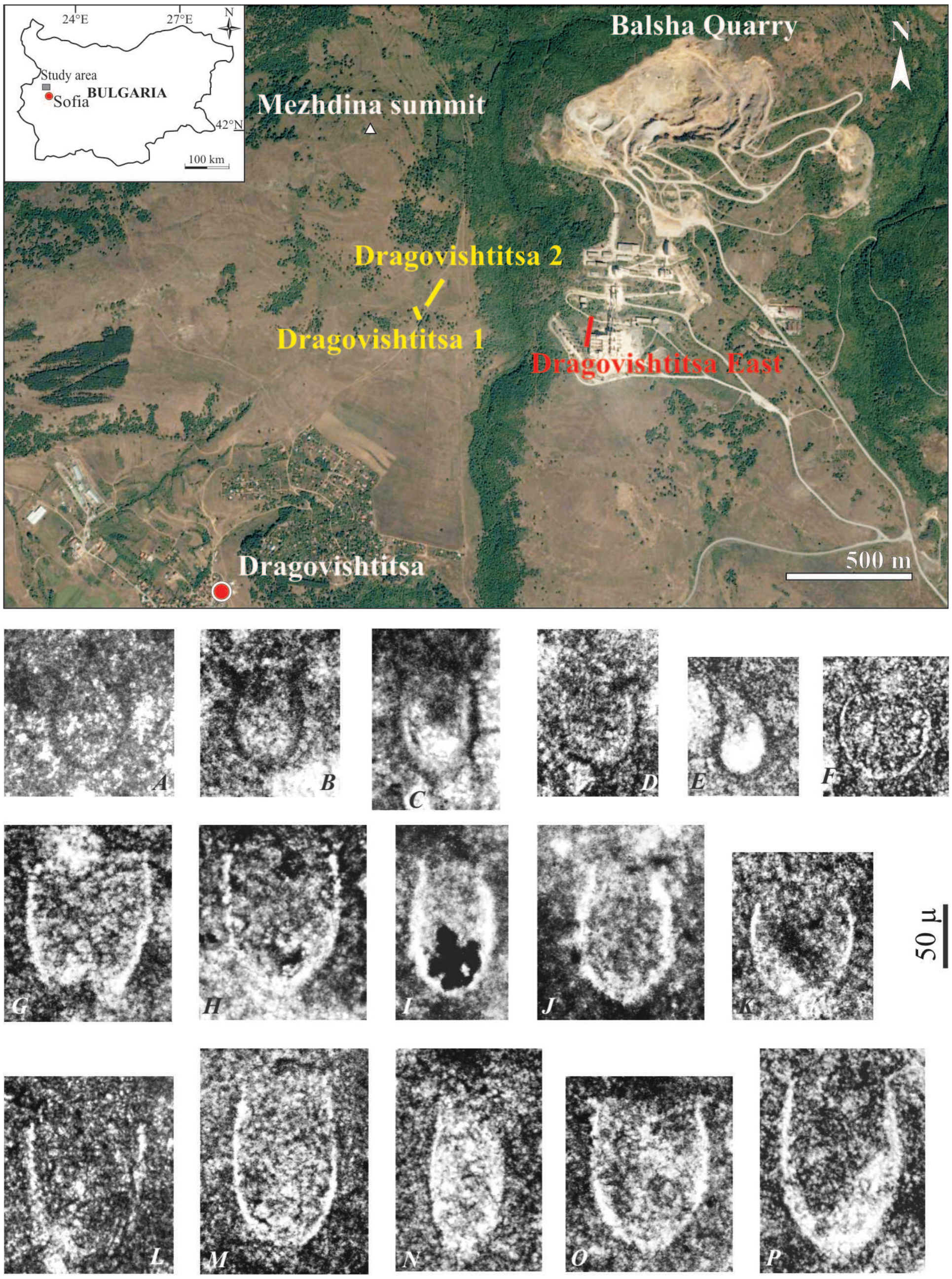
Glozhene–Slivnitsa Formation (11 m). Its lithological features differ from the typical Glozhene Formation in the pelagic settings of Western Balkan Unit. Gray micritic limestones are often medium-bedded, intraclastic, with chert nodules or platty chert interlayers. Locally, the Glozhene and Slivnitsa formations are in lateral and not only in vertical relationships. In cases, it is hard to attribute the succession to the Glozhene or Slivnitsa Formation. The presence of the well-known pelagic succession of Yavorets, Gintsi and Glozhene formations, however, partly suggests the assignment to the Glozhene Formation. It is confirmed by the microfossil content – pelagic chitinoidellids, calpionellids, calcareous dinocysts, *Saccocoma*, globochaetids representing the basic constitutents, additionally mixed with bryozoans, foraminifers, algal and coral fragments from more proximal depositional settings. Regarding the field appearance, spatial relationships with the underlaying Gintsi Formation, as well as the fast lateral transitions westerly to the typical Slivnitsa Formation, we refer this part of the carbonate succession to the Glozhene–Slivnitsa Formation. It corresponds to the upper Tithonian and lower Berriasian. Noteworthy is a newly established stratigraphic hiatus covering the Tithonian–Berriasian boundary interval (absence of the *Crassicollaria* Zone and Alpina+Remaniella subzones of the *Calpionella* Zone).

