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Callovian to Lower Cretaceous pelagic carbonates in the West Balkan Mountains (Komshtitsa and Barlya sections): integrated biostratigraphy and microfacies

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И. Лакова, П. Чумаченко, Д. Иванова, Е. Колева-Рекалова – Объединенная биостратиграфия и микрофации кэлловейских-нижнемеловых пелагических карбонатов Западнобалканской единицы (разрезы Комштица и Бырля). Юрская система в западной части Балканских гор привлекла внимание первых исследователей болгарской геологии и стратиграфии более 100 лет тому назад. В результате интенсивных полевых, палеонтологических и биостратиграфических исследований осуществилось литостратиграфическое и биостратиграфическое расчленение верхнеюрских-нижнемеловых пелагических карбонатных пород в Издремецской синклинали. Благодаря исследованиям И. Сапунова, И. Начева, Т. Николова, Г. Мандова и других специалистов в 60-ых и 70-ых годах 20-ого века в регионе были установлены все ярусы – с кэлловейского до готеривского. Объединенное микропалеонтологическое зонирование титонского, берриассового и валанжинского ярусов является результатом исследований И. Лаковой, К. Стойковой и Д. Ивановой. В последнее время П. Чумаченко расчленил разрезы Комштица и Бырля на секвенции второго и третьего порядка.

В предлагаемой работе представлена синтетическая стратиграфическая картина кэлловейской-валанжинской карбонатной последавотельности в разрезах Комштица и Бырля Западнобалканской тектонической единицы. Картина дополнена микропалеонтологическими данными и данными о микрофациальной принадлежности. Зоны, выделенные в верхнеюрской серии по диноцистам, скоррелированы с аммонитными зонами Яворецкой, Гинской и Гложенской свит. В работе обсуждаются биостратиграфические критерии, по которым проведены нижние границы ярусов (с кэлловейского до валанжинского). Выделено шесть последовательных микрофаций: филаментная, Globigerina-радиолярийная, Saccocoma, Gobochaete, калпионельная и спикульная.

Abstract. The Jurassic System in the West Balkan Mountains attracted the attention of the first scholars of geology and stratigraphy in Bulgaria F. Toula and V. Zlatarski more than 100 years ago. The intense field, palaeontological and stratigraphical studies of the Upper Jurassic and Lower Cretaceous pelagic carbonates in the Izdremets Syncline led to the lithostratigraphic subdivision and establishment of all stages from the Callovian to the Hauterivian as a relust of publications of I. Sapunov, I. Nachev, T. Nikolon and G. Mandov in the 60s and 70s of the last century. An integrated micropalaeontological zonation of the Tithonian, Berriasian and Valanginian was elaborated by I. Lakova, K. Stoykova and D. Ivanova. Recently, P. Tchoumatchenco divided the sections at Komshtitsa and Barlya into second- and third-order sequences.

The subject of this paper is a synthesis of the existing stratigraphic knowledge of the Callovian to Valanginian pelagic carbonate succession at the sections of Komshtitsa and Barlya in the West Balkan tectonic unit, as well as a correlation with new micropalaeontological and microfacial results. A zonation on calcareous dinocysts for the Upper Jurassic is here presented and correlated to the ammonite zones in the Yavorets, Gintsi and Glozhene Formations. The used biostratigraphical criteria of determination of the stage boundaries (Callovian to Valanginian) are discussed. Six successive microfacies are determined and described: filamentous, *Globuligerina*-radiolarian, *Saccocoma, Globochaete*, calpionellid and spicule.

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Key words: Upper Jurassic, Lower Cretaceous, West Balkan, biostratigraphy, microfacies.

Introduction

The pelagic carbonate succession of the Upper Jurassic and Lower Cretaceous at Komshtitsa and Barlya sections is included in a 80–100 km long band of east-west orientation in the West Balkan Mountains (Izdremets Syncline) and belongs to the West Balkan Unit according to the recent Alpine tectonic division of Bulgaria (Dabovsti et al., 2002). Tchoumatchenco, Sapunov (1984) proposed palaeogeographical reconstruction of the Jurassic sedimentary basins in Bulgaria. Сапунов и др. (1988) considered that the Late Jurassic pelagic sedimentation of the Izdremets syncline occurred in the Izdremets Basin (southern part of the Central Moesian Basin). The boundaries of the Izdremets Basin are to the north-east with Vratza Horst, to the south-west – with Dragoman Horst and to the south-east with the Nish-Troyan flysch trough. To the west, the Izdremets Basin continued on the territory of East Serbia (Tchoumatchenco et al., 2006a, b). Tchoumatchenco (2006) included the studied succession to the Jurassic Izdremets Graben Unit.

