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Late Barremian–Early Aptian Urgonian Limestones from the south-eastern Kučaj Mountains (Carpatho-Balkanides, eastern Serbia)

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Abstract. The newest results of sedimentological and paleontological investigations of part of the Urgonian Limestones studied in the surrounding of Boljevac on the SE slopes of the Kučaj Mts. (Carpatho-Balkanides, eastern Serbia) are presented. On two localities, near the village Faca Vajali, four types of microfacies and one subtype within the bioclastic limestones were separated. The characteristics of the depositional environments of the investigated Urgonian Limestones were studied and are discussed. At the base of the established rich micro-associations of foraminifera and algae, the vertical distribution of foraminiferal species was precisely defined which enabled the determination the the age of this part of the Urgonian Limestones as Late Barremian–Early Aptian.

Key words: Late Barremian–Early Aptian, Urgonian Limestones, Sedimentology, Micropaleontology, Stratigraphy, Kučaj Mountains, eastern Serbia

Апстракт. У раду су приказани најновији резултати седиментолошких и микропалеонтолошких истраживања дела ургонских кречњака откривених у околини Бољевца на југоисточним падинама Кучајских планина (Карпато-балканиди, источна Србија). На два локалитета у атару села Фаца Вајали констатована су четири типа микрофација и једна подфација у оквиру биокластичних кречњака. Утврђене и дискутоване су карактеристике депозиционих средина истраживаних ургонских кречњака. Из установљене веома богате микроасоцијације фораминифера и алги прецизно је дефинисано вертикално распрострањење фораминиферских врста које су омогућиле утврђивање старости овог дела ургонских кречњака у оквиру каснобаремског и раноаптског ката доње креде.

Кључне речи: касни барем–рани апт, ургонски кречњаци, седиментологија, микропалеонтологија, стратиграфија, Кучајске планине, источна Србија

Introduction

The rocks of Lower Cretaceous age, belonging to the eastern Serbian Carpatho-Balkanides, are widely distributed and facially heterogeneous. It refer to the Barremian and Aptian sediments and their special type known as Urgonian, Urgonian facies or Urgonian development. The mentioned sediments are most often in the mountainous area of the middle eastern Serbian Carpatho--Balkanides, which extend as an elongated arc from the Danube in the north southwards, then twist toward southeast and east until the Serbian-Bulgarian boundary. The composite range encompasses the mountains: Beljanica, Kučaj Mts., Rtanj, Ozren, Devica, Svrljig Mts., Tupižnica, Tresibaba, Paježand part of the western slope of Stara planina.

A detailed summary of investigations of the Urgonian sediments of the eastern Serbian Carpatho-Balkanides until 1974 was given by Jankičević (1978). In addition, his monograph contains numerous new and comprehensive data about the paleontology, stratigraphy, and lithology of the Urgonian. Hence in further investigations, just a few authors in Serbia paid attention to the study of these sediments. In addition to papers of Ma-

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RAN (1996, 1998), which dealt mostly with Urgonian echinids of the Kučaj Mts., the Master Thesis of RADULOVIĆ (2003) could be mentioned, in which, together with Upper Barremian and Lower Aptian brachiopods, microassociations from the Urgonian of the Kučaj were separated. It is also necessary to emphasize the paper of JANKIČEVIĆ (1996) who studied the Urgonian of the Carpatho-Balkanides using formational analysis and suggested the name Tupižnica Formation for these carbonate-terrigenous deposits of Upper Barremian and Lower Aptian (Bedoulien and possibly also lower Middle Aptian – Gargasian) time/stratigraphic position.

During field investigations for the Master Thesis of A. MARAN in the period 1994–1995, a few geological columns were made at localities near Boljevac (southeastern slope of the Kučaj Mts.) and macrofossils and material for thin sections were collected. The investigated sites were: Faca Vajali–Izvor, Faca Vajali–Ušće Arnaute, Faca Vajali–Vidikovac, Mali Izvor/1, Mali Izvor/2, Bogovina–Kamenolom and Bogovina–Pećina. At that time, relatively poor sedimentological and micropaleontological studies were used for the determination and explanation of the paleoecological characteristics of the established microassociations, and on that way, indirectly for the analysis and solutions of paleoecological problems of echinoid macrofauna (MARAN 1996).

Afterwards, the complex of the Faca Vajali sections were chosen and proposed for protection within the frame of the Cretaceous Geosite Conservation Program in Serbia as being representative, accessible and available for the geological science (MARAN 1999, MARAN *et al*. 2005).

As part of an ongoing project, in past decade, the localities Faca Vajali–Izvor and Faca Vajali–Ušće Arnaute were investigated several times and new material was collected. The aim of this paper is to present the results of the new detailed micropaleontological and sedimentological studies and evaluate these results in order to contribute to a better understanding of this part of the Urgonian sediments of eastern Serbia. In this way, the fund of our geological knowledge and practice is enriched, which is very important because a 40 m high dam will be built on the Crni Timok River close to locality Faca Vajali–Izvor, the main purpose of which will be to supply regional water to towns in the Timok Region (the towns Bor and Zaječar). As a result, the closest area surrounding the village together with all the geological localities will be submerged and lost forever.

Geological setting

Earlier, this area, was geotectonically most frequently considered as part of the Kučaj–Svrljig Structural-Facial Zone (JANKIČEVIĆ 1978, ANĐELKOVIĆ & NIKOLIĆ 1980 and many other authors), *i.e*. the Kučaj Zone (DIMITRIJEVIĆ 1997). Nowadays, it is adjoined to the Kučaj (Getic) Terrane/Unit, one of several large Alpine geotectonic (structural) units in the Carpatho-Balkanides of eastern Serbia (KARAMATA *et al*. 1997, KRÄUTNER & KRSTIĆ 2003) (Fig. 1).

The Kučaj Terrane had a long (Proterozoic to Neogene) and very complex geological evolution. The western boundary of the Unit is an Alpine eastward thrust, the eastern boundary is mostly of the same character. The time of the docking of the Kučaj Terrane to the Stara Planina–Poreč Terrane at the East is the end of the Viséan.

In the Kučaj Unit, the oldest rocks (Osanica metamorphics) are of Proterozoic age, metamorphosed under amphibolite facies conditions, and represent part of the old crystalline basement. The following Upper Proterozoic to Lower Cambrian rocks are volcanic-sedimentary rocks metamorphosed under greenschists facies conditions. Over this basement, Upper Cambrian to Lower Carboniferous sediments of the Caledonian–Variscan Cycle were deposited: shallow marine clastics (Upper Cambrian–Ordovician), deep-sea black shales (Upper Ordovician–Lower Devonian), pre-flysch (Lower and Middle Devonian) and flysch (Upper Devonian–Lower Carboniferous).

The post-Variscan overstep sequence begins with the Stephanian Limnic sediments grading into the Permian Red Sandstone Formation formed in intramountain depressions. In the Lower until the Middle or even in a part of the Upper Triassic, mainly shallow water carbonate rocks were deposited. In the Bajocian, basal clastics and oolitic limestones were formed transgressively. After that, in the eastern parts of the terrane, shallow water sediments of a carbonate platform (inclusively Urgonian Limestones were deposited up to the end of Lower Aptian. In the western regions of the Unit, Callovian–Valanginian deep water deposits are present. From the Cenomanian to the Maastrichtian, in places to the Paleocene, identical pelagic clastics and carbonate sediments occur, accompanied by a multistage magmatism (the Timok area). Brackish Upper Maastrichtian sediments represent the final stage of the marine regime. Lacustrine Paleogene sediments unconformably ovelie the Upper Cretaceous formations. The Middle and Upper Miocene limnic rocks are a post-Alpine overstep sequence.

The Lower Cretaceous sediments belonging to the Kučaj Unit/Terrane are widely distributed and thick. Differentiation of the sea bottom started in the Upper Jurassic, and continued in the Lower Cretaceous. The main rock types of the Neocomian are different kinds of shallow water limestones, but sandstones and sandy marlstones are also present. The rocks are characterized by rich association of bivalves, gastropods, brachiopods, echinoids, foraminifera and algae. A small flysch depression located in the southwestern part was formed in theUpper Jurassic and was present to the Valanginian. After the flysch sediments post-flysch marlstones and marly limestones were deposited. Over the whole area, Urgonian rocks of Barremian and Aptian age are