The *Chitinoidella* Zone corresponds to the upper part of the Gintsi Formation and the basal 3 m of the Glozhene-Slivnitsa Formation. The Dobeni Subzone (p.p.) has been recorded in the Gintsi Formation (Fig. 3). The association is scarce consisting of *Longicollaria dobeni* (Borza), *Daciella banatica* Pop, *Dobeniella colomi* (Borza) and *Borziella slovenica* (Borza) only. The Boneti Subzone covers the top of Gintsi Formation and the base of Glozhene–Slivnitsa Formation, being 5–6 m thick. The chitinoidellid species recorded are: *Chitinoidella boneti* Doben, *Ch. hegarati* Sallouhi et al., *Ch. carthagensis* Sallouhi et al., *Ch. popi* Sallouhi et al., *Ch. elongata* Pop, *Dobeniella bermudezi* (Furrazola Bermúdez), *Dob. cubensis* (Furrazola Bermúdez), *Almajella* cf. *cristobalensis* (Furrazola Bermúdez), *Dob.* cf. *pinarensis* (Furrazola Bermúdez and Kreisel), *Dob. tithonica* (Borza), *Dob. colomi* (Borza), *Daciella almajica* Pop, *Dac. svinitensis* Pop, *Dac. banatica* Pop, *Longicollaria insueta* (Řehánek), *Popiella oblongata* Reháková, and *Carpathella rumanica* Pop. The four species from the underlaying Dobeni Subzone have also been recorded in the Boneti Subzone.

The *Praetintinnopsella* Zone is represented by its index-species accompanied with certain chitinoidellid species from the Boneti Subzone in the mid of the Glozhene–Slivnitsa Formation (see Fig. 3). According to the recent chronostratigraphic scale of the Tithonian, the upper Tithonian includes the ammonite *Microcanthoceras microcanthum* and *Durangites* zones. Direct correlations of ammonites and calpionellids had shown that the base of Boneti Subzone coincides precisely with the base of *Microcanthoceras microcanthum* Zone [16, 17]. Consequently, the base of Boneti Subzone seems to be a reliable indicator for the base of the upper Tithonian.

The Elliptica Subzone in this section corresponds to a ca. 7-m thick interval of the top of Glozhene–Slivnitsa Formation. The calpionellid assemblages include *Calpionella alpina* Lorenz, *Calpionella minuta* Houša, *Calpionella elliptica* Cadisch, *Calpionella* sp. A, *Tintinnopsella carpathica* (Murgeanu & Filipescu), *Tintinnopsella doliphormis* Colom, *Crassicollaria parvula* Remane, and *Remaniella ferasini* (Catalano).