The purpose of this paper is to summarise and integrate previous biostratigraphic data on the Callovian to Valanginian in the sections of Komshtitsa and Barlya (Fig. 1), scattered in separate publications, and to complete them with new results concerning the Upper Jurassic calcareous dinocyst zonation and its correlation with the ammonite zonation, sedimentological and microfacial studies which will serve as a basis of determination of 2nd and 3rd order transgressive-regressive cycles.

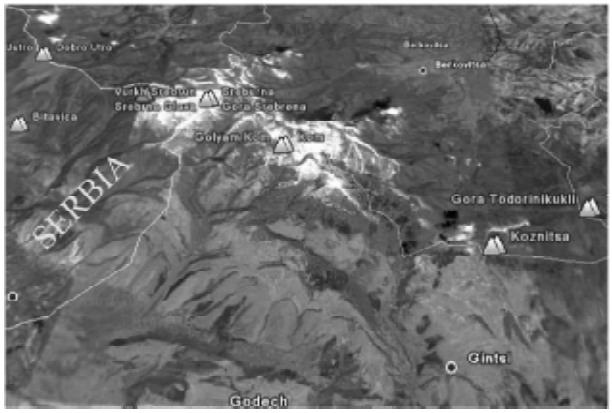

Fig. 1. Distribution of the Callovian — Lower Cretaceous carbonates in the West Balkan Mts and location of the sections studied

Previous research

The first stratigraphic notes on Jurassic rocks in the Izdremets Syncline (the area of Gintsi, Komshtitsa and Barlya) are from Toula (1878). Toula (1882) reported Oxfordian and Kimmeridgian fossils from the area. Златарски (1908) provided descriptions of the occurrence, subdivision and the faunal content of the Jurassic System. Каменов (1934) described Kimmeridgian ammonites from the section of Komshtitsa.

The modern palaeontological, biostratigraphical and sedimentological studies of the pelagic Upper Jurassic in the Izdremets Syncline started in 1959 with the regional descriptions and mapping, introduction of informal lithostratigraphic units, ammonite description and determination of the all Jurassic stages (Начев, Сапунов,1959; Сапунов, Начев, 1959). These authors defined a "Marl-Limestones Series (=Bov Formation) of Bathonian age and a "Limestones Series" of Callovian to early Cretaceous age which corresponds to West Balkan Carbonate Group (Yavorets + Gintsi + Glozhene Formations). They described a sharp lithological boundary between the Bathonian and Callovian and the presence of the Lower Callovian ammonites *Macrocephalites macrocephalus* and *M. herveyi* immediately above this boundary in the section of Komshtitsa.

Стефанов (1959) reported ammonites of the genus *Hybonoticeras* from the "Kimmeridgian" in Komshtitsa section.

After the introduction of formal lithostratigraphy of the Upper Jurassic pelagic sediments in Bulgaria (Николов, Сапунов, 1970), the West Balkan Carbonate Group and its triple subdivision — Yavorets, Gintsi and Glozhene formations, were also recognized in the Izdremets Syncline. Sapunov (1976a) and Sapunov, Ziegler (1976) described the Upper Jurassic sections of Gintsi and Komshtitsa and their ammonite successions.

The 70th of the last century saw a synthesis of the Upper Jurassic ammonite biostratigraphy in Bulgaria. The ammonite zonations of the Oxfordian, Kimmeridgian and Tithonian were established by Sapunov (1976a, b; 1977a, b). In the section of Komshtitsa, the ammonite zonation includes: *Antecedens* and *Bifurcatus* zones (Oxfordian), *Eudoxus* and *Beckeri* zones (Kimmeridgian), *Hybonotum, Vimineus* and *Ponti* zones (Lower Tithonian), *Microcanthus* subzone (Upper Tithonian) and *Jacobi* subzone (Lower Berriasian). Сапунов (1979) in the "Fossils of Bulgaria. Upper Jurassic Series" described and illustrated the ammonite finds.

In the Lower Cretaceous sediments (Salash Formation) of the Izdremets and Gubesh synclines, Мандов (1971, 1976) studied the ammonite successions and established the Berriasian, Valanginian and Hauterivian Stages. In the section of Komshtitsa, the ammonite zone *Boissieri* (Upper Berriasian) was recognized. Upwards, representatives of the genera *Kilianella* and *Thurmaniceras* proved the Lower Valanginian and ammonites of the genus *Verrucosum* - the Upper Valanginian.

In connection with the determination of the Jurassic-Cretaceous boundary, Bakalova (1977) introduced Tithonian to Valanginian calpionellid zonation of five zones in the section of Gintsi.

The next stage of the stratigraphic study of the Upper Jurassic and Lower Cretaceous pelagic carbonate sequence in Komshtitsa and Barlya sections (mid-90s of the last century) included multidisciplinary approach: micropalaeontology and zonations on calpionellids, calcareous dinocyst and calcareous nannofossils, sedimentology and microfacies, as well as sequence stratigraphic analysis. The field studies in the sections of Komshtitsa and Barlya were undertaken in the framework of a joint Bulgarian-French Project 95-96/75 funded by the international Peri-Tehyan Program.

