Uppermost Berriasian macro- and microfossil assemblages from the Ticha Formation of the Eastern Fore-Balkan Mts (Bulgaria)

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Abstract. Late Berriasian macro- and microfossil assemblages from the Ticha Formation (Eastern Fore-Balkan Mts, Bulgaria) were studied. Eight ammonite taxa, including coiled and straight forms, were described. In addition, 23 calpionellid, 12 calcareous dinocyst and 4 foraminiferal taxa were identified. The “*Thurmanniceras*” *otopeta* ammonite Subzone of the *Tirnovella alpillensis* Zone, the calpionellid *Oblonga* Subzone of the *Calpionellopsis* Zone and the *Stomiosphaera wanneri* calcareous dinocyst Zone were indicated. The advent of *Bochianites neocomiensis*, the late occurrence of *Bochianites* (?) *ambiguus* and the earliest appearance of *Phylloceras* (*Hypophylloceras*) *tethys tethys* was documented in the Eastern Fore-Balkan Mts area. The calpionellid-spicule microfacies was also recognized. The fossil data allow a correlation with similar coeval localities of the European Tethyan Realm. Pelagic macro- and microfossils and the microfacies are indicative of deeper-water basin depositional settings.

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INTRODUCTION

The first detailed studies of the Lower Cretaceous sub-flysch sediments and ammonite faunas of the Ticha Formation in the Eastern Fore-Balkan Mts area were made by Nikolov (1960, 1962) and Atanasoff (1961). The ammonite data from these papers defined a late Berriasian–Valanginian age of the formation, although the Berriasian Stage was perceived as a part of the Valanginian at that time. Atanasoff (1961) also published a few calpionellid species, which have been attributed to the Berriasian. Soon after, Mihailova-Yovcheva and Trifonova (1967) reported a Late Jurassic–Early Cretaceous age for the Ticha Formation based on foraminifera and calpionellids from a borehole section located near the fossil site of the present study. Later on, Sapunov *et al.* (1986) investigated the borehole sections penetrating the Ticha Formation in the Provadiya region (NE of the area studied herein). The ammonite, dinoflagellate and calpionellid data of the lat-

ter paper defined a total extent of these strata from the Oxfordian to the lower Berriasian. Tithonian ammonite zones, from the *Hyboniticeras hybonotum* to the *Himalayites* (*Micracanthoceras*) *microcanthus* subzone of the *Paraulacosphinctes transitorius* Zone, were indicated. The *Chitinoidella*, *Crassicollaria* and *Calpionella* calpionellid zones (with the *C. alpina* Subzone), were also recognized. More recently, Ivanova *et al.* (2002) restudied some of the borehole sections of Sapunov *et al.* (1986) and correlated the range of three microfossil groups: calpionellids, calcareous and non-calcareous dinoflagellate cysts. These authors confirmed the previously obtained results and further expanded the microfossil evidence up to the Valanginian. Calpionellid zones (from the *Chitinoidella* Zone to the *Tintinnopsella* Zone), calcareous dinocyst zones (from the *Carpistomiosphaera tithonica* Zone to the *Stomiosphaera echinata* Zone), as well as dinoflagellate cysts zones (from the *Biorbifera johnewingii* Zone to the *Spiniferites* spp. Zone), were identified.

As a result, the total chronostratigraphic extent of the Ticha Formation has been extended from the late Callovian to the late Valanginian (Ivanova *et al.*, 2002). Petrova and Metodiev (2012) studied the calpionellid successions of the Ticha Formation from outcrops in the area between the rivers of Luda Kamchiya and Armera. Three calpionellid zones and their composing subzones (from the *Calpionellopsis* Zone to the *Tintinnopsella* Zone), were indicated and allowed to assign these strata to the upper Berriasian and the Valanginian.

This paper is a renewed effort to study the fossil components of the Ticha Formation from the Luda Kamchiya–Armera area. It is focused on a specific locality, with a narrow range of the uppermost Berriasian, in which abundant representatives of the ammonite genus *Bochianites*, a few other ammonite taxa and various microfossils (calpionellids,

calcareous dinocysts and foraminifera) were recorded. The microfacies of the fossil-surrounding rocks was also determined, and thus, in addition to the direct correlation between the different fossil groups, an interpretation of the depositional environment was made.

GEOLOGICAL SETTING

The Luda Kamchiya–Armera area (Fig. 1a) includes the eastern part of the Predzhan anticline (Vangelov and Sinnyovsky, 2007). This regional structure of the Balkan Zone is composed of various Upper Cretaceous–Paleogene rocks, lying unconformably upon Lower Cretaceous sedimentary successions (Fig. 1b–c). The Lower Cretaceous strata correspond to the Ticha and Kamchiya for-

Fig. 1. a) Simplified tectonic sketch showing the position of the studied area within the framework of the Balkan orogenic system and its foreland in Bulgaria (after Dabovski and Zagorchev, 2009; modified); b) Schematic geological map of the East Fore-Balkan between the Luda Kamchiya and Armera rivers (after Vangelov and Sinnyovsky, 2007; modified), containing the Dodelen profile; c) Profile along the Dodelen River Valley with position of the Dodelen-3 outcrop.

mations. The Ticha Formation was introduced by Sapunov (1976). It crops out in several isolated narrow strips with W–E direction, south and southeast from the Tsonevo Dam (Fig. 1b). The formation is represented by an irregular alternation of gray marlstones, clayey and micritic limestones and rare layers of calcareous siltstones and sandstones. Nikolov *et al.* (1991) noted that, in the scope of the Predzhan anticline, the Ticha Formation is characterized by appreciable presence of clay-clastic rocks. Its thickness varies from 25–30 m to 100–200 m. According to Ivanova *et al.* (2002) the total chronostratigraphic extent is from the upper Callovian to the upper Valanginian. The formation is covered, with either a rapid lithological transition or angular unconformity, by the sediments of the Kamchiya Formation (along the valley of the Razkrachenitsa River), or by the sediments of the Upper Cretaceous (along the valleys of the Kozya Reka, Dodelen and Armera rivers), correspondingly (see Fig. 1b, c). Along the

valley of the Dodelen River, the Ticha Formation forms a locally developed W–E oriented synform, which is tectonically limited from north and south. This fold is composed of a few meters-thick alternation of light gray thin-bedded clayey limestones, micritic limestones and marlstones. A 1-m thick fossiliferous interval, called the Dodelen-3 outcrop, was found and studied. It is located in the Sherba Hunting Farm (42°57'16.28"N; 27°31'7.28"E) and corresponds to clayey and micritic limestones with rare marlstone interbeds (see Fig. 2a–d). This site contains six levels of ammonite faunas, in which coiled and straight forms are very common at the base and rapidly decrease to single specimens at the top.

