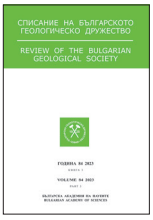
СПИСАНИЕ НА БЪЛГАРСКОТО ГЕОЛОГИЧЕСКО ДРУЖЕСТВО,
год. 84, кн. 3, 2023, с. 193–196

REVIEW OF THE BULGARIAN GEOLOGICAL SOCIETY,
vol. 84, part 3, 2023, p. 193–196



Национална конференция с международно участие „ГЕОНАУКИ 2023“
National Conference with International Participation “GEOSCIENCES 2023”

Calpionellid biostratigraphy and microfacies across the Tithonian/Berriasian boundary interval in the Western Fore-Balkan, Bulgaria

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Калпионелидна биостратиграфия и микрофациеси в Титон–Бериаския граничен интервал в Западния Предбалкан, България

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Abstract. The upper Tithonian and the lower Berriasian in the Western Fore-Balkan in Bulgaria (Gintsi and Glozhene Formations) represent a remarkable, stratigraphically expanded record of pelagic nodular and micritic limestones. More than 50 studied thin sections revealed the succession of the *Chitinoidella*, *Praetintinnopsella*, *Crassicollaria*, and *Calpionella* zones, further divided into subzones. The stratigraphical ranges of 22 chitinoidellid (the genera *Almajella*, *Borziella*, *Carpathella*, *Chitinoidella*, *Daciella*, *Dobeniella*, *Longicollaria*, and *Praetintinnopsella*) and 26 calpionellid species of the genera *Tintinnopsella*, *Crassicollaria*, *Calpionella*, *Remaniella*, *Borzaiella* and *Lorenziella* have been recorded. Eight microfacies, two of which in the Gintsi Formation, and six microfacies in the Glozhene Formation have been distinguished, all being wackestones and mudstones, characteristic of open-marine pelagic deposits and differing from each other in the prevailing bioclasts. The Tithonian/Berriasian boundary was tentatively drawn at the *Crassicollaria/Calpionella* boundary.

Keywords: calpionellid zonation, microfacies, Tithonian/Berriasian, Western Fore-Balkan.

Introduction

Calpionellids still retain their primary importance as a high-resolution stratigraphic tool for pelagic carbonates in the Tithonian to Valanginian, in spite of the powerful development in this century of magnetostratigraphy, nannofossil biostratigraphy, sequence stratigraphy, and isotope geochemistry.

A stratigraphically expanded sequence of Tithonian and Berriasian pelagic carbonates in the section Gorno Belotintsi of the Western Fore-Balkan tectonic unit in NW Bulgaria was studied in terms of calpionellid biostratigraphy, microfacies and reconstructions of the depositional environment. The section provides a continuous exposure of the Gintsi Formation (clayey nodular gray limestones) and the over 200-m thick Glozhene Formation (platy micritic limestones). A total of 51 thin sections, housed at the Geological Institute, Bulgarian Academy of Sciences, Sofia, have been studied for microbiostratigraphy and microfacies analysis. The section at Gorno Belotintsi attracted the attention of Bulgarian micropaleontologists at the end of the last century, when the first ever directly correlated zonations based on calpionellids, calcareous nannofossils, and calcareous dinocysts for the Tithonian to Valanginian were published (see Lakova et al., 1999). The present study aims to present more diverse calpionellid associations, modern taxonomic and biostratigraphic interpretations, and the first

https://doi.org/10.52215/rev.bgs.2023.84.3.193

mcrofacies study of the Jurassic/Cretaceous (JKB) boundary interval for the Western Fore-Balkan.

Calpionellid biostratigraphy

The calpionellid subdivision in zones and subzones follows that of Lakova et al. (1999) and Lakova and Petrova (2013). An exception is the *Crassicollaria* Zone, herein divided into the *Remanei*, *Intermedia*, and *Colomi* subzones as first proposed by Pop (1994). Subsequently, the same subzonal division has been applied in France (Rehakova in Wimbledon et al., 2013), the Western Balkan Mts. of Bulgaria (Petrova et al., 2019), and the Western Carpathians (Ölveczká, Reháková, 2022).

The following calpionellid zones have been determined: *Chitinoidella*, *Praetintinnopsella*, *Crassicollaria*, and *Calpionella*. Their definitions, as well as that of calpionellid subzones, are based on widely recognized calpionellid events, mainly first occurrences (FOs) of species. These are as follows, from oldest to youngest (Fig.1): the FOs of *Longicollaria dobeni*, *Chitinoidella boneti*, *Praetintinnopsella andrusovi*, *Tintinnopsella carpathica*, *Calpionella grandalpina*, *Crassicollaria colomi*, the explosion of the small spherical *Calpionella alpina*, and the FOs of *Remaniella ferasini* and *Calpionella elliptica*.