The zonations on calpionellids (Lakova, 1993, 1994) and nannofossils (Стойкова, 1995) revealed the potential of the pelagic calcareous microfossil in the detailed subdivision of the Upper Jurassic and Lower Cretaceous. Later, an integrated calpionellid-nannofossil-calcareous dinocyst zonation was established for the Tithonian, Berriasian and Valanginian in the section of Barlya (Lakova et al., 1997, 1999).

The lithostratigraphy and ammonite biostratigraphy of the Jurassic System in the section of Komshtitsa were summarized by Tchoumatchenco et al. (2001) who proposed the section as a protected palaeontological and stratigraphical site. Tchoumatchenco et al. (1997) attempted a definition of 3rd and higher order depositional sequences in Komshtitsa section. The cyclostratigraphy (Thoumatchenco, 2002) includes bundles of beds with periodicity of 34–47 Ky for the Callovian to Lower Tithonian interval (obliquity Milankovich cycles) and couplets in the Upper Tithonian and Lower Berriasian sediments with periodicity of 15–25 Ky (precessional Milankovitch cycles).

Reconstructing the evolution of the Jurassic sedimentary basin development in north-west Bulgaria, Сапунов и др. (1988) considered that the pelagic Callovian and Upper Jurassic micritic and clayey nodular limestones with ammonites of the Izdremets Syncline (about 70 m thick) deposited in a deep epibathyal environments, the depths varying between 100 and 600 m.

Stoykova, Ivanova (2000, 2001) revealed a possible relationship between calcareous microplankton occurrence and eustatic sea-level changes in Barlya section. Quantitative analyses of the nannoplankton and calcareous dinocyst species diversity and relative abundance were correlated with general trends of long-term sea-level changes (2-nd order). For example, relatively high stand of sea level at the Mid Tithonian, followed by gradual drop around the Jurassic-Cretaceous boundary, relative high stand at the Mid Berriasian and fall of the sea level in Early Valanginian are clearly documented on the graphs. The short-term (3-rd order) eustatic cycles also can be recognized. Maximal values of the species diversity and abundance generally reflect maximal rise of the sea level in the long-term cycles and /or maximum flooding surfaces in the short-term cycles.

Material

The sampling levels at Figs 2 and 3 correspond to the numbers of thin-sections for both micropaleontological and sedimentological studies. Thus, the chronostratigraphic interval of each microfacies is precisely determinated. The sampling density is about 2 m in the Yavorets and Gintsi formations, 1 m in the Glozhene Formation and 5 m in the Salash Formation. The lithostratigraphic subdivision and the ammonite zones in Fig. 1 follow the description of Sapunov (1976a, b; 1977a, b) completed with data in Tchoumatchenco et al. (2001).

Lithostratigraphy and ammonite zonation in the sections of Komshtitsa and Barlya

The studied Upper Jurassic and Lower Cretaceous interval of pelagic micritic limestones, clayey and nodular limestones and marls was subdivided into the following formal lithostratigraphic units from the base upwards: Yavorets Formations, Gintsi Forma-