MATERIAL AND METHODS

A total of 43 ammonite specimens were studied. They are preserved predominantly as deformed and

Fig. 2. Field views of the Ticha Formation from the Dodelen-3 outcrop: a) Alternation of light grey thin-bedded clayey limestones, light grey thin-bedded micritic limestones and rare layers of light grey marlstones (lower part of the outcrop); b, c) Detailed views of the Ticha Fm. (see Fig. 2a); d) Upper part of the outcrop.

fragmented internal molds. This state of preservation is due to sediment compression and considerable tectonic deformation. Ammonites are figured without additional treatment and mostly in natural size. One sample (thin-section Do 8) was taken for microfossil and microfacies studies from the lowermost ammonite-rich level (see Fig. 3). The identification of calpionellids, calcareous dinocysts and benthic foraminifera, as well as the accompanying allochems and matrix, was performed on a Jenaval transmitting light-microscope. The following literature was used in the taxonomic definitions: 1) calpionellids: Doben (1963); Remane (1963, 1965); Borza (1969); Pop (1994a, b, 1997a); and Lakova and Petrova (2013); 2) calcareous dinocysts: Borza (1969); Lakova *et al.* (1999); Reháková (2000); Ivanova and Kietzmann (2017); Petrova *et al.* (2019); and 3) benthic foraminifera: Bucur (1997); Ivanova and Kołodziej (2010); Petrova *et al.* (2012); Ivanova *et al.* (2015); Kowal-Kasprzyk (2016); and Bakhmutov *et al.* (2018). Microfacies was determined based on the textural classification

of Dunham (1962) and the predominant microfossil content in accordance to the microfacies of Lakova *et al.* (2007).

The examined materials are housed in the Department of Paleontology, Stratigraphy and Sedimentology of the Geological Institute “Str. Dimitrov” (Sofia, Bulgaria).

RESULTS

Microfossil data

The microfossil content recorded in the Dodelen-3 outcrop is characterized by rich calpionellid and calcareous dinocyst associations and less common small benthic foraminifera (Figs 3–6). In total, 23 calpionellid, 12 calcareous dinocyst and four foraminiferal taxa were identified.

The calpionellid community consists of abundant representatives of *Calpionellopsis oblonga* (Cadisch, 1932), *Calpionellopsis* sp. A (*sensu* Lakova and Petrova, 2013), *Calpionella alpina* Lorenz,

Fig. 3. Dodelen-3 outcrop: litho- and biostratigraphy, range-chart of the ammonite, calpionellid, calcareous dinocyst and foraminifer species. The microfossils were found in sample Do-3, taken from the first ammonite level.

Fig. 4. Calpionellids of the Dodelen-3 outcrop (Ticha Formation, sample Do-8, *Calpionellopsis oblonga* Zone, upper Berriasian): a–c) *Calpionellopsis oblonga* (Cadisch, 1932); d, e, ae) *Calpionellopsis simplex* (Colom, 1939); f, g) *Calpionellopsis* sp. A; h–j) *Calpionella elliptica* Cadisch, 1932; k, l) *Calpionella minuta* Houša, 1990; m–o) *Calpionella alpina* Lorenz, 1902; p, q) *Crassicollaria parvula* Remane, 1962; r) *Remaniella borzai* Pop, 1994; s) *Lorenziella hungarica* Knauer and Nagy, 1964; t) *Lorenziella plicata* Le Hégarat and Remane, 1968; u) *Tintinnopsella doliphormis* (Colom, 1939); v) *Tintinnopsella subacuta* (Colom, 1948); w–y) *Tintinnopsella carpathica* (Murgeanu and Filipescu, 1933) (small varieties); z, aa) *Tintinnopsella longa* (Colom, 1939); ab–ad, af–aj) *Tintinnopsella carpathica* (Murgeanu and Filipescu, 1933) (large varieties). Scale bars = 50 μ m.

1902 and *Tintinnopsella carpathica* (Murgeanu and Filipescu, 1933) (the latter one in both large and small varieties). There are also common *Calpionella minuta* Houša, 1990, *Crassicollaria parvula* Remane, 1962 and *Tintinnopsella longa* (Colom, 1939), as well as rare *Calpionellopsis simplex* (Co-

lom, 1939), *Calpionella elliptica* Cadisch, 1932, *Lorenziella hungarica* Knauer and Nagy, 1964, *L. plicata* Remane, 1968, *Remaniella borzai* Pop, 1994, *Tintinnopsella doliphormis* (Colom, 1939) and *T. subacuta* (Colom, 1948) (see Figs 3, 4). Rare and often poorly preserved *Longicollaria dobeni*

Fig. 5. Calcareous dinoflagellate cysts of the Dodelen-3 outcrop (Ticha Formation, sample Do-8, *Stomiosphaera wanneri* Zone, upper Berriasian): a–c) *Stomiosphaera wanneri* Borza, 1969; d, e) *Colomisphaera tenuis* (Nagy, 1966); f–h) *Committosphaera sublapidosa* (Vogler, 1941); i–k) *Stomiosphaerina proxima* Řehánek, 1987; l) *Colomisphaera carpathica* (Borza, 1964); m–o) *Colomisphaera fortis* Řehánek, 1982; p–t) *Cadosina fusca fusca* Wanner, 1940; u) *Cadosina fusca cieszynica* Nowak, 1966; v–y) *Cadosina minuta* Borza, 1980; z, aa) *Stomiosphaera moluccana* Wanner, 1940; ab, ac) *Colomisphaera* cf. *alpina* (Leischner, 1959); ad) *Colomisphaera lucida* Borza, 1986. Scale bars = 50 µm.

Fig. 6. Foraminifera of the Dodelen-3 outcrop (Ticha Formation, sample Do-8, upper Berriasian): a) *Patellina subcretacea* Cushman and Alexander, 1930; b) *Protopeneroplis* cf. *banatica* Bucur, 1993; c, d, h, i) *Spirillina* sp.; e) *Praechrysalidina* sp.; f) *Uvigerinammina uvigeriniformis* (Seibold and Seibold, 1960); g) *Verneulinoides* cf. *neocomiensis* (Mjatluk, 1939); j) *Conicospirillina* sp. Scale bars = 50 µm.