The stratigraphic hiatus here recorded corresponds to part of the upper Tithonian (the whole *Crassicollaria* Zone) and part of the lower Berriasian (Alpina and Remaniella subzones of the *Calpionella* Zone). In all pelagic sections pre-



A

B

Fig. 1. A. Geographic position of the sections (the map is a satellite image provided by Google Earth). B. Subzonal calpionellid index-species and characteristic species. *A–E* – from Dragovishtitsa 1 section, *F–P* – from Dragovishtitsa 2 section ; *A*, *B* – *Chitinoidella boneti*, *A* – sample K06, *B* – sample K6a; *C*, *D* – *Praetintinnopsella andrusovi*, *C* – sample K6c, *D* – sample K6d; *E* – *Longicollaria dobeni*, sample K06; *F*, *K* – *Lorenziella hungarica*, *F* – sample K17, *K* – sample K19a; *G*, *H* – *Remaniella ferasini*, *G* – sample K12, *H* – sample K19; *I*, *J* – *Calpionella elliptica*, *I* – sample K08, *J* – sample K10; *L* – *Remaniella cadischiana* – sample K18; *M*, *N* – *Tintnnopsella longa*, *M* – sample K 14, *N* – sample K17; *O*, *P* – *Tintinnopsella carpathica* (large form), *O* – sample K15, *P* – sample K19a

Fig. 2. *a*) and *b*) Dark gray medium-bedded nodular limestones of Gintsi Fm. (Tithonian), Dragovishtitsa 1 Section; *c*) Light gray limestones from the lower parts of Glozhene–Slivnitsa Fm. (lower Berriasian), Dragovishtitsa 1 Section; *d*) Proximal carbonate tempestite sequence from Glozhene–Slivnitsa Fm., Dragovishtitsa 2 Section; *e*) Thin-bedded gray limestones from the uppermost part of Glozhene–Slivnitsa Fm., (lower Berriasian), Dragovishtitsa 2 Section; *f*) the carbonate sediments around the boundary between the Glozhene–Slivnitsa Fm. and the Salash Fm., Dragovishtitsa 2 Section