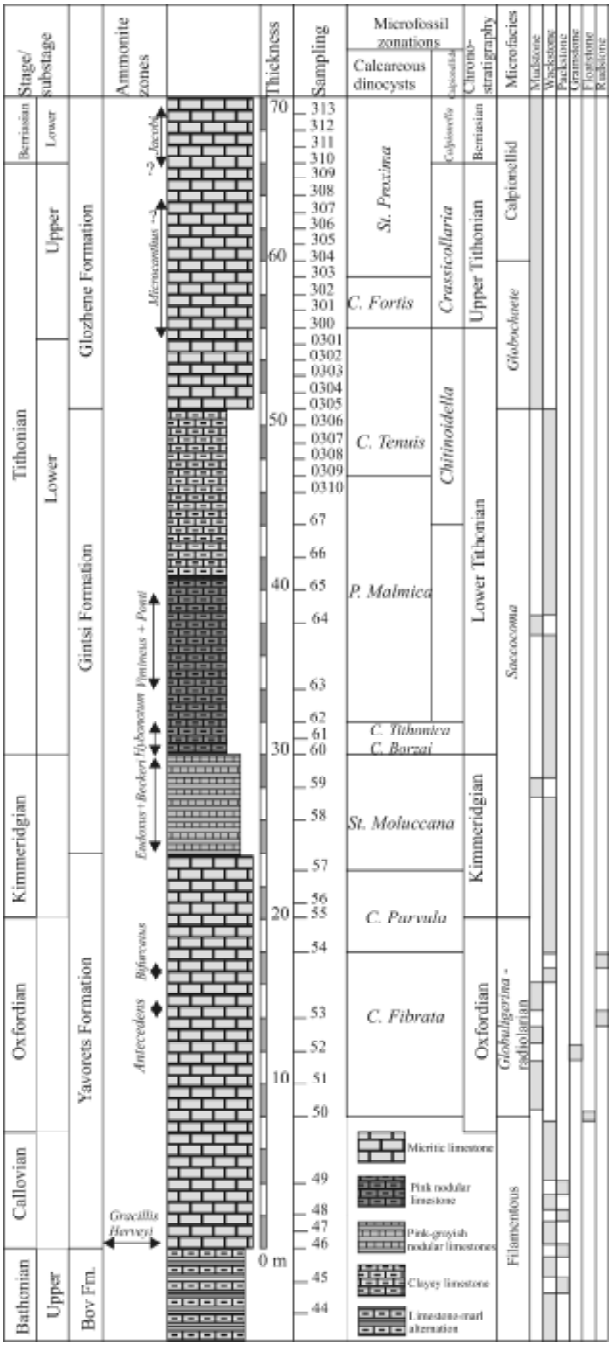

Fig. 2. Lithostratigraphy and ammonite biostratigraphy of the Callovian and Upper Jurassic in Barlya section (after Sapunov 1976a, b; Sapunov 1977a, b) correlated with calcareous dinocyst zones and microfacies (this study)

tion, Glozhene Formation and Salash Formation. Downwards, the Bov Formation represents the hemipelagic development. The boundaries between the formations are conformable representing fast lithological transitions. The only exception is the sharp boundary between the Bov and Yavorets Formations as a result of short-time break of sedimentation.

Bov Formation (Сапунов, 1969). It represents an alternation of limy marls and clayey limestones, intercalated in the middle part by the limy sandstones of the Dobrogled Member of the Polaten Formation. Above the sandstone packet, the ammonite *Retrocostatum* Zone indicates a Late Bathonian age. The stratigraphic range is Upper Bajocian to Upper Bathonian. The total thickness is 20 m.

Yavorets Formation (Николов, Сапунов, 1970). This formation is characterised by grey micritic limestones and intraclastic limestones. At the base, there is a condensed level of bioclastic clayey limestones, rich in ammonites. Начев, Сапунов (1959) reported ammonites from the lowermost Callovian *Macrocephalites herveyi* Zone from the base of Yavorets Formation. J. Thierry in Tchoumatchenco et al. (2001) determinated ammonites of the *Michalskii* Subzone of *Gracilis* Zone – the upper zone of the Lower Callovian. The ammonite *Antcedens* (Middle Oxfordian) and *Bifurcatus* Zones (Upper Oxfordian) were determined in superposition in the upper part of the formation. The formation spans the stratigraphic interval of Callovian, Oxfordian and lower part of Kimmeridgian. The thickness varies from 18 to 24 m in the sections of Barlya and Komshtitsa.

In the section of Gintski Venets (30 km to the east of Komshtitsa) Belivanova, Sapunov (2003) reported the uppermost Bathonian *Discus* Zone from the Bov Formation and the Lower Callovian ammonite *Macrocephalites cannizzaroi* from the base of the Yavorets Formation. Thus, the duration of sedimentational break was too short to be determined with biostratigraphical methods. In Komshtitsa section, however, the uppermost Bathonian *Discus* Zone is absent and the sedimentational break is related to the latest Bathonian.

Gintsi Formation (Николов, Сапунов, 1970). The formation consists of pink and gray clayey limestones of nodular aspect. The lower packet is an alternation of clayey and micritic limestones, the middle packet consists of pink nodular clayey limestones extremely rich in ammonites of *ammonitico rosso* type and the third packet represents predominantly gray nodular limestones without ammonites. A continuous zonation was established across the Kimmeridgian-Tithonian boundary in the first and second packets: *Eudoxus* and *Beckeri* Zones (upper part of the Kimmeridgian), *Hybonotum, Vimineus* and *Ponti* Zones (Lower Tithonian). The stratigraphic range is middle part of Kimmeridgian to Lower Tithonian. The thickness is 25–30 m. In the section of Gintsi, the lower part of the Gintsi Formation includes the ammonite *Divisum* and *Crussiloceras*/*Sesquinodosum* Zones (middle part of the Kimmeridgian) (Sapunov, 1976b).