(Borza, 1966), *Borziella slovenica* (Borza, 1969), *Chitinoidella boneti* Doben, 1963, *Chitinoidella elongata* Pop, 1997, *Tintinnopsella remanei* Borza, 1969, *Crassicollaria brevis* Remane, 1962, *Crassicollaria intermedia* (Durand Delga, 1957), *Crassicollaria massutiniana* (Colom, 1948) and *Crassicollaria colomi* Doben, 1963 were also recorded. Taking into account the degree of preservation and quantity of the latter calpionellids, their presence is most likely due to resedimentation from upper Tithonian sediments. Similar mixture of microfossils of different ages in the sediments of the Ticha Formation was previously noted by Ivanova *et al.* (2002).

The calcareous dinocyst association is characterized by abundant representatives of *Cadosina minuta* Borza, 1980 and *Cadosina fusca fusca* Wanner, 1940. *Stomiosphaera wanneri* Borza, 1969, *Stomiosphaerina proxima* Řehánek, 1987, *Stomiosphaera moluccana* Wanner, 1940 and *Committosphaera sublapidosa* (Vogler, 1941) are less common. There are also rare *Colomisphaera tenuis* (Nagy, 1966), *Colomisphaera fortis* Řehánek, 1982, *Colomisphaera* cf. *alpina* (Leischner, 1959) and long-ranging *Colomisphaera carpathica* (Borza, 1964). Single *Cadosina fusca cieszynica* Nowak, 1966 and *Colomisphaera lucida* Borza, 1986 were also observed (Figs 3, 5).

Foraminifera are rare but show relatively diverse morphology. The following species were found: *Patellina subcretacea* Gushman and Alexander, 1930, *Protopenneroplis* cf. *bantica* Bucur, 1993, *Uvigerinammina uvigeriniformis* (Seibold and Seibold, 1960), *Verneuilinoides* cf. *neocomiensis* (Mjatlink, 1939), as well as representatives of the genera *Spirillina*, *Praechrysalidina* and *Conicospirillina*.

Such types of microfossil assemblages have been described in many sequences of the European Tethyan areas (e.g., Wierzbowski and Remane, 1992; Blanc *et al.*, 1992, 1994; Aguado *et al.*, 2000; Grabowski *et al.*, 2016). Therefore, it can be argued that the microfossil taxa identified herein have a clear Tethyan affinity.

Microfacies

Calpionellid-spicule wackestone microfacies type was recorded in the rocks of the Ticha Formation. It contains mainly fine-grained pelagic microfossils. They are mostly represented by calcified sponge spicules, calpionellids, calcareous dinoflagellate cysts, calcified radiolarians, *Globochaete alpina* Lombard, 1945, rare benthic foraminifera, thin-shelled ostracods, crinoidal fragments and echinoderm bioclasts (Fig. 7a–c). Silt-sized quartz grains, angular mica flakes and framboidal pyrite, which creates nests and impregnates the bioclasts (Fig. 7c), are well represented (10–15%). There are also rare glauconite grains, tiny dolomite rhombohedra and organic matter. Some of the calpionellids have dark micrite borders (Fig. 4a–c, g, o–q, af). According to Reháková (*in*: Bakhmutov *et al.*, 2018), this is due to “the higher content of organic matter formed by bio-coagulation”. The micritic matrix contains dissolution seams enriched in calcite and clay minerals, locally pigmented by Fe-oxyhydroxides, and rare bioturbation (Fig. 7a, b).

This microfacies may be referred to the Standard Microfacies Type 1 (SMF 1-Burrowed: “Burrowed bioclastic wackestone with abundant fine pelagic and benthic biotritus”) of Flügel (2004). It occurs in basin and open-marine shelf settings. Abundant sponge spicules, together with other pelagic microfossils (calpionellids, calcareous dinoflagellate cysts, *Globochaete alpina* and radiolarians), ostracods, crinoids and echinoderms confirm an open-marine deep-water environment. The presence of small benthic foraminifera of the genera *Patellina* and *Spirillina* also indicates deep-water depositional settings (Barbu, 2005; Petrova *et al.*, 2012). The bioturbation fabrics and micritic matrix characterize a setting with low sedimentation rates and predominant low-energy hydrodynamic conditions.

BIOSTRATIGRAPHIC NOTES

Ammonite biostratigraphy

The ammonite assemblage recorded in this study is exclusively composed of Tethyan taxa. It indicates the upper Berriasian *Tirnovella alpillensis* Zone (“*Thurmanniceras*” *otopeta* Subzone) from the standard ammonite zonation for the West Mediterranean Province of the Tethyan Realm (Reboullet *et al.*, 2018). The ammonite association consists of abundant *Bochianites* B. (?) *ambiguus*, *B. neocomiensis* and *Bochianites* sp., and single representatives of *Tirnovella* cf. *alpillensis*, *Thurmanniceras* cf. *otopeta*, *Fauriella donzei*, *Berriasella* (*Berriasella*) ex gr. *calisto*, *Berriasella* (B.) ex gr. *momtchilovi* and *Phylloceras* (*Hypophylloceras*) cf. *tethys tethys* (Figs 3, 8–9). Similar assemblages were documented in Spain (Aguado *et al.*, 2000), SE France (Blanc *et al.*, 1992, 1994; Bulot and Thieuloy, 1995; Bulot *et al.*, 1993, 1995), the Polish Carpathians

Fig. 7. Calpionellid-spicule wackestone (Ticha Formation, sample Do 8, upper Berriasian): a–b) Calcified sponge spicules (ss) and radiolarians (cr), calpionellids (c), *Globochaete alpina* (Ga) and dissolution seams enriched in calcite and clay minerals, locally pigmented by Fe-oxyhydroxides; c) Micritic matrix containing replaced by opaque minerals (pyrite?) radiolarians (cr), sponge spicules (ss) and fine-grained biotritus. Note: all images are in plane-polarized light.

Fig. 8. Ammonites of the Dodelen-3 outcrop (Ticha Formation, uppermost Berriasian, *Tirnovella alpillensis* Zone, “*Thurmanniceras*” *otopeta* Subzone): a) *Thurmanniceras* cf. *otopeta* Thieuloy, 1979, specimen Do 3; b) *Fauriella donzei* (Le Hégarat, 1973), specimen Do 15; c) *Phylloceras* (*Hypophylloceras*) cf. *tethys* (d’Orbigny, 1841), specimen Do 14; d, e) *Berriasella* (*Berriasella*) ex gr. *momtchilovi* (Nikolov, 1982), specimen Do 13; f, g) *Berriasella* (*Berriasella*) ex gr. *calisto* (d’Orbigny, 1850), specimen Do 11; h, i) *Tirnovella* cf. *alpillensis* (Mazenot, 1939), specimen Do 16. All figures are in natural size.