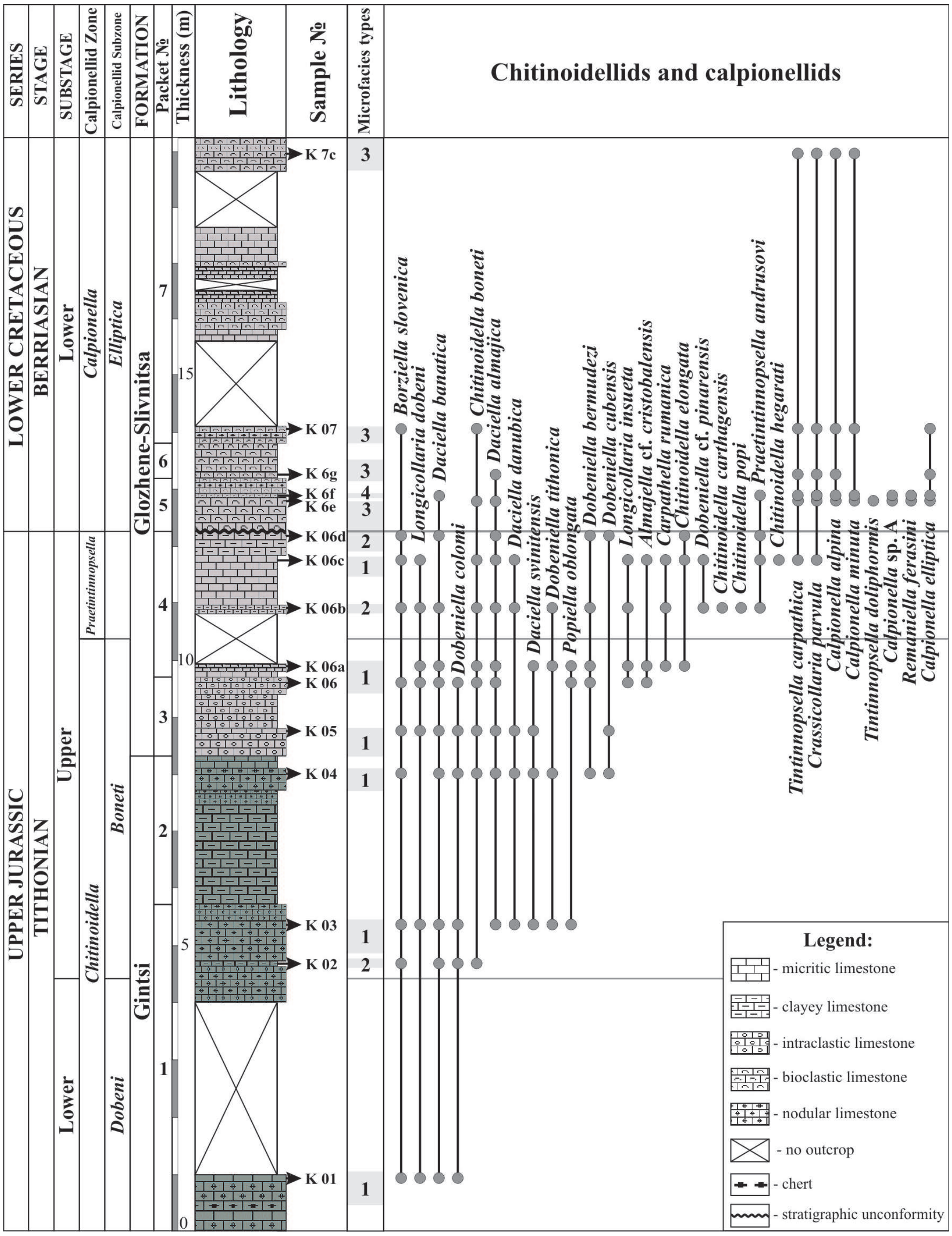


Fig. 3. Dragovishtitsa 1 Section – litho- and biostratigraphy, range-chart of the calpionellid species and the microfacies types