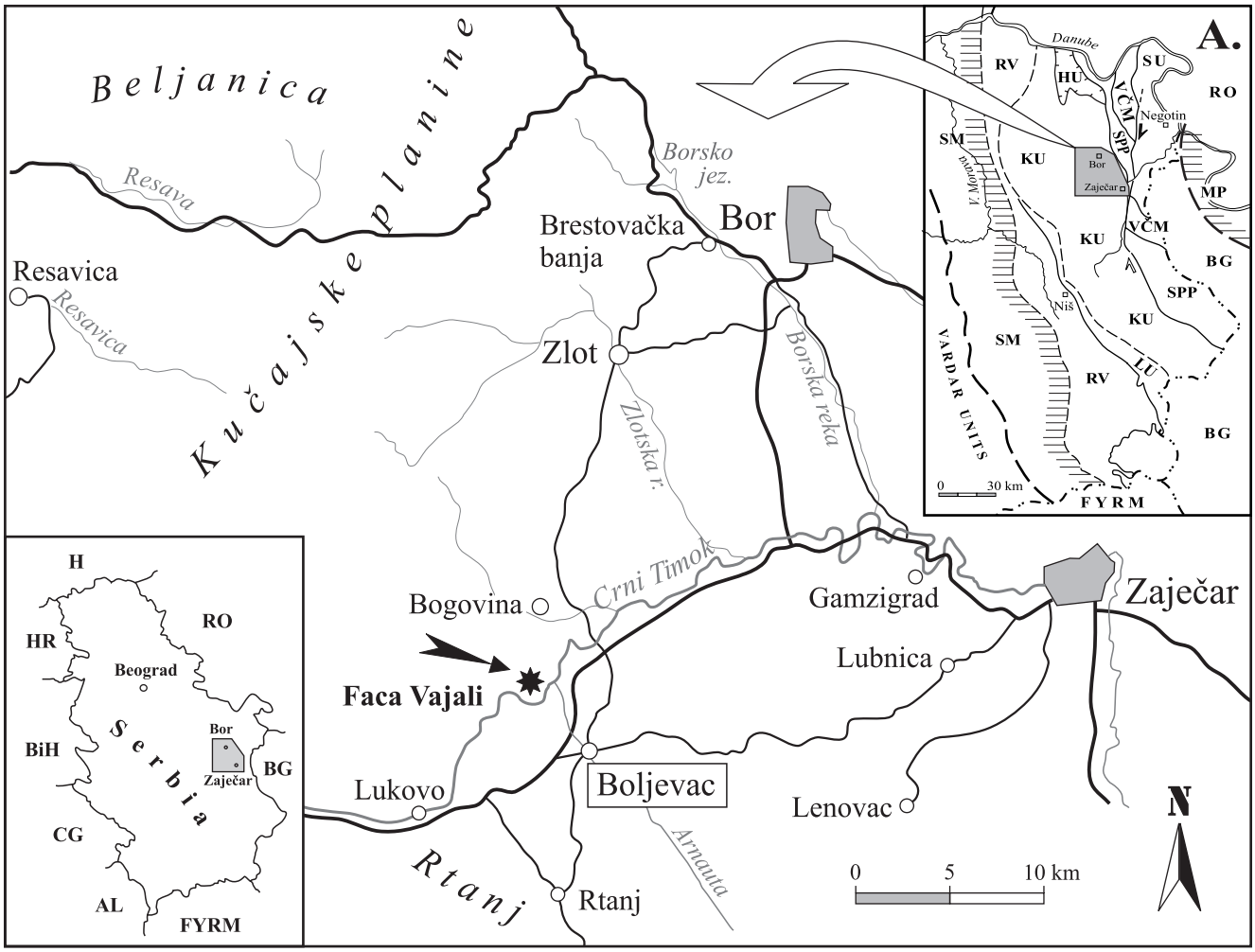


Fig. 1. Location of the Faca Vajali Village in the vicinity of Boljevac, eastern Serbia. **A**. Terranes/units of the eastern Serbia Serbian Carpatho-Balkanides (between horizontal lines) as part of the Balkan Peninsula (KARAMATA *et al*. 1997, KRÄUTNER & KRSTIĆ 2003): **SM,** Serbian-Macedonian Unit; **RV,** Ranovac–Vlasina Unit; **LU,** Lužnica Unit; **KU,** Kučaj Unit; **HU,** Homolje Unit; **SPP,** Stara Planina–Poreč Unit; **VČM,** Vrška Čuka–Miroč Unit; **SU**, Severin (Krajina) Unit; **MP,** Moesian Plate.

represented by carbonate sediments with three facies (limestone facies with rudists, facies of bioclastic limestones with orbitolinids and facies of bioclastic limestones with a terrigenous component and orbitolinids) and terrigenous non-carbonatic rocks with three/four facies (facies of sandstones and marlstones with orbitolinids, sandstone facies with ostreids and sandstone facies with plant detritus) (JANKIČEVIĆ 1978, 1996). Their total thickness is circa 450–500 m and fossils are abundant, especially representatives of rudists (and other bivalves), corals, echinoids, brachiopods, orbitolinids, other foraminifera and algae. The lower boundary of these sediments is not sharp but is undertaken because of the presence of a rich microassociation of Barremian age. The previously mentioned fauna of Neocomian age is very poor. In addition, it is almost impossible to divide the sediments of Barremian and of Aptian age, and the boundary is the most often located conditionally because only a gradual transition exists. The upper boundary is sharp. The Upper Aptian is not found, hence directly over the Lower Aptian lie conglomerates and glauconitic sandstones of Albian age or some other rocks of Upper Cretaceous age.

Microfacial analysis of Urgonian Limestones in the investigated sections

The Urgonian sediments located in the vicinity of Boljevac were sampled in detail southwestern from Bogovina near the village Faca Vajali on two sections: Faca Vajali–Izvor and Faca Vajali–Ušće Arnaute (Fig. 1). In both sections are present only a part of the Urgonian Limestones, which are macroscopically, *i.e*., lithologically, represented with two groups of limestones: thick-bedded to massive grey limestones with visible sections of macrofauna and thin- to decimeter thick-bedded friable, disintegrated partly, sandy-marly grey-yel-

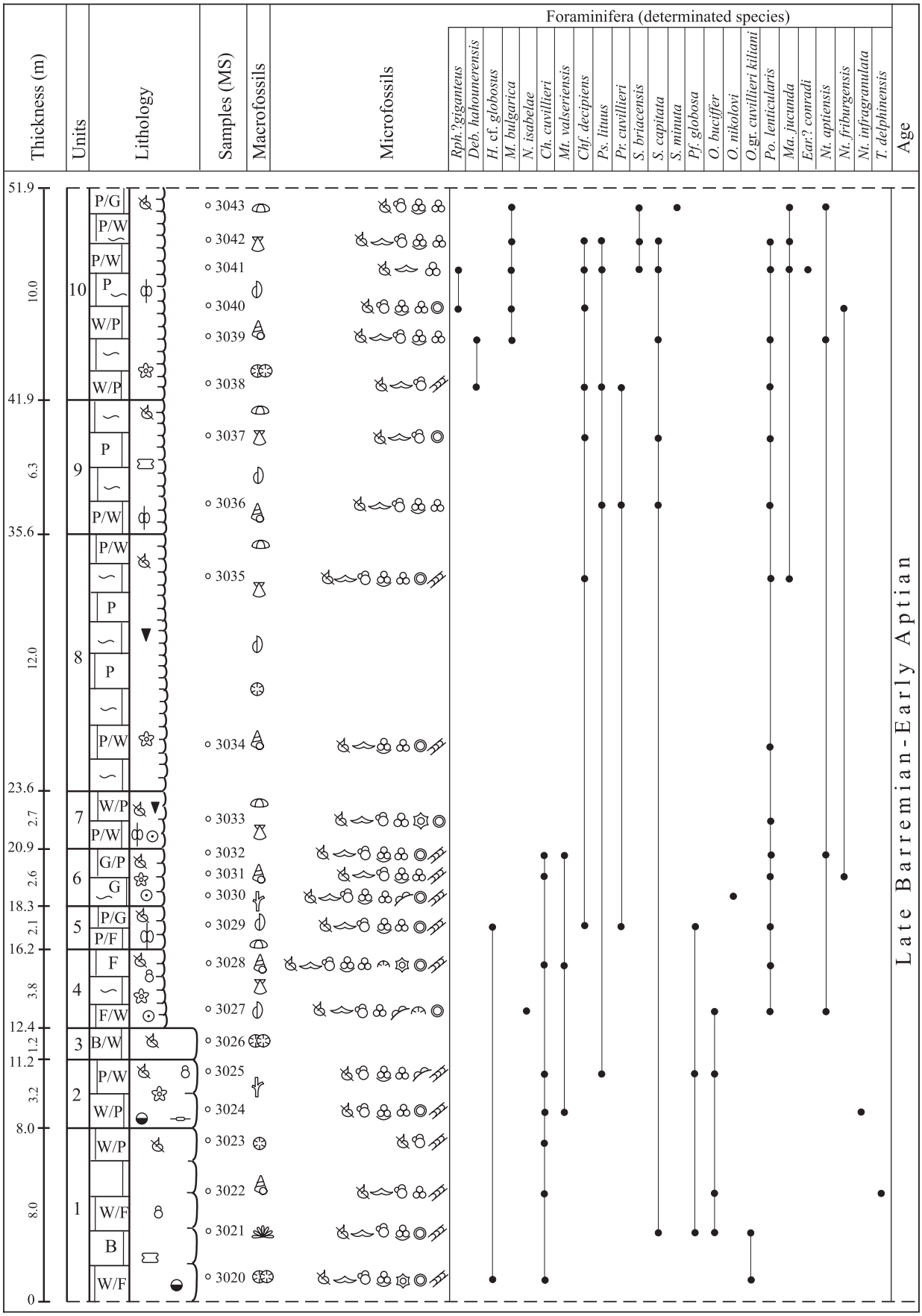


Fig. 2. Geologic column and vertical distribution of the determined foraminifera species in the Late Baremian–Early Aptian of the Faca Vajali–Izvor Section, eastern Serbian Carpatho-Balkanides (for the symbols, see Fig. 5).

lowish limestones with the whole forms of fossils. In these rocks, it was possible, on the basis of sedimentological, macro- and micropaleontological features (depositional textures, biota, *etc*.), to define four microfacies types (MFT 1–4) and one subtype (MFT 2A). The extended version of the DUNHAM (1962) and the methods described by WILSON (1975) and FLÜGEL (2004) were used for the microfacies analysis.

The thin sections are housed in the collection of M. SUDAR (Department of Paleontology, Faculty of Mining and Geology, University of Belgrade, Belgrade, Serbia), under the numbers MS 3000-3041.

The Faca Vajali–Izvor Section

The geological column from this locality is located westward of the village Faca Vajali. It begins from the middle parts of a temporary flow which from level 350 descends to the Crni Timok River and continues eastward, on the left side of the local road leading to the center of the village (coordinates: x 4859050, y 7574470). The locality is named by the spring (in Serbian = Izvor) which is situated close below the section, directly along the Crni Timok River.