Fig. 9. Representatives of the genus *Bochianites* of the Dodelen-3 outcrop (Ticha Formation, upper Berriasian, *Tirnovella alpilensis* Zone, “*Thurmanniceras*” *otopeta* Subzone): *a*) *Bochianites* (?) *ambiguus* Arkadiev, Rogov and Perminov – Do 4a; *b*, *c*, *f*, *g*–*r*) *Bochianites neocomiensis* (d’Orbigny, 1841), *b* – Do 4c, *c* – Do 5 (*c*₁ – Do 5b, *c*₂ – Do 5c, *c*₃ – Do 5e, *c*₄ – Do 5d), *f* – Do 7b, *g*–*i* – Do 8a, Do 8c, Do 8d, *j* – Do 9a, *k*, *l* – Do 9b (*k* – negative, *l* – fragment), *m* – Do 9d, *n*, *o*, *p* – Do 10a, Do 10b, Do 10f, *q* – Do 9c, *r* – Do 6b; *d*, *e*) *Bochianites neocomiensis* (d’Orbigny, 1841) morphotype *tuberculatus* Mandov, 1971, *d* – Do 6a, *e* – Do 10g; *s*–*w*) *Bochianites neocomiensis* (d’Orbigny, 1841) morphotype *goubechensis* Mandov, 1971, *s* – Do 5a, *t* – Do 6c, *u*, *v* – Do 10d, 10e, *w* – Do 17a, Do 17b; *x*, *y*) *Bochianites* sp., *x* – Do 7a, *y* – Do 10c. All figures are in natural size.

(Wierzbowski and Remane, 1992; Pszczółkowski and Myczyński, 2004) and the Northern Calcareous Alps (Immel, 1987). In Bulgaria, the index-species of the “*Thurmanniceras*” *otopeta* Subzone was reported as single finds from the region of the town of Elena (Eastern Fore-Balkan Mts) (Nikolov, 1960) and SW from Borima Village (Central Fore-Balkan Mts) (Mandov, 1990).

The presence of *Bochianites neocomiensis* in the sediments of the Ticha Formation from the study area was first reported by Atanasoff (1961), unfortunately without figured specimens. The first figured upper Berriasian specimens of the genus *Bochianites* were those of Mandov (1971), from the western part of the Eastern Fore-Balkan Mts (near Yovkovtsi Village, in the vicinity of the town of

Elena). Mandov (1975) further recorded abundant *Bochianites* fauna in the upper Berriasian sediments near Todyuvtsi Village, also in the region of the town of Elena. He reported the following taxa: *Bochianites neocomiensis tuberculatus* Mandov (mass occurrence); *Bochianites* cf. *africanus* (Tate) and *Bochianites furcatocostatus* Mandov. The representatives of *Bochianites neocomiensis* identified in this study can be partially attributed to *Bochianites neocomiensis tuberculatus* Mandov and *Bochianites neocomiensis goubenchensis* Mandov. They confirm the presence of *B. neocomiensis* in the upper Berriasian of the Eastern Fore-Balkan Mts. Also, they are supporting evidence for the opinion of Arkadiev (2008), according to whom this species evolved *in situ* in Crimea at the lower Berriasian *Jacobi* Zone and gradually became common in the Central and Western European localities of the Valanginian and the Hauterivian.

Bochianites (?) *ambiguus* was recognized for the first time in Bulgaria. Its presence in the studied interval expands the stratigraphic range of the species to the top of the Berriasian (“*Thurmanniceras*” *otopeta* Subzone).

Herein, the earliest record of *Phylloceras* (*Hypophylloceras*) *tethys tethys* in Bulgaria was also noted. Previously, it was found only in Valanginian and Hauterivian sediments of the Western Fore-Balkan Mts (Mandov, 1976), the Western Srednogorie and the Western Balkan Mts (Petrova, 2011). The appearance of the species in the Berriasian has also been recorded in France (Joly, 2000) and the Northern Calcareous Alps (Immel, 1987).

Microfossil biostratigraphy

The presence of *Calpionellopsis oblonga* and other diverse concomitant species in the calpionellid association indicates the upper Berriasian *Oblonga* Subzone of the *Calpionellopsis* Zone (*sensu* Pop 1994b, 1997b; Reháková and Michalík, 1997; Lakova and Petrova, 2013). Apart from the index-species, the taxa characteristic of this subzone are: *Calpionellopsis* sp. A; *Lorenziella plicata*; *Calpionellopsis simplex*; *Calpionella elliptica*; *Lorenziella hungarica*; *Tintinnopsella doliphormis*; *Remaniella borzai*; *Tintinnopsella subacuta* and *Tintinnopsella longa* (Figs 3, 4). In addition to these taxa, there are also long-ranging species, such as *Tintinnopsella carpathica*, *Calpionella alpina*, *Crassicollaria parvula* and *Calpionella minuta*. Both the composition of this assemblage and the large number of small and large forms of *Tintinnopsella carpathica* reveal that it corresponds to the middle part of the *Oblonga* Subzone (Grabowski *et al.*, 2016).

Calcareous dinocysts are indicative of the upper Berriasian *Stomiosphaera wanneri* Zone (Lakova *et al.*, 1999; Reháková, 2000; Grabowski *et al.*, 2016; Ivanova and Kietzmann, 2017). *Cadosina minuta* and *Cadosina fusca fusca* are dominant. The representatives of *Stomiosphaera wanneri* (index-species), *Stomiosphaera moluccana*, *Stomiosphaerina proxima* and *Committosphaera sublapidosa* are common. The zonal association also includes *Colomisphaera tenuis*, *C. fortis*, *C. carpathica*, *C. lucida*, *Colomisphaera* cf. *alpina* and *Cadosina fusca cieszynica* (Figs 3, 5). The calcareous dinocyst assemblage is akin to that reported in the West Balkan Mts (Grabowski *et al.*, 2016).