Glozhene Formation (Николов, Сапунов, 1970). It is characterized by hard grey micritic medium-bedded limestones. Ammonites are very scarce. However, *Transitorius* Zone was established in the lowermost 23 m. This zone is divided into two subzones: *Microcanthus* Subzone (Upper Tithonian) and *Jocobi* Subzone (lowermost Berriasian). Thus, the Jurassic-Cretaceous boundary was traced in the lower part of the Glozhene Formation to coincide with the

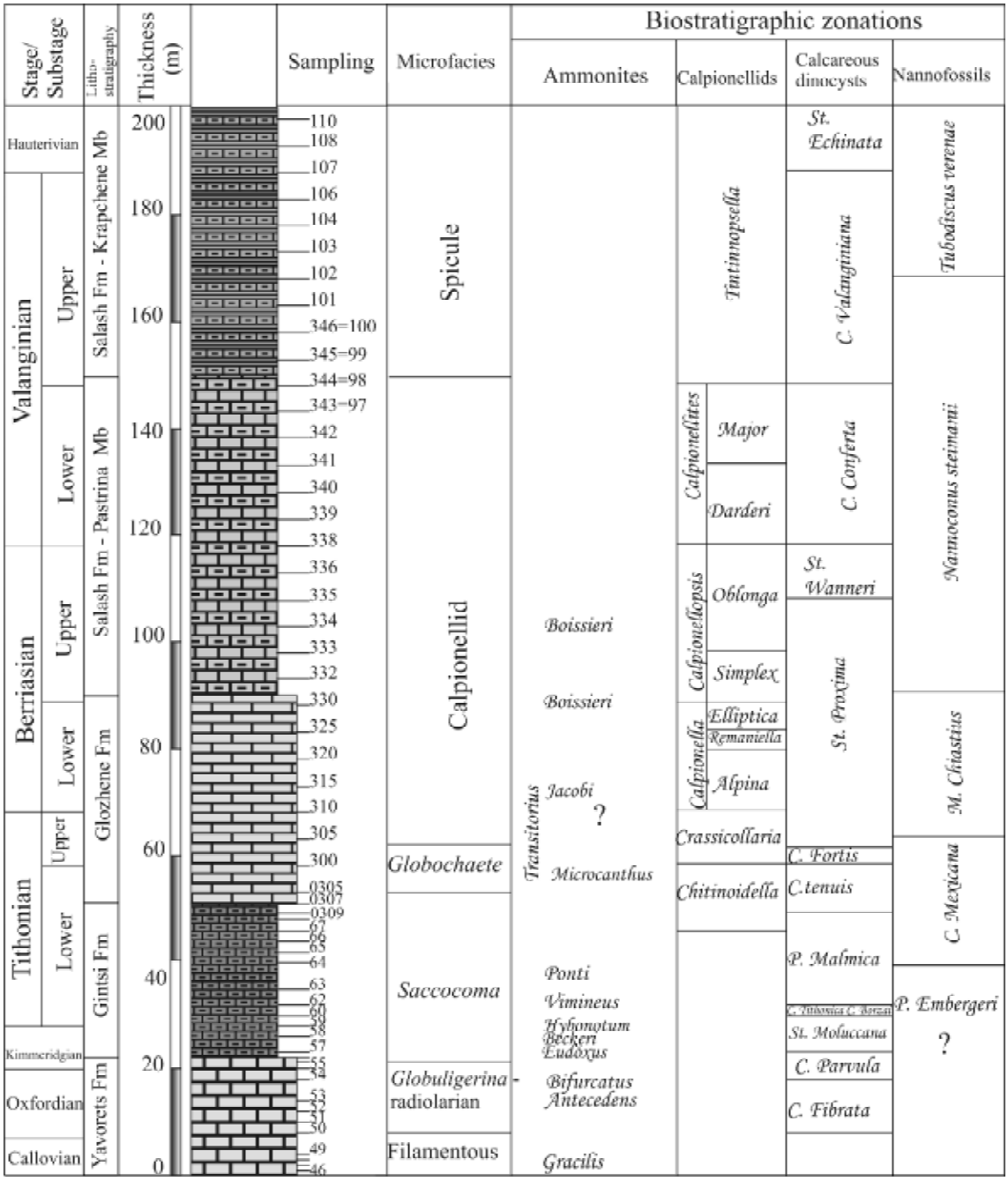

Fig. 3. Integrated ammonite and microfossil zonations of the Callovian and Valanginian in the section of Barlya

first occurrence of *Beriassella jacobi*. Calpionellids zonation confirms this position of the system boundary at the base of *Calpionella* Zone (sample 310). The stratigraphic range is Lower Tithonian to Lower Berriasian. The thickness is 39 m.

Salash Formation (Nikolov, 1969, Николов, Цанков, 1971). It represents an alternation of thin-bedded grey micritic limestones and clayey limestones in the lower part. This part is to be attributed to the Pastrina Member as defined by (Монов, Николов, 1991). Ammonite finds allowed Мандов (1971) to recognise the Upper Berriasian (*Boissieri* Zone) and Lower Valanginian. Diverse calpionellids, calcareous nannofossils and calcareous dinocyst gave ground to elaborate joint microfossil zonations (Lakova et al., 1997, 1999). The Berriasian-Valanginian boundary is traced at 28 m above the lower boundary of the Salash Formation at the first occurrences of *Calpionellites darderi* and *Colomisphaera conferta*. The stratigraphic range of the Pastrina Member covers the Upper Berriasian and Lower Valanginian, the thickness being 60 m.