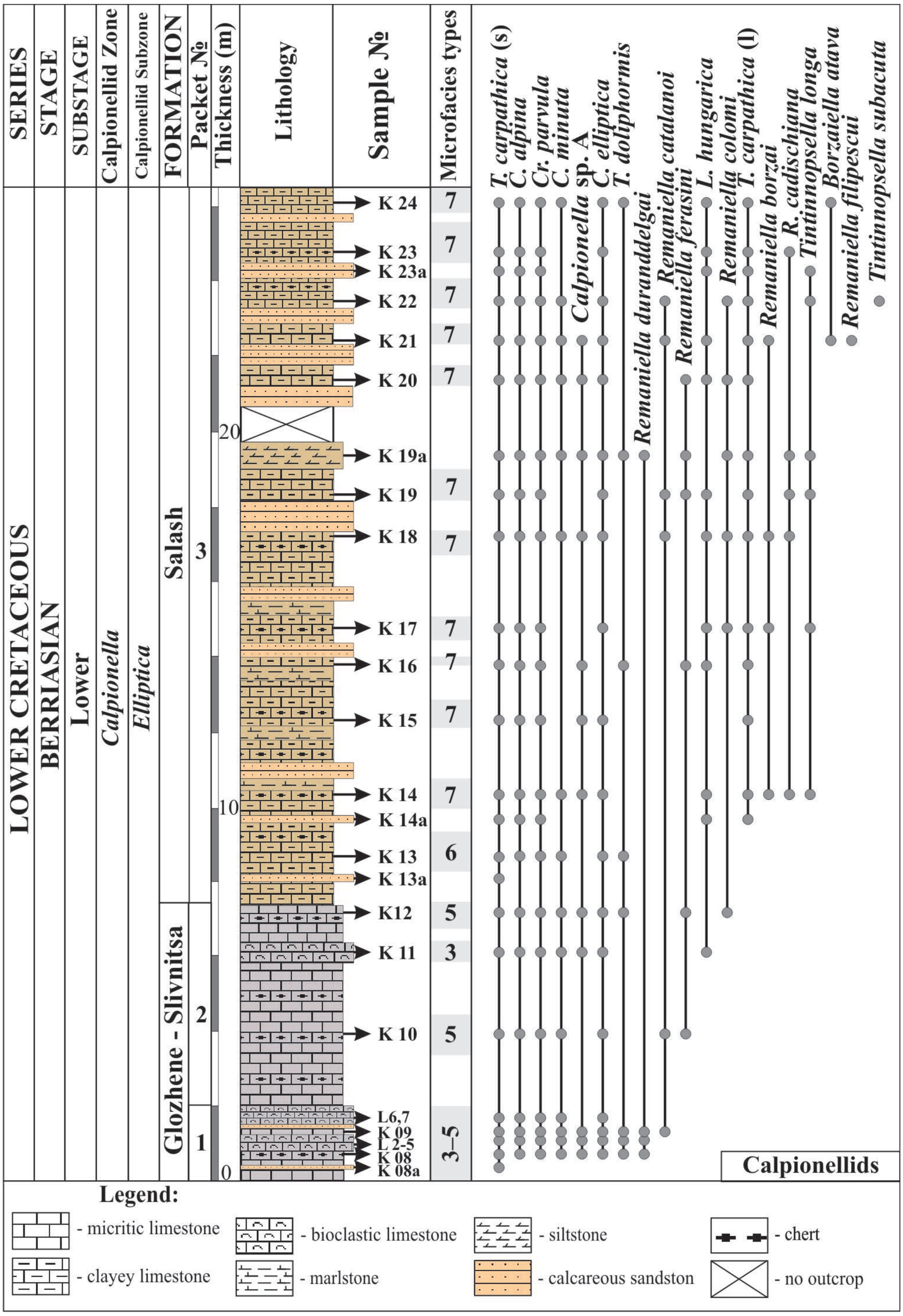


Fig. 4. Dragovishtitsa 2 Section – litho- and biostratigraphy, range-chart of calpionellid species and the microfacies types

viously studied in the Western Balkan and Western Fore-Balkan in Bulgaria [13] there is a complete sedimentation record across the Tithonian–Berriasian boundary. Here, the considerable hiatus reflects most probably dynamic conditions on the shelf due to local tectonics of a foreland basin. Similar palaeoenvironmental conditions were described by MICHALÍK et al. [18] from the Manín Units of the Western Carpathians.

Dragovishtitsa 2 Section (Fig. 4)**.** The section covers the Glozhene–Slivnitsa Formation of 7.5 m thickness and the overlying Salash Formation with thickness of 19 m. The last mentioned is built of irregular alternation of thin-bedded gray clayey limestones, marlstones, rare siltstones and thin-bedded yellowish calcareous sandstones, the latter increasing in thickness upwards. The age is late early Berriasian (Elliptica Subzone).

Representing a natural continuation of Dragovishtitsa 1, this outcrop is quite different in sedimentology. The Salash Formation together with the underlaying top of the Glozhene–Slivnitsa corresponds to the Elliptica Subzone of the *Calpionella* Zone. The calpionellid association is quite rich in species (see Fig. 4): *Calpionella alpina, Calpionella minuta, Calpionella elliptica, Calpionella* sp. A, *Remaniella duranddelgai* Pop, *Remaniella ferasini, Remaniella catalanoi* Pop, *Remaniella colomi* Pop, *Remaniella borzai* Pop, *Remaniella cadischiana* (Colom), *Crassicollaria parvula, Tintinnopsella carpathica* (both small and large forms), *Lorenziella hungarica* (Knauer and Nagy), *Tintinnopsella longa* (Colom), *Tintinnopsella subacuta* (Colom), *Tintinnopsella doliphormis*, *Borzaiella atava* Grün and Blau, and *Remaniella filipescui* Pop. The occurrence of *T. longa* and *T. subacuta* has suggested that the upper 3 m belong to the uppermost Elliptica Subzone.