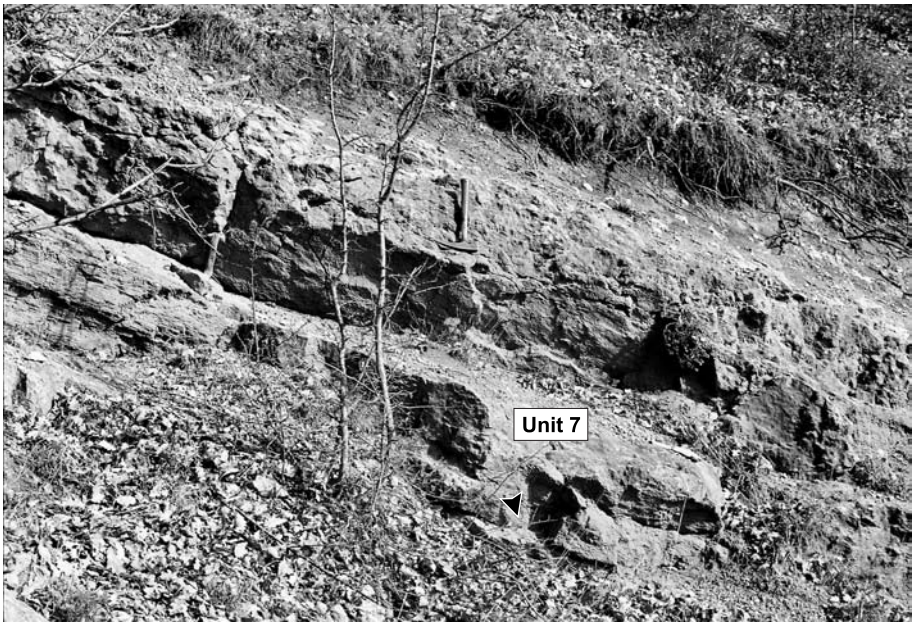


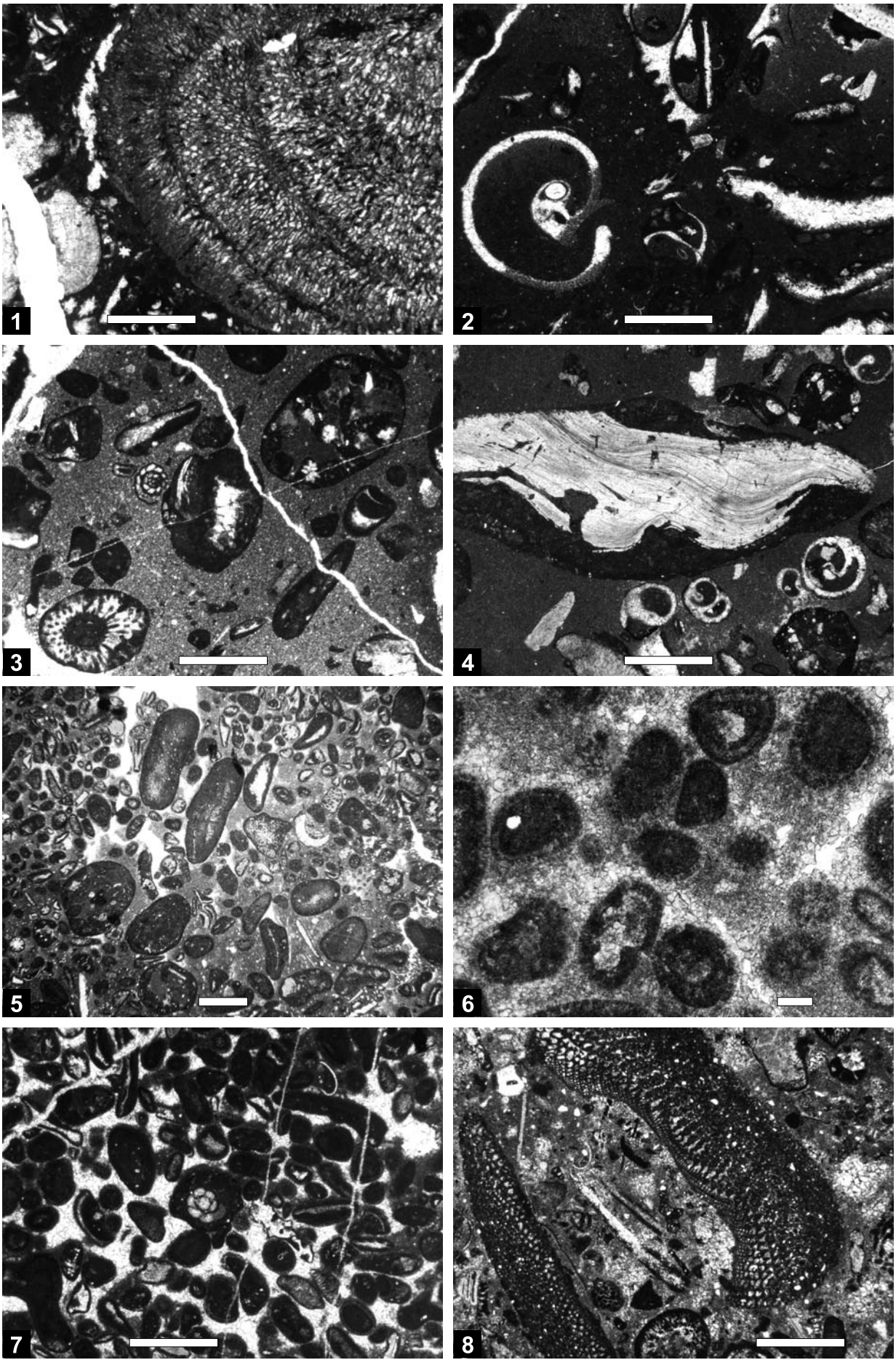
Fig. 3. Thick-bedded, friable and disintegrated grey-yellowish marly limestones from the middle parts (unit 7) of the Faca Vajali–Izvor Section, eastern Serbian Carpatho-Balkanides.

At the locality Faca Vajali–Izvor, the studied column has a thickness 51.9 m (Fig. 2). It is possible to distinguish the lower and upper part of the column on the field. The lower part (3 units, 12.4 m thickness) is composed of compact, grey thick-bedded to massive limestones with a good visible extracted macrofauna on the surfaces – colonial and solitary corals, stromatoporoids, chaetetids, gastropods, bryozoans and other forms. In the upper part of the column (thickness 39.5 m, units 4–10) predominate friable thick- to thin-bedded carbonate sediments, partially enriched by clayey and sandy fractions and with a yellowish weathering of the surfaces. Only sporadically are harder beds, thick to a few dm, visible (Fig. 3). This part of the.column is abundant with whole forms of fossils: bivalves (no rudists), echinoids, gastropods, brachiopods, orbitolinids, *etc*.

On the the Faca Vajali–Izvor Section column are separated the.following two characteristic microfacies types and one subtype, the photomicrographs of which are given in Fig. 4: MFT 1 – *bioclastic wackestone with transitions to packstone, grainstone or floatstone*; MFT 2A – *bioclastic wackestone with transition to packstone, rare boundstone*; and MFT 4 – *orbitolinid packstone*.

MFT 1. ***Bioclastic wackestone with transitions to packstone, grainstone or floatstone*** (Fig. 4, 5–7) are present in rocks, around 70 %, mostly from the upper parts of the column (units 4–10). In addition to rich macrofaunal biota, the microassociation is represented by fragments (bioclasts) of bivalves (but no rudists), gastropods, corals, algae, foraminifera, echinoids, brachiopods, crinoids, *etc*. The bioclasts are unequally distributed in micrite, rarely microsparite, sporadically enriched by Fe-pigment or fine siliciclastic detritus (quartz predominates). Their size varies from 0.1 mm and less to over 2 mm and more. The bioclastic and another allochems (coated grains, grapestone, rarely ooids, pelloids *etc*., sometimes with geopetal fillings) are well rounded, mostly middle to bed sorted. Very often they have micritic envelopes as a result of work of cyanobacterias, fungi *etc*., which are characteristic for protected shoals and lagoons of higher salinity.

The following algae were established: green algae (Chlorophyta), represented by numerous Dasycladaceae (*Neomeris*, *Acroporella*, *Salpingoporella, etc*.), Udoteaceae (*Boueina*, *Lithocodium*), other Halimedaceae and some dasycladacean morphogenera (*Coptocampylodon*, *Terquemella*). Red algae (Rhodophyta) are scarse, represented only by crusty structures of the genus *Polystrata*. Cyanobacterias (blue-green algae – "Cyanophyta"), as endolithic algae and fungi, produce micrite (the result of activities of prokaryotes) which envelopes the allochems.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In association connected with bioclastic wackestone are present numerous benthic foraminifera and between them various orbitolinids (*Orbitolinopsis*, *Palorbitolina*), simple or complex agglutinated forms (*Ammobaculites*, *Charentia*, *Everticyclammina*, *Sabaudia*, *Debarina*, *Nezzazata*, *Nezzazatinella*, *Choffatella*, *Daxia, etc*.), calcareous imperforate, porcelaneous forms, represented by miliolids (*Quinqueloculina*, *Rumanoloculina*, *Pyrgo*, *Sigmolina*, *Dervantina*), calcareous perforate forms (*Neotrocholina*, *Trocholina*, *Spirillina*, *Lenticulina*, *etc*.) and scarse sessile foraminifera (*Coscinophragma* and others).

These sediments were deposited in a shallow subtidal, and/or rather deeper intertidal area (carbonate platform margin, *i.e.,* open shelf lagoon behind a platform margin; WILSON 1975; FLÜGEL 2004).

MFT 2A. ***Bioclastic wackestone with transition to packstone; rare boundstone*** (Fig. 4, 1–4), are minor, in rocks of the lower part of the section (units 1–3) and are present with around 20 %. At coarse sparry calcite are distributed well-rounded, unsorted intraclasts, which represent coated and reworked bioclasts formed by tidal currents and waves. Their cores, as the other fine detritus, is made of fragments of colonial and solitary corals, foraminifera, algae (Fig. 4, 3), crinoids, bryozoans, echinoids, stromatoporoids, chaetetids (Fig. 4, 1), (micro)gastropods (Fig. 4, 2), bryozoans, stromatoporoids, calcareous sponges, some undeterminable "organic" structures, *etc*. In some parts, the carbonate mud is not washed out and rests like small patches.

The microassociation of these rocks is very diverse, as in the previous microfacies. Algae are represented only by green algae: thedasycladacean genera (*Neomeris; Zittelina*), *Boueina* from Udoteaceae, and also with some dasycladacean morphogenera (*Coptocampylodon, Terquemella)*. Aggutinated foraminifera (*Ammobaculites, Evertyciclammina, Charentia, Sabaudia and* numerous orbitolinids) are more typical than benthic calcareous forms (*Neotrocholina* and some tiny miliolids).