The upper part of the Salash Formation is made up by alternation of thin-bedded clayey limestones and marls very rich in ammonites - Krapchene Member as defined by Монов, Николов (1991). Мандов (1971) determined the Upper Valanginian on ammonites. The subdivision on nannofossils and calcareous dinocysts (Stoykova and Ivanova in Lakova et al., 1999) suggests that the Valanginian/Hauterivian boundary is probably traced some 40–50 m above the base of the Krapchene Member which is supported by the find of *Crioceratites* sp. at level of sample 107 determined by T. Nikolov. Although the post-Valanginian part of the Salash Formation is not included in this study, it should be mentioned that the upper part of the Salash Formation is of Hauterivian and early Barremian age. The thickness of the Upper Valanginian – Lower Hauterivain part of the Krapchene Member is about 60 m.

Microfossil zonations

The Tithonian, Berriasian and Valanginian in the Barlya section were subdivided on the basis of calpionellids, calcareous dinocysts and nannofossils (Lakova et al., 1999). Joint study of the three microfossil groups led to an integrated zonation (Fig. 3). Newly obtained calcareous dinocyst zonation of the Oxfordian and Kimmeridgian in Barlya section is here presented and is integrated with the ammonite zonation of Sapunov (1976a; 1977a, b).

The calcareous dinocyst zonal subdivision of the Oxfordian, Kimmeridgian Tithonian is useful in determination of the stage and substage boundaries (Fig. 2). In this study, *Colomisphaera fibrata* Zone (Lower Oxfordian to lower part of Upper Oxfordian) is established in the middle-upper part of the Yavorets Formation (sample levels 50–54) and correlates with the ammonite *Antecedens* and *Bifurcatus* Zones (Sapunov, 1976 a).

Upwards, *Cadosina parvula* Zone (spanning the Oxfordian-Kimmeridgian boundary interval) occurs in the uppermost part of the Yavorets Formation within grey micritic limestones barren of ammonites (sample levels 54–56). Thus, the Oxfordian-Kimmeridgian boundary is to be traced within this level.

Stomiosphaera moluccana Zone (Lower and Middle Kimmeridgian) occurs in the interval between levels 57–59 in the lower and middle packets of the Gintsi Formation. It corresponds to *Eudoxus* and *Beckeri* ammonite zones of the upper part of Kimmeridgian. There is a discrepancy, however, between the ammonite and calcareous dinocysts age determination.

Carpistomiosphaera borzai and *Carpistomiosphaera tithonica* Zones (sample levels 60–62), corresponding to the Upper Kimmeridgian – Lower Tithonian, occur in the *ammonitico rosso* part of the Gintsi Formation. This interval correlates with the Lower Tithonian *Hybonotum* Zone.

The Lower Tithonian calcareous dinocyst zones *Parastomiosphaera malmica* (sample levels 62–0309) and *Colomisphaera tenuis* (sample levels 0309–300) are established in superposition in the upper part of Gintsi Formation and in the lower part of Glozhene Formation. The lower boundary of the Tithonian, defined at the base of the ammonite *Hybonotum* Zone, passes within *St. mollucana* Zone which is normally of Kimmeridgian age.

Upwards, the calpionellid zones and subzones of the Upper Tithonian, Berriasian and Lower Valanginian in the section of Barlya provide evidence of tracing the chrionostratigraphic boundaries (Fig. 2): the base of *Crassicollaria* Zone – the Lower-Upper Tithonian boundary, the base of *Calpionella* Zone – the Tithonian-Berriasian boundary, the base of *Calpionellopsis* Zone – the Lower-Upper Berriasian boundary, and the base of *Calpionellites* Zone – the Berriasian-Valanginian boundary. The position of the Valanginian/Hauterivian boundary still remains unclear as the calcareous dinocyst *St. echinata* Zone and the nannofossil *T. verenae* Zone occur in the Upper Valanginian and the Lower Hauterivian.

Stages and stage boundaries

The ammonite and microfossil zonations of the Callovian to Valanginian pelagic carbonates in the sections of Barlya and Komshtitsa has allowed the definition of the lower stage and substage boundaries in accordance with the definition of the Geological Time Scale (Gradstein et al., 2004).