In the active Balsha Quarry located immediately east of Dragovishtitsa 1 and 2 sections, a triple alternation of sandstones, marlstones and clayey limestones of the Salash–Cherni Osam Formation [8] has also been studied. Calpionellids suggest a late early Berriasian age (Elliptica Subzone).

Carbonate microfacies and depositional environments. Seven microfacies types (MFT 1–7) have been distinguished within the studied Tithonian–Berriasian sections north of Dragovishtitsa Village. Lower to upper Tithonian microfacies (MFT 1, bioclastic wackestone/packstone, and MFT 2, bioclastic wackestone alternating with intraclastic-bioclastic grainstone laminae), in the Gintsi and Glozhene–Slivnitsa formations from Dragovishtitsa 1 Section are interpreted as deposited in relatively deep-water settings located near or below the storm wave base.

The mid-Berriasian microfacies represent a deepening-upward sequence. Thus, the carbonate deposits of Glozhene–Slivnitsa Formation at Dragovishtitsa 1 and Dragovishtitsa 2 (MFT 3, bioclastic packstone and rudstone with large foraminifers and *Lithocodium-Bacinella;* MFT 4, intraclastic-bioclastic packstone/grainstone; and MFT 5, peloid-bioclastic wackestone and wackestone/packstone) have been interpreted as result from storm-influenced sedimentation and represent proximal tempestites, deposited between the fair-whether wave base and the storm wave base. On the other hand, siliciclastic-carbonate succession of the Salash Formation (Dragovishtitsa 2) is regarded as formed in a relatively deep-marine setting located below the storm wave base, where fine-grained bioclastic-peloidal packstones and grainstones (MFT 6) and bioturbated bioclastic wackestones and wackestones/packstones (MFT 7) have been formed.

Regional stratigraphy. The area around Dragovishtitsa Village provides vast outcrops of the Slivnitsa Formation in the northern and western part. There, the Slivnitsa Formation is covered by atypical Salash Formation [7]. In north-eastern direction, the Slivnitsa Formation passes both vertically and laterally into the Glozhene–Slivnitsa Formation of late Tithonian and mid-Berriasian age. Separated by a stratigraphical hiatus (latest Tithonian and early Berriasian) within the Glozhene–Slivnitsa Formation, the upper part of the Glozhene–Slivnitsa Formation and the overlying Salash Formation correspond to the late early Berriasian (Elliptica Subzone), the latter being locally characterized by presence of calcareous sandstones.

Discussion and conclusions. The carbonate succession in the eastern part of Western Srednogorie Unit consisting of Yavorets, Gintsi and Glozhene formations is of Callovian to early-mid Berriasian age. Previous and new data indicate a Kimmeridgian to early Tithonian age of the Gintsi Formation. The Glozhene–Slivnitsa Formation, even rich enough in chitinoidellids and calpionellids, contains also microfossils characteristic of the shallow parts of the carbonate platform. In this study, the Tithonian–Berriasian carbonate and siliciclastic-carbonate successions are regarded as carbonate platform deposits. Thus, it could be assumed that the lower Berriasian sequence was most probably formed on a carbonate ramp, with well distinguished storm-dominated middle zone (MFT 3–MFT 5) and deeper outer-ramp setting (MFT 6 and MFT 7) (cf. [19]). It differs from the typical development of Glozhene Formation in the distal pelagic basin parts (e.g., in the Western Balkan Mts.) and is here referred to as the Glozhene–Slivnitsa Formation and Salash Formation. It covers a time interval from the late Tithonian to early Berriasian. The Tithonian–Berriasian boundary interval itself is missing – *Crassicollaria* Zone and Alpina+Remaniella subzones are absent. The overlaying Salash Formation is of early-mid Berriasian age (Elliptica Subzone). Thus, facial differentiation seems to have occurred during the late early Berriasian being represented by different environmentally modified lithostratigraphic units of same age (Slivnitsa, Glozhene–Slivnitsa, Salash formations).

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