MFT 4. ***Orbitolinid packstone*** is present in the rocks of the both parts of the column in an amount of 10 %. Higher contents of sandy-clayey, hence ferruginous matter, is typical in microsparite-micrite. In addition to numerous agglutinated orbitolinids (only *Palorbitolina*, Fig. 4, 8), they contain small coated bioclasts with a core of dasycladaceans, stromatoporoids, and other organisms, whole tiny foraminifera and microgastropods, tiny organic debris (echinoid spines, *etc*.), *etc*.

Their microfossil community is monotonous because of the presence of terrigenous matter which reduced flourishing of the organic world. In addition orbitolinids, *Nezzazata*, *Nezzazatinella*, *Everticyclammina*, and calcareous perforate genera *Neotrocholina*, *Lenticulina* and some miliolids were determined. Algae are present only with rare *Boueina* (Udoteaceae).

These microfacies types were probably formed in the shallow subtidal of a partially protected lagoon in a carbonate platform.

The Faca Vajali–Ušće Arnaute Section

The section is located in the eastern part of the village, on the slope of Cukloj, 200 m SW from the confluence (in Serbian = Ušće) of the Arnauta River into the Crni Timok River (coordinates: x 4858950, y 7576175). The column, thick 45.5 m contains 10 units (Fig. 5). At the base (3 units, thickness 6.2 m) are yellow friable sandy-marly limestones without macrofauna. They are followed by thick-bedded to massive grey limestones (units 4–9, thickness 37 m), which represent thicker and a more imposing part of the column with surfaces where numerous concentrations are visible, coquinas of the rudists and very rare other macrofaunas – corals, stromatoporoids, gastropods, bryozoans, *etc*. (Fig. 6). The highest part of the column (unit 10, thickness 2.3 m) is made.up of yellowish disintegrated sandy-marly limestones, identical to the sandstones at the base of the section and also without fauna.

On the geological column of the Faca Vajali–Ušće Arnaute Section the following characteristic three microfacies types are present and their photomicrographs are given in Fig. 7: MFT 2 – *bioclastic wackestone with transition to packstone*; MFT 3 – *bioclastic grainstone* and MFT 4 – *orbitolinid packstone*.

The MFT 2 microfacies (Fig. 7, 1, 3–6) from the middle part of column and the friable MFT 3, which is present in the lowest and final part of the Faca Vajali–Ušće Arnaute Section (Fig. 7, 2) are dominant. In adition to these, in the whole column also exist rocks with the MFT 4, but with much fewer and rarer microfossils than in the same MFT of the Faca Vajali–Izvor Section.

MFT 2. ***Bioclastic wackestone with transition to packstone.*** In comparison with the microfacies subtype 2A from the Faca Vajali–Izvor Section, in the MFT 2

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Fig. 4. Thin-section photomicrographs of the sediments from the Faca Vajali–Izvor Section, eastern Serbian Carpatho-Balkanides. **1,** Bioclastic wackestone/floatstone with a large fragment of chaetetids, MS 3020; **2,** Bioclastic wackestone/packstone with numerous bioclasts of gastropods, molluscs *etc*., MS 3022; **3,** Bioclastic wackestone/packstone with dasycladacean algae (*Salpingoporella pygmea*), foraminifera (*Charentia cuvillieri*) and other well-rounded coated grains, MS 3023; **4,** Bioclastic wackestone/packestone with a large shell fragment coated with micrite, small gastropods and other fragments, MS 3024; **5,** Bioclastic grainstone with large and small unsorted intraclasts, peloids and bioclasts (undifferentiated foraminifera, algae, *etc*.), MS 3030; **6,** Bioclastic grainstone/packstone with large, badly preserved ooids, MS 3031; **7,** Bioclastic grainstone/packstone with will sorted micritized ooids and bioclasts (benthic foraminifera, *etc*.), MS 3032; **8,** Bioclastic packestone/wackstone with large orbitlinids (*Palorbitolina lenticularis, Palorbitolina* sp.) and other bioclasts, MS 3035. Scale bar = 1 mm.

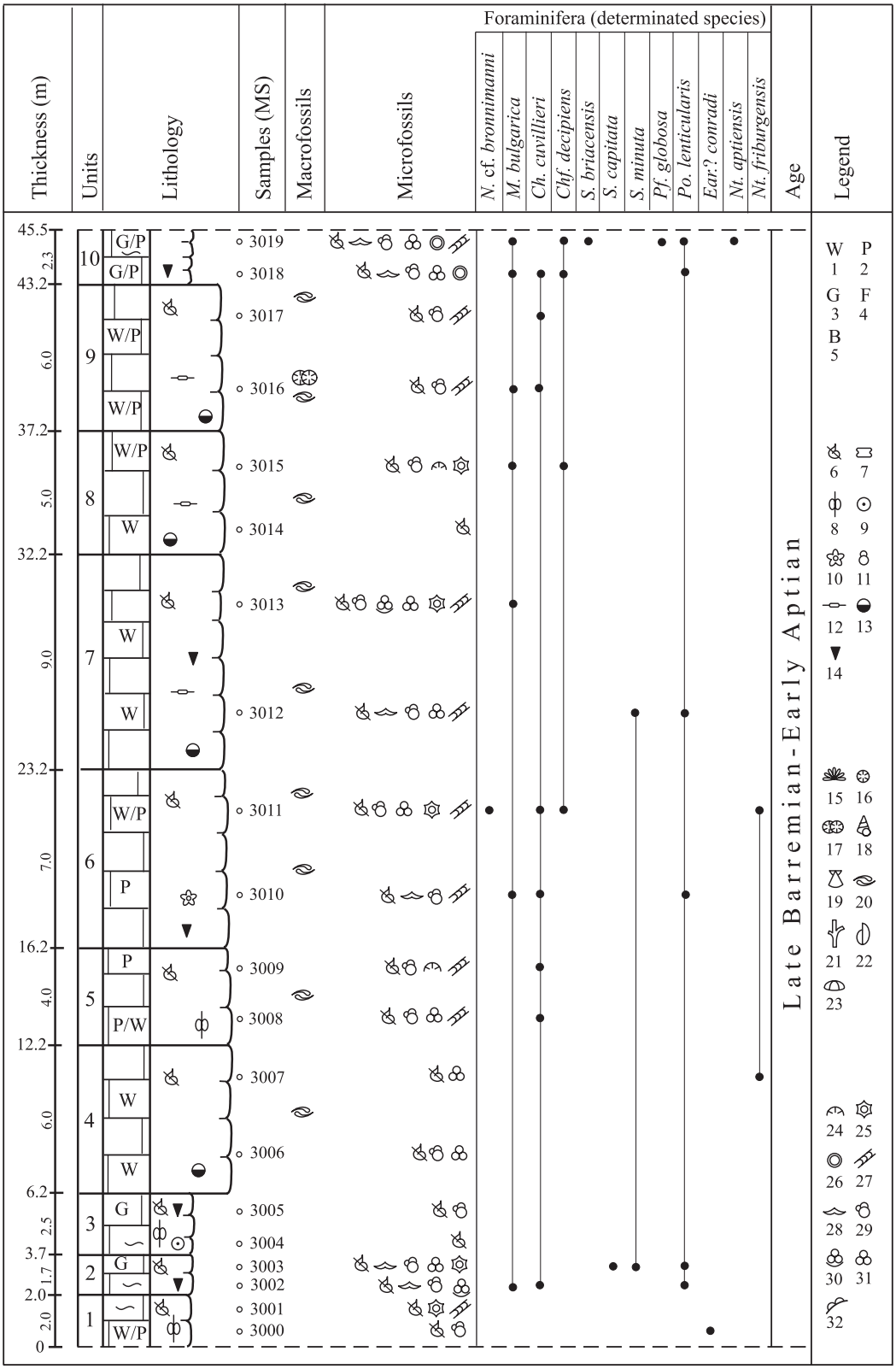

Fig. 5. Geologic column and vertical distribution of the determined foraminifera species in the Late Baremian–Early Aptian of the Faca Vajali–Ušće Arnaute Section, eastern Serbian Carpatho-Balkanides. Legend: **1,** wackestone; **2,** packstone; **3,** grainstone; **4,** floatstone; **5,** boundstone; **6,** bioclasts; **7,** lithoclasts; **8,** pelloids; **9,** ooids; **10,** oncoids; **11,** agregated grains; **12,** fenestrae; **13,** geopetal fabric; **14,** quartz; **15,** chaetetids; **16,** solitary corals; **17,** colonial corals; **18,** gastropods; **19,** bivalves in general; **20,** pachyodonts; **21,** bryozoans; **22,** brachiopods; **23,** echinoids; **24,** cyanobacterias; **25,** rhodophycean algae; **26,** udoteacean green algae; **27,** dasycladacean green algae; **28,** orbitolinids; **29,** other agglutinated foraminifera; **30,** calcareous porcelaneous (imperforate) foraminifera (miliolids *etc.*); **31,** calcareous perforate foraminifera; **32,** sessile foraminifera.