Callovian. The age determination of the beginning of the pelagic sedimentation (Yavorets Formation) is difficult due to a presence of a condensed "lag deposits" and ammonite breccia. Nevertheless, the lowermost 2–5 m of the Yavorets Formation were assigned to the Lower Callovian *Herveyi* and *Gracilis* Zones in Komshtitsa section (Nachev, Sapunov, 1959, Tchomatchenco et al., 2001). In the section of Gintsi, Sapunov (in Начев, Сапунов, 1959) reported ammonites of the genus *Hecticoceras* of Late Callovian age from the Yavorets Formation.

Oxfordian. The Callovian-Oxfordian boundary is traced tentatively in the middle part of the Yavorets Formation. The boundary passes somewhat lower than the base of *C. fibrata* Zone. The ammonite *Antecedens* and *Bifurcatus* Zones prove the Middle and Upper Oxfordian.

Kimmeridgian. The base of the Kimmeridgian Stage is here determinated within the *C. parvula* Zone at sample level 55 about 2 m below the top of the Yavorets Formation. The ammonite *Eudoxus* and *Beckeri* Zone from the lowermost part of the Gintsi Formation were assigned to the middle-upper parts of the Kimmeridgian.

Tithonian. The base of the Tithonian Stage is defined at the base of *Hybonotum* Zone between the ammonite-bearing packets 1 and 2 of pink nodular clayey limestones (*ammonitico rosso*) in the Gintsi Formation. *C. borzai* and *C. tithonica* Zones occur higher in the sample levels 60–62. According to the chronostratigraphic assignment of the Upper Juras-

sic calcareous dinocyst zonation (Ivanova, 1997, Rehakova, 2000) the Kimerridgian-Tithonian boundary passes within the *C. borzai* Zone. In Barlya section, however, there are certain discrepances between the position of the base of the Tithonian on ammonites (*Hybonotum* Zone) and on calcareous dinocysts (*C. borzai* Zone). The Lower-Upper Tithonian boundary passes at 5 m above the base of the Glozhene Formation (sample level 300) and is defined at the bases of the *Microcanthus* Subzone, *Crassicollaria* and *C. Fortis* Zones.

Berriasian. The system boundary between the Jurassic and Cretaceous is very well defined by the explosion of the medium-sized forms of *Calpionella alpina* (base of *Calpionella* Zone) at sample level 310, at 17 m above the lower boundary of the Glozhene Formation (Lakova, 1993, 1994). This level approximately coincides the base of *B. Jacobi* Subzone, the upper subzone of *Transitorius* Zone in Sapunov (1977b). The Lower-Upper Berriasian boundary is traced at the base of *Calpionellopsis* zone in the top of the Glozhene Formation

Valanginian. The base of the Valanginian is determinated at the coinciding bases of the *Calpionellites* and *C. conferta* Zones at level 338, about 28 m above the base of the Salash Formation (Pastrina Member). The Lower-Middle Valanginian boundary passes at the bases of *Tintinnopsella* and *C. valanginiana* microfossil zones (at level 344) and approximates the transition from more calcareous facies (Pastrinata member) to more clayey sedimentation (Krapchene member) within the Salash Formation.

The thicknesses of the established stages are as follows: Callovian – 7 m, Oxfordian – 13 m, Kimmeridgian – 8 m, Tithonian – 38 m, Berriasian – 50 m, Valanginian – about 70 m. The beginning of the deposition of pelagic micritic and intraclastic limestones is related to very low rate of sedimentation during the Callovian, Oxfordian and the beginning of the Kimmeridgian (average rates of sedimentation between 1.9 and 2.1 mm/Ky). Even the supply of bioclasts and limy mud from the carbonate platform in the Oxfordian (in *Globuligerina*-radiolarian microfacies) did not contribute to the formation of thicker sediments. The depositional rates considerably increase with the start of formation of the pink nodular ammonite-bearing limestones of Gintsi Formation and the micritic limestones of Glozhene Formation (average rates of sedimentation in the early Tithonian – 7.8 mm/Ky, in the late Tithonian – 6.0 mm/Ky, in the Berriasian – 9.4 mm/Ky). One possible explanation is the general increase of $CaCO_3$ and carbonate accumulation rates (abundant nannoliths, prolific carbonate production on platforms and reefs) in the Tithonian and Berriasian of the Tethyan Realm (Tremolada et al., 2006). The accumulation of thick limestone-marl alternation sequence during the late Berriasian and Valanginian (Salash Formation) was due to the increasing supply of clayey material from the proximal part of the basin and the average rate of sedimentation reached 18–19 mm/Ky.

Microfacies

Six successive microfacies have been recognised in the Callovian to Valanginian part in the section of Barlya on the basis of predominant microfossil content.

Filament microfacies (Bov and Yavorets Formations, Bathonian and Callovian) is characterized by the presence of *Bositra* shells. The filament content varies from 15 to 75% and limestones possess wackestone and packstone textures. The filament wackestones prevail over the packstones.