The *Chitinoidella* Zone is remarkable in its diverse and abundant chitinoidellids and semichitinoidellids, maybe the richest ones in the Tethyan Realm. Eight genera and 22 species well characterize both subzones *Dobeni* and *Boneti*. The lower/upper Tithonian boundary is to be traced at the base of the *Boneti* Subzone, since in Tunisia and elsewhere the FO of *Chitinoidella dobeni* coincides with the base of the *Microcanthum* ammonite Zone (Benzaggagh et al., 2010; Boughdiri et al., 2006). The *Crassicollaria* Zone is divided into the *Remanei*, *Intermedia* and *Colomi* subzones. The JKB, i.e., the base of the Berriasian, has been drawn at the base of the *Calpionella alpina* Subzone at ca. 110 m above the base of the Glozhene Formation. A direct correlation of calcareous dinocyst and calpionellid zones (see Lakova et al., 1999; Ivanova et al., 2006) has revealed that the calcareous dinocyst zones *C. borzai*, *C. tithonica* and *P. malmica* characterize the lower Tithonian strata of the Gintsi Formation below the onset of the chitinoidellids; upwards, the *Chitinoidella* Zone correlates with the *C. tenuis* Zone, and the Upper Tithonian *Crassicollaria* Zone – with the *C. fortis* Zone and the lowest level of the *St. proxima* Zone.

In the Berriasian, the *Calpionella* Zone includes three successive subzones, namely *Alpina*, *Remanella*, and *Elliptica*. The *Alpina* Subzone could be further subdivided into four parts due to the presence of a marker level of acme of *Crassicollaria parvula* and *Crassicollaria colomi*, as well as the FO of *Calpionela minuta*. The *Remaniella* Zone is characterized by the presence of early remaniellas, such as *R. duranddelai*, *R. ferasini*, *R. catalanoi*, and *R. colomi*. In the *Elliptica* Subzone, the FOs of *Lorenziella hungarica*, *Remaniella cadischiana*, and the large form of *Tintinnopsella carpathica* are herein reported like in the Western Balkan Unit (see Grabowski et al., 2014, and discussion therein).

Microfacies

Microfacies were described, following the textural classification proposed by Dunham (1962). Flügel's (2004) diagnostic microfacies criteria were used in defining the microfacies types. In the present study, eight microfacies types (MFT 1–8) have been determined throughout the Tithonian–Berriasian succession (Fig. 1): *Saccocoma* wackestone (MFT 1); *Saccocoma*-radiolarian wackestone (MFT 2); *Globochaete alpina*-radiolarian wackestone (MFT 3); *Globochaete alpina*-pelecypod mudstone and wackestone (MFT 4); Calpionellid-radiolarian mudstone and wackestone (MFT 5); Calpionellid mudstone and wackestone (MFT 6); Radiolarian-calpionellid mudstone and wackestone (MFT 7); and *Globochaete alpina*-calpionellid mudstone and wackestone (MFT 8).

The described microfacies types contain typical pelagic microfossil associations (*Saccocoma,* pelagic pelecypods, *Globochaete alpina, Globuligerina* ("protoglobigerina"), radiolarians, dinoflagellate cysts, sponge spicules, calpionellids) and are interpreted as open-marine deep-water deposits. All microfacies are characterized by mudstone or wackestone non-winnowed textures indicating depositional settings with relatively calm hydrodynamic conditions.

In the Gorno Belotintsi section, MFT 1 and MFT 2 predominated during the late Kimmeridgian and beginning of early Tithonian (Gintsi Formation) and are regarded as formed mostly in a low-energy setting, that was locally affected by more energetic hydrodynamic events. This interpretation is supported by the presence of intraclasts that originated from pelagic wackestones as well as commonly observed broken pelecypod shells and *Saccocoma* remains. The latter are often concentrated in groups due to agitated hydrodynamic conditions, most probably related to stronger storms and/or bottom currents. The observed sporadic benthic foraminifera tests also suggest transport and redeposition from shallow-water settings.