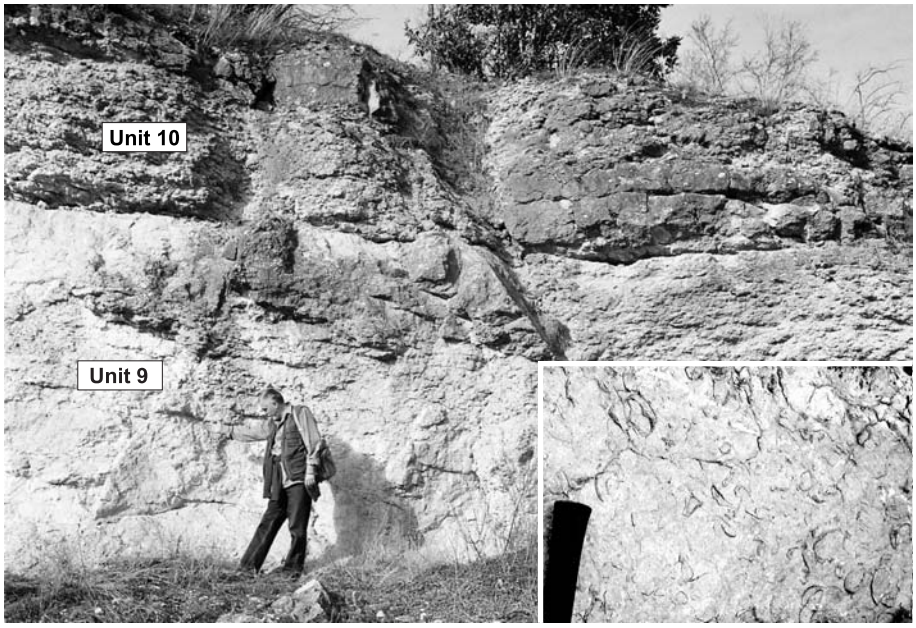

Fig. 6. The uppermost middle (massive grey limestone of unit 9) and upper (thin- to decimetre thick-bedded grey-yellowish friable and disintegrated limestones of unit 10) parts of the Faca Vajali–Ušće Arnaute Section (eastern Serbian Carpatho-Balkanides) with the detail of a rudist coquina.

of this site, the most important differences lie in the biota and the diversity of the macrofaunal species, which is more dominant. Except for rare colonial and solitary corals, the macrofauna is represented by abundant rudist genera *Toucasia, Matheronia, Monopleura* and *Requienia,* which build coquinas. Fragments of shells, stromatoporoids, chaetetids, *etc*. which are distributed in micrite can be rounded (rarely angular) because of transport. Usually they are unsorted, often with micritized coats. Corals, which fix the base, are scarse and fragmented. Due to periodical and intense movements and wave actions, robust forms of fossils were accumulated in the tidal area.

In parts with an unequal presence of a sandy fraction, the development of an abundant organic world was enabled but it was also suitable for agglutinated foraminifera (orbitolinids). They rarely appear together with algae in the bioclastic packstone (MFT 4).

Microfossils are poorer than in the previous sections: rarely algae (cyanobacterias, red – *Polystrata*, dasycladaceans – *Neomeris*, "*Epimastopora*", dasycladacean morphogenera *Coptocampylodon*, *Terquemella)*; simple or complex agglutinated (*Charentia*, *Sabaudia*, *Pseudotextulariella*, orbitolinids) and forms of calcareous perforate foraminifera (*Neotrocholina)*.

These rocks have two main characteristics: an abundance of rudists (and rare specimens of other reef macrofaunas) and a bioclastic character. Although the first characteristic indicates reef origin, the fauna present in the bioclastic, very fragmented limestones is not sufficient to mark the limestone of MFT 2 and MFT 2A as reefal. This was confirmed with their view, manner of appearance, structure, *etc*. For the other characteristics of these limestone with rudists and an interpretation of their depositional nature see in the penultimate chapter of this paper.

MFT 3. ***Bioclastic grainstone*** appears subordinately in yellowish, partially friable and thicker limestone beds without macrofauna but with a relatively rich and diverse microfossil community.

Limestone of this microfacial type were deposited in intertidal (WILSON 1975, washed grains of a platform margin; LOGMAN 1981, backreef sands).

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For comparison with the given investigated sections, existing results of sedimentological and paleontological analyses from a few other localities near to Boljevac were used but the given data will not be presented separately. These localities are: Faca Vajali–Vidikovac, Mali Izvor/1, Mali Izvor/2, Bogovina–Pećina and Bogovina–Kamenolom. The established microfacial types and subtype are distingished on the following sections.

MFT 1 and especially MFT 4: Faca Vajali–Izvor (units 4–10), Bogovina–Pećina, and Mali Izvor (both fossiliferous sites). MFT 3 is found only in the lower and higher part of the Faca Vajali–Ušće Arnaute Section (units 1–3 and 10). MFT 4 is also present in remaining sections but in smaller amounts than other microfacial types.

MFT 2 is the most common in the middle part of the Faca Vajali–Ušće Arnaute Section (units 4–9) and at the locality Bogovina–Kamenolom. MFT 2A, characterized by rarer presence or almost without rudists, is found in the lower units (1–3) of the Faca Vajali–Izvor Section and at the site Faca Vajali–Vidikovac.

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In comparison with the facies studied in the Barremian–Lower Aptian sediment complex established by

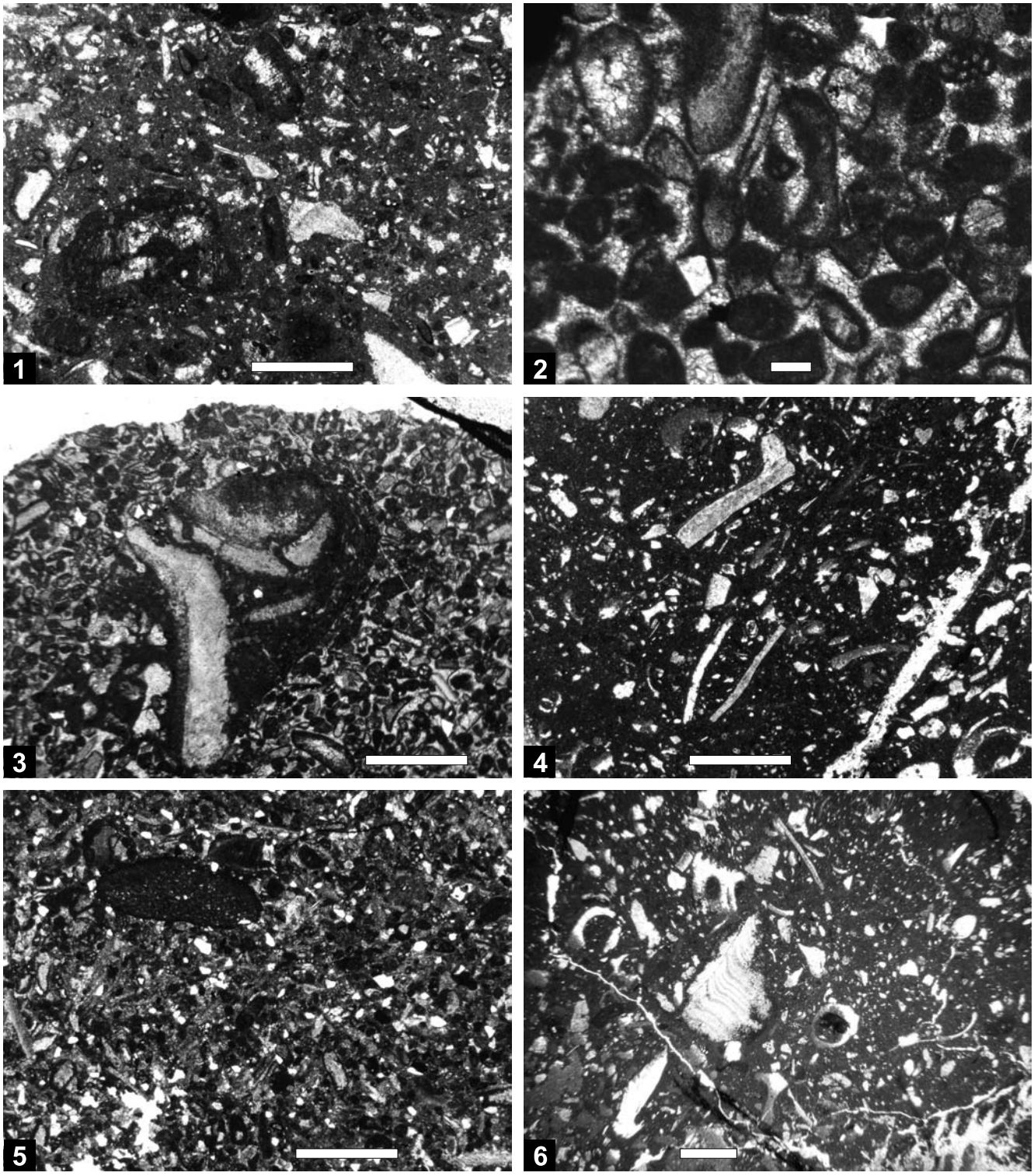


Fig. 7. Thin-section photomicrographs of the sediments from the Faca Vajali–Ušće Arnaute Section, eastern Serbian Carpatho--Balkanides. **1,** Biolithoclastic wackestone/packestone with angular, unsorted bioclasts, MS 3001; **2,** Well sorted bioclastic grainstone with rare foraminifera (miliolids), MS 3002; **3,** Bioclastic wackestone/packestone with one large lithoclast (fragments of bivalve shells) and numerous other small, well sorted grains, MS 3003; **4,** Bioclastic wackestone with abundant detritus (mostly of bivalve shells), MS 3006; **5,** Sandy wackestone/packstone with a large undeteriminable orbitolinid, MS 3011; **6,** Bioclastic wackestone/packestone with fragments exclusively from bivalve shells, MS 3015. Scale bar = 1 mm.

JANKIČEVIĆ (1978), the microfacial types and subtypes separated and described herein could be probable equalized with the facies with rudists (= MFT 2 and 2A), *i.e.,* with facies of bioclastic limestones (= MFT 1, 3 and 4). The first type of limestones (the present MFT 2 and 2A) was define by the mentioned author as Urgonian facies *sensu stricto* and, according to his opinion, it was formed in a reef environment, i.e., in infralittoral, more in his internal part (*op. cit.*, p. 172). As was pointed out in the previous section, sufficient reasons which would allow this limestone with rudists to be designated as reefal do not exist. The second type of JANKIČEVIĆ (1978), *i.e.*, the present MFT 1, 3 and 4, was signified as bioclastic (para-Urgonian) limestones deposited in a para-reef environment – internal and/or external infralittoral (*op. cit.*, p. 174).

Summary and conclusions

The herein presented results of a detailed sedimentological and paleontological (especially micropaleontological) study of a part of the Urgonian bioclastic limestones from near to the village Faca Vajali, the Boljevac Area on the SE slopes of the Kučaj Mts. (Carpatho--Balkanides, eastern Serbia), some summary discussions and conclusions in relation to the interpretation of their depositional environment and stratigraphy can be made.