Globuligerina-radiolarian microfacies (Yavorets Formation, Oxfordian) with dominantly mudstone texture comprises mainly planktic foraminifers and calcitified radiolarians. In some places the mudstones are intercalated with thin limestone beds containing rounded lithoclasts without good sorting and gradation. Microscopically these clasts are represented by both micritic limestones embracing mostly calcified radiolarians and shallow-water peloidal limestones. The limestone beds contain also crinoidal and shell bioclasts, various types of algae, *Tubiphytes*, bryozoan fragments, benthic foraminifers, superficial ooids, cortoids, micritic peloids. All allochems are cemented by sparite mosaics. According to the sizes and amount of the bio- and lithoclasts the limestones are determined as grainstones, floatstones and rudstones. They represent grain and debris mass flows that accidentally interrupt pelagic sedimentation.

The characteristic component of *Saccocoma* microfacis (Gintsi Formation, Kimmeridgian and Lower Tithonian) are filaments and plates of *Saccocoma*. Macroscopically, most of the limestones of these microfacies display distinct nodular appearance. Microscopically, the limestones possess wackestone and rarely mudstone texture. Stylolites, dissolution seams and zones are common features.

Globochaete microfacies (lower part of Glozhene Formation, Lower-Upper Tithonian) is detached in accordance with the relative abundance of *Globochaete alpina* in limestones, although calcified radiolarians and rare calpionellids (in the upper part) also exists. The limestones are mostly mudstones.

Calpionellid microfacies (Glozhene and Salash Formations, Upper Tithonian, Berriasian and Lower Valanginian) is composed of limestones (predominantly mudstones) containing abundant calionellids.

Spicule microfacies (Salash Formation – Krapchene member, Upper Valanginian) is characterized by abundance of spicules and nannofossils and rare foraminifers. It developed with the decline of calpionellids.

Conclusions

The correlation of the ammonite and microfossil (calpionellids, calcareous dinocysts and nannofossils) zonations in the Yavorets, Gintsi, Glozhene and Salash Formation in the sections of Komshtitsa and Barlya is a background of determination the lower stage boundaries of the Callovian to Valanginian

according to the recent Geological Time Scale. Ammonite data are used to define the Bathonian-Callovian and Kimmeridgian-Tithonian boundary, and microfossil data – for all other stages. The lower stage boundaries are determinated as follows: Callovian – at the base *Herveyi* Zone, Oxfordian – close to the base of *C. fibrata* Zone, Kimmeridgian – within the *C. parvula* Zone, Tithonian – at the base of *Hybonotum* Zone, Berriasian – at the base of *C. alpina* Subzone and Valanginian – at the base of *Calpionellites* Zone.

Six successive microfacies are characterized in the Callovian to Valanginian succession of micritic, clayey limestiones, and limestone marl alternation: filamentous microfacies, *Globuligerina* – radiolaria microfacies, *Saccocoma* microfacies, *Globochaete* microfacies, calpionellid microfacies and spicule microfacies.

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И. Лакова, П. Чумаченко, Д. Иванова, Е. Колева-Рекалова – Интегрирана биостратиграфия и микрофациеси на каловско – долнокредни пелагични карбонати от Западнобалканската единица (разрезите Комщица и Бърля). Юрската система в Западна Стара планина е привлякла вниманието на първите изследователи на геологията и стратиграфията в България Ф. Тула и В. Златарски преди повече от 100 години. Интензивните теренни, палеонтоложки и биостратиграфски изследвания на горноюрските и долнокредните пелагични карбонати в Издремецката синклинала доведоха до литостратиграфска и биостратиграфска подялба и установяването на всички етажи от каловския до хотривския през 60-те и 70-те години на XX век благодарение на трудовете на И. Сапунов, И. Начев, Т. Николов, Г. Мандов и др. Създадено бе интегрирано микропалеонтоложко зониране на титонския, бериаския и валанжинския етаж от И. Лакова, К. Стойкова и Д. Иванова. Напоследък П. Чумаченко поделя разрерите при Комщица и Бърля на секвенции от втори и трети порядък.

Предмет на тази статия е синтезираното представяне на съществуващата стратиграфска картина за калов-валанжинската карбонатна пелагична последователност в разрезите при с. Комщица и с. Бърля от Западно-Балканската тектонска единица, както и допълването с нови микропалеонтоложки и микрофациални резултати. Тук са представени зони по варовити диноцисти в горноюрската серия, които са корелирани с амонитните зони в Яворецката, Гинската и Гложенската свита. Дискутирани са използваните биостратиграфски критерии за прокарване на долните граници на етажите от каловския до валанжинския. Отделени са шест последователни микрофациеса: филаментен, *Globuligerina*-радиоларien, *Saccocoma, Globochaete*, калпионелиден и спикулен.