Additional elements of the fossil assemblage are the small benthic foraminifera. The foraminiferal taxa do not have biostratigraphic value for this locality since they are known to have too wide stratigraphical ranges. Their recorded ranges are as follows: *Patellina subcretacea*, upper Tithonian–Barremian (Petrova *et al.*, 2012; Kowal-Kasprzyk, 2016); *Protopenelopis* cf. *bantica*, Berriasian–Aptian (Blanc *et al.*, 1992; Bucur, 1997); *Uvigerinammina uvigeriniformis*, Oxfordian–lower Valanginian (Krajewski and Olszewska, 2007; Olszewska, 2010); and *Verneuilinoides* cf. *neocomiensis*, Tithonian–Aptian (Ivanova and Kołodziej, 2010; Ivanova *et al.*, 2015; Bakhmutov *et al.*, 2018). These taxa contribute to the available data by being dated as late Berriasian, based on the other coeval fossil groups.

SYSTEMATIC PART

The classification of the ammonites studied herein follows those of Joly (1993) and Klein *et al.* (2009) for phylloceratids; Klein (2005) for perisphinctids; and Company (1987), Vermeulen (2006) and Klein *et al.* (2007) for bochianitids. An asterisk indicates the type specimen of the species. Standard dimensions were measured and given both in millimeters and as percentages of the diameter in the text as follows: D (shell diameter), Wh (whorl height), U (umbilical width). Due to the strong deformation of the specimens, the measurements Wb (whorl breadth) are not included.

Subclass Ammonoidea Agassiz, 1847

Order Ammonitida Agassiz, 1847

Suborder Phylloceratina Arkell, 1950

Superfamily Phylloceratoidea von Zittel, 1884

Family Phylloceratidae von Zittel, 1884

Subfamily Phylloceratinae von Zittel, 1884

Genus *Phylloceras* Suess, 1865

Type species. *Ammonites heterophyllus* Sowerby, 1820.

Subgenus *Phylloceras* (*Hypophylloceras*) Salfeld, 1924

Type species. *Phylloceras onoensis* Stanton, 1896.

Phylloceras (*Hypophylloceras*) cf. *tethys tethys* (d'Orbigny, 1841)

(Fig. 8c)

- *1841. *Ammonites Thetys* d'Orbigny, pp. 174–175, Pl. 53, Figs 7–9.
2009. *Phylloceras* (*Hypophylloceras*) *tethys tethys* (d'Orbigny): Klein *et al.*, pp. 24–26 (cum syn.).
2010. *Phylloceras tethys* (d'Orbigny): Főzy *et al.*, p. 529.
2011. *Phylloceras* (*Hypophylloceras*) *tethys* (d'Orbigny): Petrova, pp. 78–79, Pl. 1, Figs 1–4, 5a, b, 6, 7.
2012. *Phylloceras thetys* (d'Orbigny): Lukeneder, p. 4, Fig. 4Y.
2012. *Phylloceras* (*Hypophylloceras*) *tethys* (d'Orbigny): Joly and Mercier, p. 145, Figs 11a, b, 12a, b, 13a–c, 14a, b, 15–20.
2012. *Phylloceras* (*Hypophylloceras*) cf. *tethys* (d'Orbigny): Joly and Mercier, p. 147, Fig. 21a, b.
- non 2013. *Euphylloceras* cf. *thetys* (d'Orbigny): Bujtor *et al.*, p. 278, Fig. 4A [= ?*Phylloceras* (*Hypophylloceras*) *serum*].
2016. *Phylloceras* (*Hypophylloceras*) *tethys* (d'Orbigny): Lukeneder, p. 256, Fig. 6a.

Lectotype. The lectotype, designated and refigured by Joly (2000, pl. 35, fig. 4), is the original specimen of d'Orbigny (1841, pl. 53, figs 7–8), from the Valanginian of Saint-Julien-en-Beauchêne, Hautes-Alpes. It takes part of d'Orbigny's collection (coll. nr 4841B-1) kept at the Muséum national d'Histoire naturelle in Paris.

Material and record. A single fragment of calcareous mold (specimen Do 14), which corresponds to the body chamber. Ticha Formation, Dodelen-3 outcrop (20 cm above the base), *Tirnovella alpillensis* Zone, “*Thurmanniceras*” *otopeta* Subzone (see Fig. 3).

Measurements: Wh = 19.5 mm.

Description. Fragment of a small-sized involute and compressed ammonite, with high oval section and slightly convex whorl sides. The venter is rounded. The ornamentation is represented by dense, very thin radial ribs slightly projected forwards in the outer half of the whorl sides.

Remarks. The closest species to *Phylloceras* (*Hypophylloceras*) *tethys tethys* is *Phylloceras* (*Hypophylloceras*) *serum* (Oppel, 1865), but these taxa differ in section and suture-line (see Reboulet, 1996; Houša and Vašíček, 2004; Joly and Mercier, 2012). Ornamentation can be also taken as an

additional criterion. The ribs of *P. (H.) serum* are straight, while those of *P. (H.) tethys tethys* are always slightly curved forwards in the outer half of the whorl sides.

Occurrence. *Phylloceras* (*Hypophylloceras*) *tethys tethys* is widespread from the Berriasian to the Barremian (inclusive) in the Tethyan region (Joly, 2000). The species has been reported from France, Italy, Spain, Germany, Austria, Switzerland, Hungary, Poland, Czech Republic, Slovakia, Romania, Serbia, Caucasus, Israel, Algeria, Tunisia, Madagascar, California and Bulgaria. This is the first record of this species in the Berriasian of Bulgaria. Up until now, it had been found only in sediments with Valanginian and Hauterivian age in the areas of the Western Fore-Balkan Mts, Western Balkan Mts and Western Srednogorie (Mandov, 1976; Petrova, 2011).

Suborder Ammonitina Agassiz, 1847

Superfamily Perisphinctoidea Steinmann, 1890

Family Neocomitidae Salfeld, 1921

Subfamily Berriasellinae Spath, 1922

Genus *Berriasella* Uhlig, 1905

Type species. *Ammonites privasensis* Pictet, 1867.

Subgenus *Berriasella* (*Berriasella*) Uhlig, 1905

Type species. Same as for the genus.

Berriasella (*Berriasella*) ex gr. *momtchilovi* (Nikolov, 1982)

(Fig. 8d, e)

Material and record. Deformed fragment, part of the body chamber, transversely flattened (specimen Do 13). Ticha Formation, Dodelen-3 outcrop (10 cm above the base), *Tirnovella alpillensis* Zone, “*Thurmanniceras*” *otopeta* Subzone (see Fig. 3).