Interpretation of the depositional environment

Sedimentological and paleontological data of the Late Barremian–Early Aptian Urgonian Limestones of the studied area of eastern Serbia confirmed shallow water carbonate sedimentation of a platform type under conditions of a tropical to subtropical climate on a wide unstable shelf of developed relief in a warm sea of the Tethyan areal. In French literature, this area is traditionally known as the "carbonate (Urgonian) platform" (ARNAUD-VANNEAU 1980; MASSE & PHILIP 1981; MASSE 1993, *etc*. and many other earlier and newer references) and in Serbian literature, it is defined as the "paraplateforme carbonatique" (GRUBIĆ & JANKIČEVIĆ 1973) or the "shelf carbonate platform" (JANKIČEVIĆ 1978, 1996).

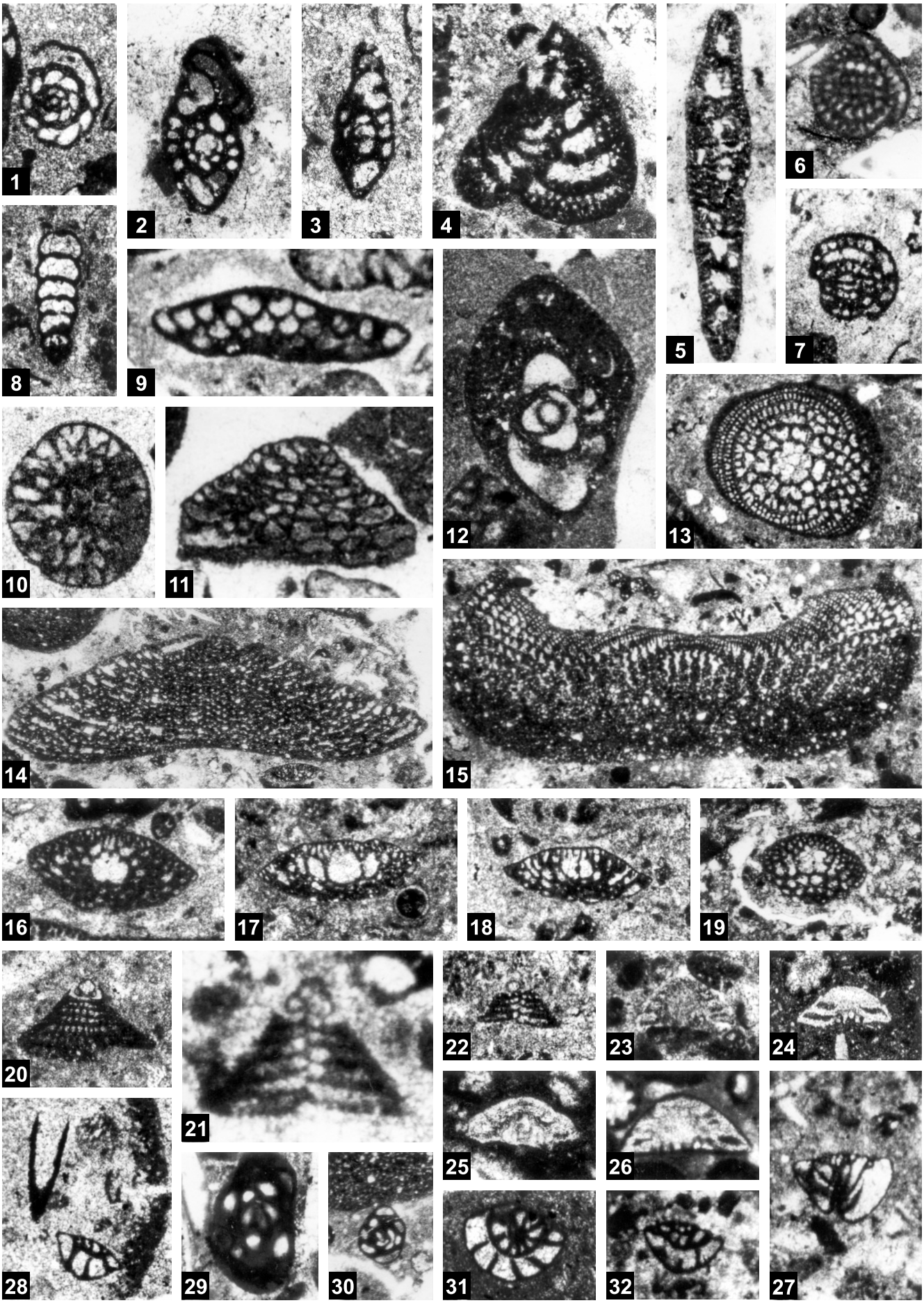
GUŠIĆ & JELASKA (1990) while establishing some depositional environments of the Upper Cretaceous of the Brač Island made comparisons with the ambients of the middle shelf in sense of WILSON & JORDAN (1983). The investigated biotop of part of the Urgonian sediments near to Boljevac could be correlated with the ambient and characteristics of that area. It represents an extensive and morphologically differentiated backreef platform, partially opened (presence of sceletal carbonate sands of higher water energy formed in sandy shoals, beaches, tidal accumulations, submarine rises – bioclastic grainstone), with a depth from shallow low and/or high energy infralittoral (subtidal less than 10 m) to littoral (intertidal, tidal flat). Different microfacies rich with carbonate mud from the protected shelf lagoon of limited circulation below the wave base are very frequent.

Bioclasts (whole or fragmented fossil specimens) mostly derived from rudist shells and also from other reef fauna: corals, chaetetids, stromatoporoids, *etc*. indicate the interspersing of these organisms on the platform or accumulation in coquinas. According to WILSON & JORDAN (1983) and MASSE (1990, 1993), the Urgonian forms of rudists were formed on the middle shelf, *i.e.*, on the internal parts of the external platform margin and in an intraplatform lagoon (margin or inside), in which occupy different paleoecological niches.

These small ecologic reefs (small biostromes, carbonate build-up or patch reefs) built by the mentioned bioclasts and other reef organisms were formed as elevations a few meters over the sea bottom (3–6 m in recent analogues, JAMES 1983) in the interior of the platform. In addition, they represented immature ecosystems in the initial stabilization/colonization stadium and because of their fast destruction, nowadays, just products of their erosion and disintegration are found, such us in the limestone B group, *i.e.*, in MFT 2.

Fig. 8. Overthurned colonial coral from the lower part (unit 3) of the Faca Vajali–Izvor Section, eastern Serbian Carpatho--Balkanides.

A special characteristic of the sedimentary area of the investigated Urgonian Limestones of the Faca Vajali area is the exclusive presence of bioclastic varieties of all the included limestones. In addition, some fauna was found in an abnormal position, as an example the overturned coral colony in the beginning of the FacaVajali–Izvor section (Fig. 8). Chaotical distribution of the rest of macrofauna (especially rudists), recognizable transport and erosion of allochems (for example many of the orbitolinids have not a top with an embryonic chamber). All this points to constant transport, *i. e.*, to parautochthonity of all the presented biota and other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material in a depositional marine environment of very shallow subtidal and/or somewhat deeper intertidal.

Hence, it can be concluded that all these paleoenvironments, essentially infralittoral to partially or rarely littoral, with a more or less distinct water energy, probably occupy an area linked either just before the outer edge of a platform or just inside, *i. e.,* also before the inner open, to more of less protected parts of the platform lagoon.

Stratigraphy

The age of the Urgonian sediments from eastern Serbia is of great importance. Usually it is determined as Barremian–Aptian, Upper Barremian–Lower Aptian, *etc*. As is shown in the geological setting, their boundaries are distinctly determined, the upper more than the lower. In spite of the presence of rich fossil material, especially macrofauna and the absence of lithological variabilities, the precise determination of Barremian––Aptian boundary is not always sure and simple. For this reason, during earlier geological investigations of the Lower Cretaceous of eastern Serbia, the presence of Urgonian sediments and their Barremian and/or Aptian age was mostly established.

In the Serbian geological literature attempts were made to subdivide the mentioned stages. The first results were given by V. PETKOVIĆ who considered that the boundary between the Barremian and the Aptian on the Tupižnica Mt. lies "eventually between limestones with pachydont shells and orbitolinid limestones" (PETKOVIĆ 1908 from JANKIČEVIĆ 1978, p. 161). The question of boundary in the investigated Urgonian complex of eastern Serbia was of special interest for JANKIČEVIĆ (1978). The same author defined the whole complex as Barremian–Lower Aptian, although he considered all separated limestone facies as Barremian (whole, or only their upper part) to Lower Aptian, and other terrigenous non-carbonate sediments as only Lower Aptian.

Also of interest is part from his conclusion: "The boundary between the Barremian and Aptian stage is most often provisory undertaken, because exists a gradual transition. But, the fossil association of organisms, in which are numerous *Palorbitolina lenticularis* (Blum.), surely confirms Lower Aptian" (*op. cit*., p. 183). A very similar is opinion is shared by RADULOVIĆ (2003). She decided that the parts of the columns of Urgonian sediments at the localities Faca Vajali and Mali Izvor with a defined microassociation of *Palorbitolina lenticularis* and *Neotrocholina aptiensis* are of Lower Aptian age. Unfortunately, their conclusions were not confirmed with detailed defined stratigraphic characteristics of the whole microassociation and their members. In addition, the mentioned foraminifera have a range from the Late Barremian to the earliest Late Aptian (ARNAUD--VANEAU *et al*. 1991, and many other earlier and newer papers).

However, for stratigraphic/biostratigraphic subdivision of the Urgonian sediments, microfossils are much more suitable than the present macrofauna. This paper is one attempt to precisely define the stratigraphic ranges of the present foraminifera, *i.e*., to separate characteristic microfossil associations into Barremian and/or Aptian. For this reason, the vertical distributions of the determined foraminifera species in both studied sections were given (Figs. 2 and 5). It was possible to separate three foraminiferal microassociations:

– first, for the Barremian (*Charentia cuvillieri* (even from the Berriasian), *Praereticulinella cuvillieri* and *Neotrocholina* cf. *friburgensis*),

– second, for the Late Barremian and the Early Aptian (*Melathrokerion valserinensis*, *Choffatella decipiens* (even from the Hauterivian), *Sabaudia minuta*, *Pfenderina* cf. *globosa*, *Orbitolinopsis buccifer*, *Orbitolinopsis* gr. *cuvillieri kiliani*, *Palorbitolina lenticularis*, *Neotrocholina* cf. *aptiensis*, and *Neotrocholina* cf. *infragranulata* (even from the Berriasian), and

– third, for the Aptian, even the Albian (*Mayncina bulgarica*, *Sabaudia* cf. *briacensis* and *Sabaudia capitata*).

