



## Berriasian and Valanginian calpionellids from the Ticha Formation of the East Fore-Balkan (Bulgaria)

### Бериаски и валанжински калпионелиди от Тичанската свита в Източния Предбалкан (България)

*Silviya Petrova, Lubomir Metodiev*  
*Силвия Петрова, Любомир Методиев*

Geological Institute, Bulgarian Academy of Sciences, 1113 Sofia; E-mail: silviya\_p@geology.bas.bg; lubo@geology.bas.bg

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#### Introduction

This review is based on a new biostratigraphic study of the exposures of the Ticha Formation from the East Fore-Balkan. More than 80 samples were studied that allowed us to indicate three calpionellid zones and four subzones from the Upper Berriasian to Valanginian, briefly described here. The sampling for calpionellids was jointed with the collection of ammonites that has led to the receiving of many specimens, but the ammonites will be published elsewhere. This is the first authentic record of the calpionellid successions in the Ticha Formation, from the area between the rivers Luda Kamchia and Armera. These data are useful in dating of the Lower Cretaceous sedimentary rocks and further understanding of formation of the Young Alpine structures of this region.

#### Geological setting and previous studies

The study area includes the eastern parts of the Predjanska anticline (see Vangelov, Sinnyovsky, 2007). Generally, this is a regional structure that is composed of varied Upper Cretaceous-Paleogene rocks, lying unconformably upon the Lower Cretaceous sediments. The latter are represented by the Kamchia and the Ticha Formations. The Kamchia Formation displays a wider distribution in the region, and consists of marls with rare sandstone beds with graded bedding, spanning from the Hauterivian to the Barremian (Nikolov, 1962). It grades from below from the Ticha Formation, which is composed of 100 to 200 m thick irregularly alternating marls, clayey and micritic limestones and rare calcareous siltstones and sandstones. The Ticha Formation crops out as a narrow and fragmented strip of intensively folded successions, with W–E trend, S and SE of the Tsonevo dam.

The first investigation on the rocks and the ammonite faunas of the Ticha Formation in the studied area

was made by Nikolov (1960, 1962). The ammonite record defined the age of the formation as Berriasian–Valanginian. At that time, Atanasoff (1961) obtained scattered calpionellid data from the same exposures of the formation. Three species were recorded and attributed to the Berriasian: *Tintinnopsella carpathica* (Murgeanu & Filipescu), *Calpionella alpina* Lorenz and *C. elliptica* Cadisch. Soon after, Mihailova-Yovcheva and Trifonova (1967) reported Late Jurassic–Early Cretaceous foraminifera from the Ticha Formation of borehole drilled in an adjacent region to the studied area. Bakalova (in Sapunov et al., 1986) defined calpionellid zones in the borehole sections throughout the Ticha Formation, from Provadia region (NE of the studied area). The total extent of these zones was from the Tithonian to the Lower Berriasian, and included the *Chitinoidella*, *Crassicollaria* and *Calpionella* Zones (with *C. alpina* Subzone). More recently, Ivanova et al. (2002) restudied some of the sections of Sapunov et al. (1986) and continued the calpionellid evidence up to the Valanginian. Using the zonal scheme proposed by Lakova et al. (1999), the record of these authors covered six calpionellid zones and seven subzones, from the *Chitinoidella* to the *Tintinnopsella* Zone, and the total chronostratigraphic extent of the Ticha Formation was evaluated as Late Callovian–Late Valanginian (Ivanova et al., 2002).

#### Results and discussion

Five profiles throughout the Ticha Formation were carefully measured and sampled. From the west to the east they are: WSW of the Asparuhovo village, in Razkrachenitsa, Kozia Reka, Dodelen, and Armera River valleys. The indicated calpionellid zones are: *Calpionellopsis* Zone (Upper Berriasian), *Calpionelites* Zone (Lower Valanginian) and *Tintinnopsella* Zone (Upper Valanginian).

**Calpionellopsis Zone.** The zone corresponds to the upper part of the Upper Berriasian. It is represented by the *Oblonga* and *Murgeanui* Subzones. Both subzones were indicated by the occurrences of the index-species *Calpionellopsis oblonga* (Cadisch) and *Praecalpionellites murgeanui* (Pop), as well as by several associated species: *Calpionellopsis* sp. A, *Calpionellopsis simplex* (Colom), *Calpionella minuta* Houša, *C. alpina*, *Lorenziella hungarica* Knauer & Nagy, *Lorenziella plicata* Remane, *T. carpathica*, *Tintinnopsella longa* (Colom), *Tintinnopsella subacuta* (Colom), *Remaniella borzai* Pop, *Remaniella catalanoi* Pop and *Remaniella filipescui* Pop. The *Oblonga* Subzone was indicated in the rivers KoZIA Reka (2 outcrops), Dodelen (8 exposures) and Armera ("Trite Kladentsi" locality). The *Murgeanui* Subzone was evidenced in one outcrop of the river Dodelen.

**Calpionellites Zone.** This zone matches with the Lower Valanginian. It was indicated in the outcrops along the Razkrachenitsa River valley. The zone consists of the *Darderi* and *Major* Subzones. The *Darderi* Subzone was documented in one sample only, the calpionellid association including the index-species, *Calpionellites darderi* (Colom), together with *L. hungarica*, *L. plicata*, and *T. carpathica*. The *Major* Subzone was evidenced in four samples by the co-occurrence of the index-species *Calpionellites major* (Colom), and several other species: *Calpionellites caravacaensis* Allemann, *Calpionellites coronatus* Trejo, *L. hungarica*, *L. plicata*, *T. longa*, *T. subacuta*, and *T. carpathica*.

**Tintinnopsella Zone.** The zone corresponds to the Upper Valanginian. It was indicated in the outcrops WSW of the Asparuhovo, as well as in the rivers Razkrachenitsa and Armera. The calpionellid association is dominated by *T. carpathica*. Rare specimens of *Tintinnopsella dacica* Filipescu & Dragastan, *T. subacuta*, *T. longa*, *L. hungarica*, *L. plicata*, and single examples of the genera *Praecalpionellites* and *Remaniella* also occur.

Being intensively folded, somewhere trusted and progressively isolated from each other from the west to the east, the outcrops of the Ticha Formation were considered difficult for biostratigraphy and correlation. However, every sample yielded calpionellids and

enabled us to understand that the age of the formation varies from Late Valanginian westward to Late Berriasian eastward. The oldest exposures were located in the rivers KoZIA Reka and Dodelen, and in the locality "Trite Kladentsi". That agrees with the previously obtained evidence (Nikolov, 1960, 1962). Atanassoff (1961) recorded Lower Berriasian in the Dodelen River exposures, but our record did not confirm that. Westwards the KoZIA Reka, the outcrops of the Ticha Formation were found to be of Valanginian age.

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