Measurements: Wh ≈ 14.5 mm.

Description. Fragment of a small-sized, moderately evolute ammonite, with depressed subrectangular whorl section (due to the transverse flattening of the specimen). The whorl sides are slightly convex. The venter is rounded, with smooth groove. The ornamentation is represented by very thin, sharp and dense, gently flexuous, prorsiradiate ribs. A few ribs run single from the umbilical edge. Most of the ribs bifurcate at approximately 1/2 of the height of the whorl. The ribs can both break and pass without interruption through the ventral area.

Remarks. The fragment is very close by size and style of ornamentation to *Berriasella* (*Berriasella*) *momtchilovi* (Nikolov) (1982, pl. 18, fig. 8), but its incompleteness does not allow full identification.

***Berriasella (Berriasella) ex gr. calisto* (d'Orbigny, 1850)**

(Fig. 8f, g)

Material and record. Fragment and a negative of the body chamber with preserved lappet (specimen Do 11). Ticha Formation, Dodelen-3 outcrop (10 cm above the base), *Tirnovella alpillensis* Zone, “*Thurmanniceras*” *otopeta* Subzone (see Fig. 3).

Measurements: Wh = 17.5.

Description. Small- to medium-sized ammonite. The section is subrectangular, with weakly convex walls. The ventral area and the umbilical edge are rounded. The sculpture is represented by thin and gently flexuous prorsiradiate ribs. Ribs start from the umbilical edge. Most of them bifurcate approximately at mid-flanks. A simple rib is also present. The aperture ends with a pronounced constriction and long spatula-shaped lateral lappet.

Remarks. The available specimen has all diagnostic features of *Berriasella (Berriasella) calisto* (d'Orbigny), but its incompleteness does not allow full species identification.

Subfamily Neocomitinae Salfeld, 1921

Genus *Tirnovella* Nikolov, 1966

Type species. *Berriasella alpillensis* Mazenot, 1939.

***Tirnovella* cf. *alpillensis* (Mazenot, 1939)**

(Fig. 8h, i)

*1939. *Berriasella alpillensis* Mazenot, pp. 73–74, Pl. VI, Fig. 22a–c.

2005. *Tirnovella alpillensis* (Mazenot): Klein, pp. 253–254 (cum syn.).

2007. *Tirnovella alpillensis* (Mazenot): Arkadiev, pp. 115–116, Pl. 1, Fig. 4.

2009. *Tirnovella alpillensis* (Mazenot): Cantú-Chapa, Fig 7n, o (= Howarth, 1992, Pl. 9, Figs 3, 4).

2011. *Tirnovella alpillensis* (Mazenot): Arkadiev, p. 11, Pl. 3, Fig. 8 (= Arkadiev, 2007, Pl. 1, Fig. 4).

2012. *Tirnovella alpillensis* (Mazenot): Arkadiev and Bogdanova, pp. 158–159, Pl. 7, Fig. 10 (= Arkadiev, 2007, Pl. 1, Fig. 4; Arkadiev, 2011, Pl. 3, Fig. 8).

2013. *Tirnovella* cf. *alpillensis* (Mazenot): Bujtor *et al.*, p. 286, Fig. 5E, F.

2015. *Tirnovella alpillensis* (Mazenot): Boorová *et al.*, p. 119, Fig. 10E.

Holotype. The holotype is the original specimen of Mazenot (1939, pl. 6, fig. 22a–c). It was refigured by Le Hégarat (1973, pl. 49, fig. 2) and Nikolov (1982, pl. 84, fig. 2). The holotype originates from the Berriasian of the Eyguières (Bouche-du-Rhône), SE France.

Material and record. Strongly laterally flattened calcareous mold, partially leached. The umbilical

area is poorly preserved (specimen Do 16). Ticha Formation, Dodelen-3 outcrop (75 cm above the base), *Tirnovella alpillensis* Zone, “*Thurmanniceras*” *otopeta* Subzone (see Fig. 3).

Measurements: D = 109 mm, Wh $\approx$ 46 mm, U = 28.5 mm, Wh/D = 0.42, U/D = 0.26.

Description. Medium-sized and moderately evolute ammonite, with compressed, subtrapezoidal whorl section. The venter is narrow, with smooth band. Despite the poor preservation of the specimen, there is a clear difference in the ornamentation on the phragmocone and the body chamber. The sculpture on the phragmocone is represented by very fine and dense ribs, typically running in pairs from small umbilical tubercles, or occurring as single ribs without tubercles between the paired ribs. The bulk of the ribs bifurcate at the middle or at the upper part of the whorl. All ribs interrupt at the ventral area. The body chamber is characterized by the same style of ornamentation as that in the inner whorls, but the ribs are stronger and gently flexuous, with wider intervals between them. In addition, the umbilical nodes are stronger and more pronounced.

Remarks. The species is closest to *Tirnovella subalpina* (Mazenot, 1939). The differences between the two types were commented by Le Hégarat (1973), Nikolov (1982) and Tavera (1985).

Occurrence. This species is typical for the upper part of the upper Berriasian in the Mediterranean Province (Reboullet *et al.*, 2018). *Tirnovella alpillensis* is known from France, Spain, Italy, Austria, Hungary, Bulgaria, Crimea, Georgia, Iraq, Algeria, Tunisia and Morocco.

Genus *Thurmanniceras* Cossmann, 1901

Type species. *Ammonites thurmanni* Pictet and Campiche, 1860.

***Thurmanniceras* cf. *otopeta* Thieuloy, 1979**

(Fig. 8a)

2005. *Thurmanniceras otopeta* Thieuloy: Klein, p. 278 (cum syn.).

?2013. *Thurmanniceras* sp. aff. *otopeta* Thieuloy: Bujtor, p. 9, Fig. 5I.

2015. *Thurmanniceras otopeta* Thieuloy: Boorová *et al.*, p. 119, Fig. 10A.

Holotype. The holotype is the original specimen of Thieuloy (1979, pl. 1, fig. 1). It comes from the lower Valanginian of the Barret-le-Bas, Les Sausses (Hautes-Alpes). The specimen (ID 10059) takes part of Thieuloy's collection, kept at the University of Grenoble.

Material and record. One mold with deformed sculpture and poorly preserved umbilical area (speci-

men Do 3). Ticha Formation, Dodelen-3 outcrop (the very base), *Tirnovella alpillensis* Zone, “*Thurmanniceras*” *otopeta* Subzone (see Fig. 3).