Fig. 9. Late Baremian–Early Aptian foraminifera from the Faca Vajali–Izvor Section, eastern Serbian Carpatho-Balkanides (determined by S. POLAVDER). **1,** *Charentia cuvillieri* NEUMANN, thin-section MS 3023; **2, 3,** *Mayncina bulgarica* LAUG, PEYBERNES & REY, Fig. 5.2, thin-section MS 3040, Fig. 5.3, thin-section MS 3041; **4, 5,** *Choffatella decipiens* SCHLUMBERGER, thin-section MS 3041; **6, 7,** *Praereticulinella cuvillieri* DELOFRE & HAMAOUI, Fig. 5.6, thin-section MS 3029, Fig. 5.7, thin-section MS 3038; **8,** *Martinottiella jucunda* ARNAUD-VANNEAU, thin-section MS 3041; **9–11,** *Orbitolinopsis buccifer* ARNAUD-VANNEAU & THIEULOY, Fig. 5.9, and 5.10, thin-section MS 3027, Fig. 5.11, thin-section MS 3022; **12,** *Melathrokerion valserinensis* BROENNIMANN & CONRAD, thin-section MS 3028; **13–19,** *Palorbitolina lenticularis* (BLUMENBACH), Figs. 5.14. and 5.16–18, thin-section MS 3036, Fig. 5.13, thin-section MS 3034, Figs. 5.15. and 5.19, thin-section MS 3035; **20, 21,** *Sabaudia* cf. *capitata* ARNAUD-VANNEAU, Fig. 5.20, thin-section MS 3042, Fig. 5.21. thin-section MS 3036; **22,** *Sabaudia* cf. *briacensis* ARNAUD-VANNEAU, thin-section MS 3041; **23, 24,** *Neotrocholina* cf. *aptiensis* IOCHEVA, Fig. 5.23, thin-section MS 3039, Fig. 5.24, thin-section MS 3027; **25,** *Neotrocholina* cf. *infragranulata* (NOTH), thin-section MS 3024; **26,** *Neotrocholina* cf. *friburgensis* GUILLAUME & REICHEL, thin-section MS 3031; **27,** *Nezzazatinella* sp., thin-section MS 3038; **28,** *Earlandia*? *conradi* ARNAUD-VANNEAU (left) and *Nezzazata* sp. (right), thin-section MS 3041; **29, 30,** Miliolids (?*Quinqueloculina* sp.), Fig. 5.29, thin-section MS 2029, Fig. 5.30, thin.section MS 3037; **31, 32,** *Nezzazata* sp., Fig. 5.31, thin-section MS 3039, Fig. 5.32, thin-section MS 3041. Figs. 5.14, 5.15, 5.29, 5.30. are × 6,5 and all other Figs. are × 13.

However, some foraminiferal taxa from different associations in the whole investigated interval appear together, mutually overlap, and it was not possible to put a boundary between them, *i.e.*, between Barremian and Aptian. Therefore, in this paper, the age of the studied part of the Urgonian Limestones is still treated as the interval Late Barremian–Early Aptian. Most probably, the main cause for this is the exclusively bioclastic character of the investigated part of the Urgonian Limestones, in which are obviously inserted organisms of different ages and from different biotops.

A large part of the mentioned interval belongs to the *Palorbitolina lenticularis* Zone according to the range of this foraminifera, one of the most important taxon and geographically widespread in the Tethys. Since detailed investigations and a more exact dating of the whole Urgonian geologic column of eastern Serbia are missing, their later biostratigraphic sudivision was not possible. Also, real knowledge about the lower and upper boundary of the investigated Late Baremian–Early Aptian Urgonian Limestone in the Boljevac area does not exist.

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References

ANĐELKOVIĆ, M. & NIKOLIĆ, P. 1980. *Tectonics of the Karpatho-Balkanides of Yugoslavia*. Univerzitet u Beogradu, Monografija 20: 248 pp. (in Serbian, English summary).

ARNAUD-VANNEAU, A. 1980. Micropaléontologie, paléoécologie et sédimentologie d'une plate-forme carbonatée de la marge passive de la Téthys: L'Urgonien du Vercors septentrional et de la Chartreuse (Alpes occidentales). *Geologie Alpine, Memorie*, 11/3: 874 pp.

ARNAUD-VANNEAU, A., DECROUEZ, D., LONGO-SALVADOR, G., LUPERTO-SINNI, E., MASSE J.-P., PEYBERNES, B., PIRINI-RADRIZZANI, C., PUGLIESE, N., RADOIČIĆ, R., SARTORIO, D., SKOUSIS-CORONEAU, V. & VELIĆ, I. 1991. IGCP Project 262 Tethyan Cretaceous Correlation; Working Group on Platform Benthic Foraminifera: Distribution of the Lower Creatceous Benthic Foraminifera on the Adriatic Area and Northern Margin of the Tethys. Second International Symposium on the Adriatic Carbonate Platform, relation with adjacent regions, Zadar, May 12–18. 1991, Abstracts, p. 22 (and working tables).

DIMITRIJEVIĆ, M.D. 1997. *Geology of Yugoslavia*. Geological Institute Gemini, Special Publication, 187 pp. Barex, Belgrade.

DUNHAM, J.B. 1962. Classification of carbonate rocks according to depositional texture. *In*: HAM, W.E. (ed.), Classification of Carbonate rocks. *American Association of Petroleum Geologists*, *Memoir*, 1: 108–121.

FLÜGEL, E. 2004. *Microfacies of Carbonate Rocks. Analysis, Interpretation and Application*. 976 pp. Springer-Verlag, Berlin-Heidelberg.

GRUBIĆ, A. & JANKIČEVIĆ J. 1973. Paraplateforme carbonatique au Jurassique superieur et au Cretace inferieur de la Serbie orientale. *Zapisnici Srpskog geološkog društva za 1972. godinu (Zbor 25. IV 1972)*, 73–85 i 178–179 (in Serbian, French summary).

GUŠIĆ, I. & JELASKA, V. 1990. *Upper Cretaceous stratigraphy of the Island of Brač within the geodynamic evolution of the Adriatic carbonate platform*. Djela Jugoslavenske akademije znanosti i umjetnosti, Razred za prirodne znanosti, 69: 160 pp. (in Croatian, English summary).

JAMES, N.P. 1983. Reef environment. *In*: SCHOLLE, P.A., BEBOUT, D.G. & MOORE, C.H. (eds.), Carbonate depositional environments. *American Association of Petroleum Geologists*, *Memoir*, 33: 346–440.

JANKIČEVIĆ, J. 1978. Barrémien et Aptien des parties moyennes des Carpatho-Balkanides dans la Serbie orientale au point de vue du développement d'Urgonien. *Geološki anali Balkanskoga poluostrva,* 42: 103–194 (in Serbian, French summary).

JANKIČEVIĆ, J. 1996. Urgonian of the Carpatho-Balkanides of Serbia in the light of formation analysis. *Geološki anali Balkanskoga poluostrva,* 60 (2): 29–40 (in Serbian and English).

KARAMATA, S., KRSTIĆ, B., DIMITRIJEVIĆ, M.D., DIMITRIJEVIĆ, M.N., KNEŽEVIĆ, V., STOJANOV, R. & FILIPOVIĆ, I. 1997. Terranes between the Moesian Plate and the Adriatic Sea. *In*: PAPANIKOLAOU, D. (ed.), IGCP Project No 276 – Terrane maps and terrane descriptions. *Annales Géologiques des Pays Helléniques,* 1e Serie, 37(1996–1997): 429–477.

KRÄUTNER, H.–G. & KRSTIĆ, B. 2003. *Geological Map of the Carpatho–Balkanides between Mahadia, Oravita, Nis and Sofia (Scale 1:300 000)*. Republic of Serbia, Ministry for Science and Environmental Protection, Directorate for Environmental Protection, Geoinstitute, Belgrade.

LONGMAN, M.W. 1985. A process approach to recognizing facies of reef complexes. *In*: TOOMEY, D.F. (ed.), European fossil reef models. *Society of Economic Paleontologists and Mineralogists, Special Publication*, 30: 9–40.

MARAN, A. 1996. *Echinoidea* from the Urgonian sediments of eastern Serbia. Unpublished M. Sc. thesis, Rudarsko-geološki fakultet, Univerzitet u Beogradu, 77 pp. (in Serbian, English abstract).

MARAN, A. 1998. Urgonian Echinoids in the area of Boljevac (Eastern Serbia). *Geološki anali Balkanskoga poluostrva,* 62: 193–211 (in Serbian and English).

MARAN, A. 1999. Conservation of Urgonian profiles – a part of eastern Serbia's geoheritage (Yugoslav Carpatho-Balkanides). *ProGeo News*, No 2, p. 7.

MARAN, A., JEMCOV, I., MILANOVIĆ, S. & STEVANOVIĆ, Z., 2005. Dam construction or geoheritage conservation? An example from Eastern Serbia. *Proceedings of the ProGeo WG-1 subregional meeting "Ten years geological heritage in SE Europe"* (Tirana, 2005), 18–19.

MASSE, J.-P. 1992. The Lower Cretaceous Mesogean benthic ecosystems: palaeoecological aspects and palaeobiogeographic implications. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 91: 331–345.

MASSE, J.-P. 1993. Valanginian–Early Aptian carbonate platform from Provance, southeastern France. *In*: TONI SIMO, J.A., SCOTT, R.W. & MASSE, J.-P. (eds.), Creataceous Carbonate Platforms. *American Association of Petroleum Geologists*, *Memoir*, 56: 363–374.