A microfacies change occurred later during the Early Tithonian (*Chitinoidella* Zone, *Dobeni* Subzone) when *Globochaete alpina*-radiolarian wacke-

stones (MFT 3) and *Globochaete alpina*-pelecypod mudstones and wackestones (MFT 4) were formed also in calm deep-water settings (lower part of the Glozhene Formation). During the late Tithonian–early Berriasian (middle–upper parts of the Glozhene Formation), other pelagic microfacies association predominated (MFT 5–7 and only sporadic MFT 8). These microfacies are mostly character-

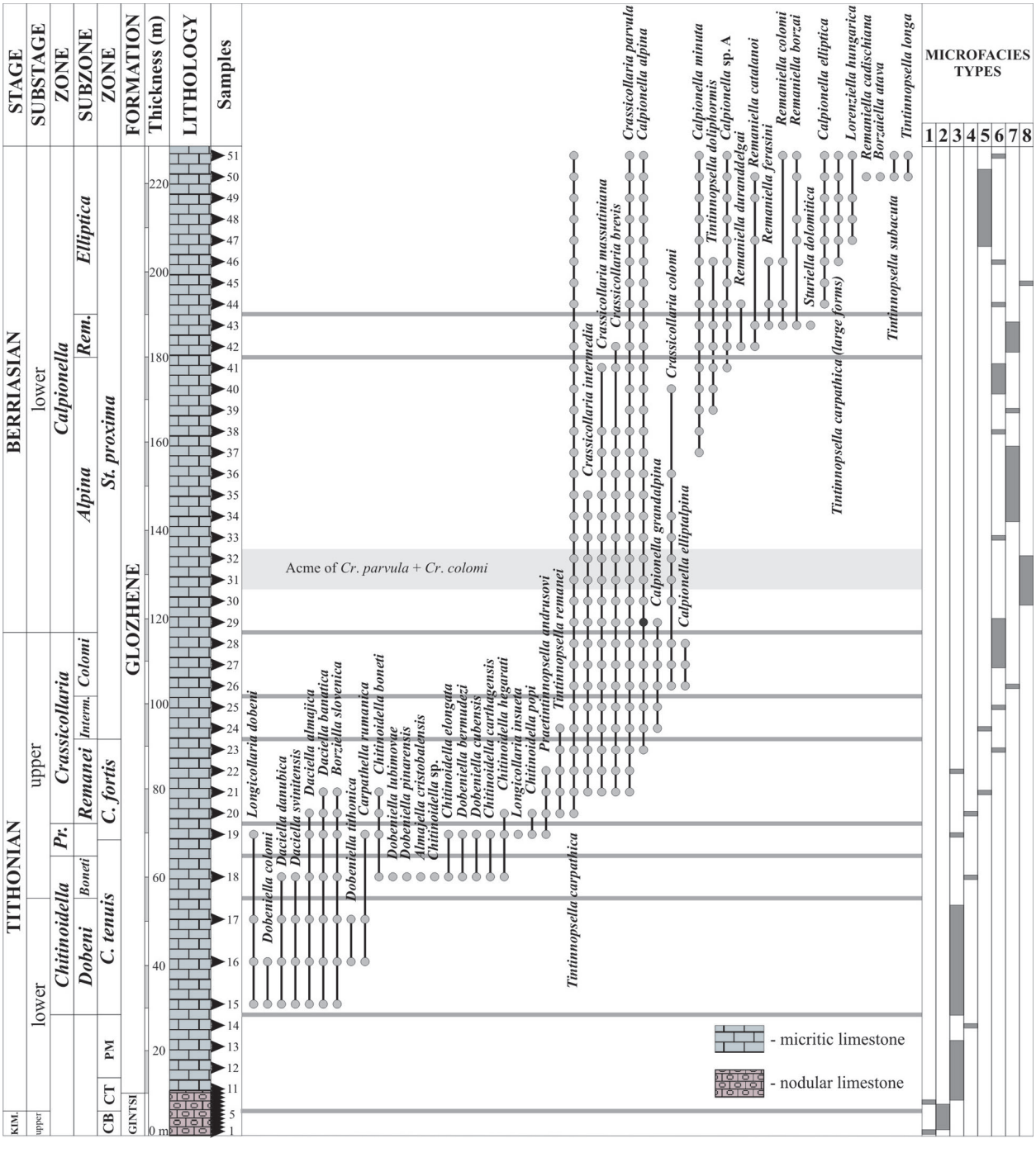

Fig. 1. Section Gorno Belotintsi – stratigraphy, geological column, range-chart of calpionellids and zonation, and microfacies distribution. Calcareous dinocyst zones of Ivanova et al. (2006) are also included in the lower Tithonian part: CB, *Colomispaera borzai* Zone, CT, *Colomishera tithonica* Zone, and PM, *Parastomiosphaera Malmica* Zone. Microfacies type vertical distribution is shown in the rightmost column: 1, *Saccocoma* wackestone; 2, *Saccocoma*-radiolarian wackestone; 3, *Globochaete alpina*-radiolarian wackestone; 4, *Globoshaete alpina*-pelecypod mudstone/wackestone; 5, *Globochaete alpina*-calpionellid mudstone/wackestone; 6, calpionellid mudstone/wackestone; 7, radiolarian-calpionellid mudstone/wackestone; 8, calpionellid-radiolarian mudstone/wackestone.

ized by various amounts of radiolarians and calpionellids (calpionellid-radiolarian, calpionellid, radiolarian-calpionellid). Finally, at the end of the early Berriasian (*Calpionella* Zone, *Elliptica* Subzone), only *Globochaete alpina*-calpionellid mudstones and wackestones were formed (MFT 8).