Measurements: Wh = 25.5 mm, U = 14 mm.

Description. Deformed, small-sized, moderately evolute ammonite. The whorl section is compressed, subtrapezoidal. The walls are weakly convex. The umbilical edge is rounded. The venter is narrow, with smooth groove. The ornamentation in the inner whorls is represented by dense and thin radial ribs, starting from the umbilical edge. The bulk of the ribs bifurcate approximately at mid-flanks. The ribs on the body chamber are stronger, wider, rounded and gently flexuous. Most of them are bipartite, but there is also one tripartite rib. All ribs break in the ventral area.

Remarks. The specimen is very close to those figured by Company (1987), especially to that in his pl. 5, fig. 6.

Occurrence. *Thurmanniceras otopeta* occurs at the uppermost part of the Berriasian in the Mediterranean area (Reboulet *et al.*, 2018). It has been found in France, Spain, Austria, Poland, Hungary, Romania and Bulgaria.

Genus *Fauriella* Nikolov, 1966

Type species. Berriasella gallica Mazenot, 1939.

Fauriella donzei (Le Hégarat, 1973)

(Fig. 8b)

*1973. *Tirnovella donzei* Le Hégarat, pp. 183–185, Pl. 27, Figs 5, 7, 8; Pl. 49, Fig. 6.

2005. *Fauriella donzei* (Hégarat): Klein, p. 261 (cum syn.).

2013. *Fauriella donzei* (Le Hégarat): Bujtor *et al.*, p. 287, Fig. 5L.

Holotype. The holotype (ID 538) was figured by Le Hégarat (1973, pl. 49, fig. 6) and comes from the Berriasian of Sarcenas, SE France. It is stored at the University of Grenoble. The holotype was refigured by Nikolov (1982, pl. 86, fig. 3).

Material and record. One deformed, partially leached mold, with incompletely preserved sculpture (specimen Do 15). Ticha Formation, Dodelen-3 outcrop (50 cm above the base), *Tirnovella alpillensis* Zone, “*Thurmanniceras*” *otopeta* Subzone (see Fig. 3).

Measurements: D = 55 mm, Wh = 21 mm, U = 17.5 mm, Wh/D = 0.38, U/D = 0.32.

Description. Small-sized and moderately evolute specimen. The whorl section is compressed, subtrapezoidal. The walls are weakly convex. The umbilical edge is rounded and poorly preserved on the last whorl. The venter is narrow, with smooth band.

The sculpture is represented by thin and densely arranged radial ribs, running either as single or in pairs from the umbilical edge. The bulk of ribs bifurcate approximately at the middle part of the whorl, but there are also rare simple ribs. The pairs of ribs start from small umbilical tubercles. They are rare on the phragmocone, but on the last whorl their number is significantly increasing. All ribs are flexuous on the body chamber.

Remarks. Similarities with other species were discussed in detail by Le Hégarat (1973), Nikolov (1982) and Tavera (1985).

Occurrence. *Fauriella donzei* is a characteristic species for the upper Berriasian. According to Tavera (1985), it occurs in the *Boissieri* Zone, but Vašíček *et al.* (1999) fixed it also around the Berriasian/Valanginian boundary (*Thurmanniceras otopeta*/*Thurmanniceras pertransiens* zones). The species has been found in France, Spain, Austria and Bulgaria.

Suborder Protancyloceratina Vermeulen, 2005

Superfamily Bochianitoidea Spath, 1922

Family Bochianitidae Spath, 1922

Subfamily Bochianitinae Spath, 1922

Genus *Bochianites* Lory, 1898

Type species. Baculites neocomiensis d’Orbigny, 1842.

Bochianites (?) *ambiguus* Arkadiev, Rogov and Perminov, 2011

(Fig. 9a)

?1975. *Bochianites* sp.: Mandov, pp. 49–50, Pl. 1, Figs 11, 13, 14.

2008. *Bochianites goubenchensis* Mandov, 1971: Arkadiev, p. 474, Pl. 3, Fig. 6a, b.

*2011. *Bochianites* (?) *ambiguus* Arkadiev, Rogov and Perminov, pp. 392–394, Pl. 5, Fig. 1a, b, 2a, b, 3a, b.

2012. *Bochianites* (?) *ambiguus* Arkadiev, Rogov and Perminov: Arkadiev and Bogdanova, pp. 222–223, Pl. 39, Figs 1a, b, 2a, b, 3a, b (= Arkadiev, Rogov and Perminov, 2011, Pl. 5, Figs 1a, b, 2a, b, 3a, b).

?2016. *Bochianites* cf. *ambiguus* Arkadiev, Rogov and Perminov: Hoedemaeker *et al.*, pp. 160–161, Pl. 14, Fig. 8.

Holotype. The holotype is the original specimen of Arkadiev, Rogov and Perminov (2011, pl. 5, fig. 3a, b, coll. nr 1/13217). It comes from the Berriasian (*Jacobi* Zone, *Grandis* Subzone) of Eastern Crimea, Feodosiya, Cape St Elias. The holotype is from the collection of V.A. Perminov, kept at the Museum of the Russian Geological Research Institute, St Petersburg (Russia).

Material and record. One fragmentary sculptured mold (specimen Do 4a). Ticha Formation, Dodel-

en-3 outcrop (the very base), *Tirnovella alpillensis* Zone, “*Thurmanniceras*” *otopeta* Subzone (see Fig. 3).

Measurements. The specimen is 46 mm long.

Description. Baculicone, with elliptical, laterally compressed section. Ornamentation is represented by relatively dense, evenly distributed, rounded single ribs, forming an angle of 15° to the axis of the shell. Near the aperture, there is a well-defined constriction parallel to the ribbing, surrounded by ribs with a slightly more pronounced relief.

Remarks. The specimen is very close in morphology to the fragments figured by Mandov (1975), especially to the one in his pl. 1, fig.13. It differs from the specimens of the type series (Arkadiev *et al.*, 2011) by the presence of only one constriction, but this may be due to the small size of the specimen and its relatively poor preservation.

Occurrence. Berriasian, Crimea, Spain and Bulgaria. According to Arkadiev *et al.* (2011) and Hoedemaeker *et al.* (2016), *Bochianites* (?) *ambiguus* occurs in the *Jacobi* ammonite Zone. Mandov (1975) also refers his *Bochianites* sp. fragments to the lower Berriasian. The present material extends the stratigraphical distribution of the species to the top of the Berriasian.

***Bochianites neocomiensis* (d’Orbigny, 1842)** (Fig. 9b–w)

- *1842. *Baculites neocomiensis* d’Orbigny, p. 560, Pl. 138, Figs 1–5 (compilation of several specimens).
- 2007. *Bochianites neocomiensis* (d’Orbigny): Klein *et al.*, pp. 5–7 (cum syn.).
- 2008. *Bochianites neocomiensis* (d’Orbigny): Arkadiev, pp. 471–472, Pl. 3, Figs 1–3, 4a–c, 5a–c, Text-figs 2a, 3b, 4b.
- 2008. *Janenschites oosteri* (Sarasin and Schöndelmayer): Arkadiev, p. 475, Pl. 3, Figs 12a–d, Text-figs 3e, 4b.
- 2008. *Bochianites oosteri* Sarasin and Schöndelmayer: Arkadiev, Text-figs 4a, c, d.
- 2011. *Bochianites neocomiensis* (d’Orbigny): Petrova, pp. 90–91, Pl. 4, Figs 7–11, 12a, b.
- 2011. *Bochianites goubechensis* Mandov: Petrova, pp. 91–92, Pl. 5, Fig. 3.
- 2012. *Bochianites neocomiensis* (d’Orbigny): Arkadiev and Bogdanova, pp. 218–219, Pl. 38, Figs 1–3, 4a–c, 5a–c, (= Arkadiev, 2008, Pl. 3, Figs 1–3, 4a–c, 5a–c), Text-fig. 76b (= Arkadiev, 2008, Text-fig. 3b).
- 2020. *Bochianites oosteri* Sarasin and Schöndelmayer: Vašíček, p. 77, Fig. 2A.
- 2020. *Bochianites neocomiensis* (d’Orbigny): Vašíček, Fig. 2B.

Lectotype. The lectotype (nr LPMP-R734) was designated by Busnardo (in Gauthier, 2006, p. 164, pl. 9, fig. 4, text-fig. 73a, 73b). It is from upper Val-

anginian of Lioux près de Senez (Alpes-de-Haute-Provence). It takes part of d’Orbigny’s collection (coll. nr 4883-1) kept at the Muséum national d’Histoire naturelle in Paris.

Material and record. Thirty-three fragmentary, laterally compressed, sculptured molds and imprints representing both juvenile shells and larger adult shells (specimens Do 4b, c, Do 5a–f, Do 6a–c, Do 7b, Do 8a–d, Do 9a–e, Do 10a, b, d, Do 10e–k, Do 17a, b). Ticha Formation, Dodelen-3 outcrop (the very base and 100 cm above the base), *Tirnovella alpillensis* Zone, “*Thurmanniceras*” *otopeta* Subzone (see Fig. 3).

Measurements. The largest fragment (Do 4b) is 51 mm long.

Description. The conch is straight, with oval section, but the bulk of the fragments have elliptical section due to lateral compression. The dorsal side is smooth. The ornamentation is represented by thin, simple and evenly distributed annular, oblique ribs, which cross the ventral region without interruption and form an arcuate bend in the direction of the aperture. In some specimens (Do 6a and Do 10g), a tubercular swelling on the ribs occurs in the ventral region, while, in others, there are clearly expressed constrictions parallel to the ribbing, as the ribs on both sides of the constriction have a more pronounced relief (specimens Do 5a, Do 6c, Do 10d, Do 10e, Do 17a, b). The suture line is not preserved.

Remarks. Herein, the broad conception of the species proposed by Company (1987) and Klein *et al.* (2007) is adopted. However, since this is most likely a case of intraspecific variability, it may be good to give the variations as morphotypes as suggested by Reboulet (1996). Thus, specimens that show differences from the type species can be attributed to *Bochianites neocomiensis* (d’Orbigny) morphotype *tuberculatus* Mandov and *Bochianites neocomiensis* (d’Orbigny) morphotype *goubechensis* Mandov.

According to other authors (Vašíček, 1999, 2020; Houša and Vašíček, 2004; Arkadiev, 2008), *Bochianites neocomiensis* and *Bochianites oosteri* are two completely separate species, which differ in their sculpture, suture lines, sizes and stratigraphical ranges. Arkadiev (2008) even includes representatives of *Bochianites oosteri* in the genus *Janenschites*.

Occurrence. *Bochianites neocomiensis* is widespread from the Berriasian to the lower Barremian in the Tethyan and Boreal realms (Arkadiev, 2008). The species has been reported from France, Spain, Italy, Switzerland, Austria, Hungary, the Czech Republic, Poland, Romania, Bulgaria, Crimea, Caucasus, Morocco, Tunisia, Siberia, Germany, England, Greenland and Antarctica.

***Bochianites* sp.**
(Fig. 9x–y)

Material and record. Three fragments, two of them are sculptured molds (specimens Do 5g and Do 10c), and one is with a very thin preserved shell (specimen Do 7a). Ticha Formation, Dodelen-3 outcrop (the very base), *Tirnovella alpillensis* Zone, “*Thurmanniceras*” *otopeta* Subzone (see Fig. 3).

Measurements. The fragments are 11–19 mm long and 5.5–7.5 mm wide.

Description. The specimens are small parts of straight ammonites with oval cross-section. The sculpture is represented by very dense, fine, evenly spaced ribs, perpendicular to the axis of the shell.

Remarks. These ammonites are close to *Bochianites* (?) *ambiguus*, but are characterized by finer and more dense ribbing, lack of constrictions, and perpendicular location of the ribs relative to the axis of the shell. A similar specimen from the lower Berriasian was figured as *Bochianites* sp. by Mandov (1975, pl. 1, fig. 12).

CONCLUSION

The combined fossil data reveal a late Berriasian age for the studied interval of the Ticha Formation. The indicated presence of the “*Thurmanniceras*” *otopeta* ammonite Subzone, the calpionellid *Oblonga* Sub-

zone and the calcareous dinocyst *Stomiosphaera wanneri* Zone points to the upper parts of the upper Berriasian. The fossil data are completely comparable to those from the Western Balkan Mts in Bulgaria, SE Spain, SE France, Polish Carpathians and the Northern Calcareous Alps. The earliest appearance of *Phylloceras* (*Hypophylloceras*) *tethys tethys* was also recorded and the first appearance of *Bochianites neocomiensis* was confirmed in the upper Berriasian of the Eastern Fore-Balkans in Bulgaria. The stratigraphical range of *Bochianites* (?) *ambiguus* was extended to the uppermost Berriasian.

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