Conclusion

Detailed calpionellid biostratigraphic and microfacies results from the section Gorno Belotintsi in the Western Fore-Balkan of Bulgaria proved the presence of four zones and eight subzones, as well as eight microfacies in a continuous succession of pelagic carbonates. The described stratigraphic microfacies are typical for the deep-water marine environments of the northnern passive Tethyan margin. The Gorno Belotintsi section is unique in its remarkably high rate of sedimentation in the Tethyan Realm for the upper Tithonian and the lower Berriasian. This contribution of basic stratigraphy and sedimentology is a background for further specialized investigations, e.g., cyclostratigraphy, magnetostratigraphy, and geochemistry**.**

References

Benzaggagh, M., F. Cecca, I. Rouget, 2010. Biostratigraphic distribution of ammonites and calpionellids in the Tithonian of the internal Prerif (Msila area, Morocco). – *Paläontol. Z.*, *84*, 2, 301–315; https://doi.org/10.1007/s12542-009-0045-1.

Boughdiri, M., H. Sallouhi, S. Haddad, F. Cordey, M. Soussi. 2009. Integrated biostratigraphy and regional correlations of Upper Jurassic–lowermost Cretaceous series in northern Tunisia. – *GFF*, *131*, 1, 71–81; https://doi.org/10.1080/11035890902847763.

Dunham, R. J. 1962. Classification of carbonate rocks according to depositional texture. – In: Ham, W. E. (Ed.), *Classification of Carbonate Rocks*. AAPG, Tulsa, 108–121; https://doi.org/10.1306/M1357.

Flügel, E. 2004. *Microfaceis of Carbonate Rocks*. Springer, 976 p.; https://doi.org/10.1007/978-3-662-08726-8.

Grabowski, J., I. Lakova, P. Schnabl, K. Sobien, S. Petrova. 2014. Berriasian bio- and magnetostratigraphy and magnetic susceptibility of the Barlya section (Western Balkan Unit, Bulgaria) – preliminary results. – *Volumina Jurassica*, *12*, 1, 185–194.

Ivanova, D., E. Koleva-Rekalova, I. Lakova, L. Metodiev. 2006. Callovian to Berriasian pelagic carbonates in the Western Fore-Balkan, Bulgaria: microfacies, ammonite and microfossil zonations. – *Volumina Jurassica*, *4*, 175–177.

Lakova, I., S. Petrova. 2013. Towards a standard Tithonian to Valanginian calpionellid zonation of the Tethyan Realm. – *Acta Geol. Pol., 63*, 2, 201–221; http://dx.doi.org/10.2478/apg-2013-0008.

Lakova, I., K. Stoykova, D. Ivanova 1999. Calpionellid, nannofossil and calcareous dinocyst bioevents and integrated biochronology of the Tithonian to Valangian in the Western Balkanides, Bulgaria. – *Geol. Carpath*., *50*, 2, 151–168.

Ölveczká, D., D. Reháková. 2022. Upper Tithonian *Crassicollaria* Zone: new data on the calponellid distribution and subzonal division of the Pieniny Klippen Belt in Western Carpahians. – *Acta Geologica Slovaca*, *14*, 1, 37–56.

Petrova, S., E. Koleva-Rekalova, D. Ivanova, I. Lakova. 2019. Bistratigraphy and microfacies of pelagic carbonate formations (Tithonian–Berriasian), Western Balkan Mts, Bulgaria. – *Geologica Balc*., *48*, 2, 51–73; https://doi.org/10.52321/GeolBalc.48.2.51.

Pop, G. 1994. Calpionellid evolutive events and their use in biotratgraphy. – *Romanian J. Stratigraphy*, *76*, 7–24.

Wimbledon, W. A. P., D. Reháková, A. Pszczółkowski, C. E. Casellato, E. Halásová, C. Frau, L. G. Bulot, J. Grabowski, K. Sobień, P. Pruner, P. Schnabl, K. Čížková. 2013. An account of the bio- and magnetostratigraphy of the Upper Tithonian–Lower Berriasian interval at Le Chouet, Drôme (SE France). – *Geol. Carp*., *64*, 437–460; https://doi.org/10.2478/geoca-2013-0030.