MASSE, J.-P. & PHILIP, J. 1981. Creataceous coral-rudist buildups of France. *In*: TOOMEY, D.F. (ed.), European fossil reef models. *Society of Economic Paleontologists and Mineralogists, Special Publication*, 30: 399–426.

RADULOVIĆ, B., 2003. Lower Cretaceous brachiopods of the Kučaj–Svrljig Zone (eastern Serbia). Unpublished M. Sc. thesis, Rudarsko-geološki fakultet, Univerzitet u Beogradu, 83 pp. (in Serbian, English abstract).

WILSON, J.L. 1975. *Carbonate facies in geological history*. 471 pp. Springer-Verlag, Berlin-Heidelberg-New York.

WILSON, J.L. & JORDAN C. 1983. Middle Shelf Environment. *In*: SCHOLLE, P.A., BEBOUT, D.G. & MOORE, C.H. (eds.), Carbonate depositional environments. *American Association of Petroleum Geologists*, *Memoir*, 33: 298–343.

Appendix: Determined limestone types and fossils in the thin sections

Faca Vajali–Izvor Section

MS 3020. Bioclastic wackestone/floatstone; fragments of bivalves, brachiopods, bryozoans, corals, echinoderms; chaetetids *Chaetetopsis rumanus* (SIMONESCU); *Orbitolinopsis* gr. *cuvillieri kiliani, Haplophragmoides* cf. *globosus* LOZO, *Charentia cuvillieri* NEUMANN, *Rumanoloculina* sp.; Solenoporaceae, *Coptocampylodon fontis* PATRULIUS, *Terquemella* sp.

MS 3021. Bioclastic wackestone/floatstone; fragments of bivalves, brachiopods, bryozoans, corals, stromatoporoids, echinoderms; *Orbitolinopsis buccifer* ARNAUD-VANNEAU & THIEULOY, *Orbitolinopsis* gr. *cuvillieri kiliani, Sabaudia* cf. *capitata* ARNAUD VANNEAU, *Pfenderina* cf. *globosa* FOURY, miliolids; *Lithocodium aggregatum* ELLIOT, *Salpingoporella pygmea* (GUEMBEL), *Coptocampylodon fontis* PATRULIUS, *Zittelina* sp., *Triploporella* sp.

MS 3022. Bioclastic wackestone/packstone; fragments of bivalves, brachiopods, bryozoans, corals, echinoderms; *Orbitolinopsis buccifer* ARNAUD-VANNEAU & THIEULOY, *Charentia cuvillieri* NEUMANN, *Trocholina* sp.; *Boueina* sp., *Gyroporella* cf. *lukicae* SOKAC & VELIC, *Salpingoporella pygmea* (GUEMBEL), *Salpingoporella* sp.

MS 3023. Bioclastic wackestone/packstone; fragments of bivalves, brachiopods, bryozoans, corals, echinoderms; *Charentia cuvillieri* NEUMANN; *Salpingoporella pygmea* (GUEMBEL), *Neomeris* sp., *Zittelina* sp.

MS 3024. Bioclastic wackestone/packstone; fragments of bivalves (rudists and others), corals, calcareous sponges, bryozoans, stromatoporoids, and others; *Charentia* cf. *cuvillieri* NEUMANN, *Melathrokerion* cf. *valserinensis* BROENNIMANN & CONRAD, *Neotrocholina* cf. *infragranulata* (NOTH), *Pseudotriloculina* sp., *Pyrgo* sp., *Rumanoloculina* sp., *Spirillina* sp.; *Lithocodium aggregatum* ELLIOT, *Coptocampylodon fontis* PATRULIUS, *Neomeris* sp., *Terquemella* sp., *Zittelina* sp.

MS 3025. Bioclastic packstone/wackstone; fragments and sceletal detritus of bivalves, gastropods, echinoderms, bryozoans; *Orbitolinopsis buccifer* ARNAUD-VANNEAU & THIEULOY, *Charentia cuvillieri* NEUMANN, *Pseudocyclammina* cf. *P. lituus* (YOKOHAMA), *Pfenderina* cf. *globosa* FOURY, *Nezzazata* sp., *Verneuilina* sp., *Sigmoillina* sp. (and other miliolids), *Neotrocholina* sp., *Spirillina* sp., sessile foraminifera; undeterminable dasycladaceans.

MS 3026. Bioclastic boundstone/wackestone; large colonial coral structure.

MS 3027. Bioclastic floatstone/wackestone; fragments of bivalves (rudists: *Monopleura* sp. and others), gastropods, calcareous sponges, bryozoans, *etc*.; *Orbitolinopsis buccifer* ARNAUD-VANNEAU & THIEULOY, *Palorbitolina lenticularis* (BLUMENBACH), *Orbitolinopsis* sp., *Nezzazata isabellae* ARNAUD-VANNEAU & SLITER, *Neotrocholina* cf. *aptiensis* IOCHEVA, *Ammobaculites* sp., *Charentia* sp., *Melathrokerion* sp., *Everticyclammina* sp., *Bolivinopsis* sp., sessile foraminifera *Coscinophragma* sp.; cyanobacterial crusts, *Boueina* cf. *hochstetteri* TOULA, *Boueina* sp.; other Halimedaceae; *Acroporella* sp.

MS 3028. Bioclastic floatstone; fragments of bryozoans; microgastropod *Nerinea* sp.; *Palorbitolina lenticularis* (BLUMENBACH), *Charentia cuvillieri* NEUMANN, *Melathrokerion valserinensis* BROENNIMANN & CONRAD, *Mayncina* sp., tiny miliolids, *Lenticulina* sp.; cyanobacterial crusts, *Polystrata album* (PFENDER), *Lithocodium aggregatum* ELLIOT, *Gyroporella lukicae* SOKAC & VELIC, *Triploporella* sp., *Neomeris* sp.

MS 3029. Bioclastic packstone/floatstone; fragments of gastropods, *etc*.; *Palorbitolina lenticularis* (BLUMENBACH) and many other undeterminable orbitolinids, *Haplophragmoides* cf. *globosus* LOZO,

Choffatella decipiens SCHLUMBERGER, *Praereticulinella cuvillieri* DELOFRE & HAMAOUI, *Pfenderina* cf. *globosa* FOURY, *Nezzazatinella* sp., *Everticyclammina* sp., *Lenticulina* sp., miliolids (? *Quinqueloculina* sp. and others); Udoteaceae (*Boueina* cf. *hochstetteri* TOULA, *Boueina* sp.); other Halimedaceae; *Terquemella* sp.

MS 3030. Bioclastic grainstone; fragments and detritus of macrofauna, *e.g.*, bryozoans and others; microgastropod; *Orbitolinopsis* cf. *nikolovi* PEYBERNES, CONRAD & CUGNY, and many other undeterminable orbitolinids, *Ammobaculites* sp., *Everticyclammina* sp., miliolids, sessile foraminifera; *Boueina* cf. *hochstetteri* TOULA, *Boueina* sp.; other Halimedaceae; *Coptocampylodon fontis* PATRULIUS, *Terquemella* sp.

MS 3031. Bioclastic grainstone/packstone; tiny organic debris of crinoids, bryozoans; microgastropod (*Nerinea* sp.); *Palorbitolina lenticularis* (BLUMENBACH), *Orbitolinopsis* sp. and many other undeterminable orbitolinids, *Charentia cuvillieri* NEUMANN, *Neotrocholina aptiensis* IOCHEVA, *Neotrocholina* cf. *friburgensis* GUILLAUME & REICHEL, *Ammobaculites* sp., small miliolids, *Neotrocholina* sp., *Lenticulina* sp.; *Terquemella* sp.

MS 3032. Bioclastic packstone/grainstone; fragments of macrofauna, *e.g.*, bryozoans and others; microgastropods; *Palorbitolina lenticularis* (BLUMENBACH), *Charentia cuvillieri* NEUMANN, *Melathrokerion valserinensis* BROENNIMANN & CONRAD, *Neotrocholina* cf. *aptiensis* IOCHEVA, *Mayncina* sp., *Sabaudia* sp., *Rumanoloculina* sp., *Neotrocholina* sp.; *Boueina* sp., *Coptocampylodon fontis* PATRULIUS, *Terquemella* sp., *Neomeris* sp. and numerous algal fragments.

MS 3033. Bioclastic wackestone/packstone; tiny sceletal detritus with numerous bryozoans; *Palorbitolina lenticularis* (BLUMENBACH) and other orbitolinids, *Nezzazata* sp., *Lenticulina* sp.; *Marinella lugeoni* PFENDER, *Boueina hochstetteri* TOULA and other algal debris.

MS 3034. Bioclastic packstone/wackestone; fragments of bryozoans, crinoids, echinoids (*e.g.*, spines, *etc.*), stromatoporoids, annelids, *etc.*; *Palorbitolina lenticularis* (BLUMENBACH) and other numerous orbitolinids, *Neotrocholina aptiensis* IOCHEVA, *Sabaudia* sp., *Neotrocholina* sp.; *Boueina* sp., *Terquemella* sp.

MS 3035. Bioclastic packstone/wackestone with orbitolinids; fragments of different macrofauna; *Palorbitolina lenticularis* (BLUMENBACH) and other numerous orbitolinids, *Choffatella decipiens* SCHLUMBERGER, *Martinottiella jucunda* ARNAUD-VANNEAU, *Neotrocholina* cf. *infragranulata* (NOTH), miliolids, *Neotrocholina* sp, *Lenticulina* sp.; *Boueina* sp., *Terquemella* sp., *Neomeris* sp.

MS 3036. Bioclastic packstone/wackestone; fragments and detritus of macrofauna; *Palorbitolina lenticularis* (BLUMENBACH) and other numerous orbitolinids, *Pseudocyclammina* cf. *lituus* (YOKOHAMA), *Praereticulinella cuvillieri* DELOFRE & HAMAOUI, *Sabaudia* cf. *capitata* ARNAUD-VANNEAU, *Debarina* sp., numerous miliolids, *Lenticulina* sp.

MS 3037. Bioclastic packstone with orbitolinids; fragments and detritus of macrofauna; *Palorbitolina lenticularis* (BLUMENBACH) and other numerous orbitolinids, *Choffatella decipiens* SCHLUMBERGER, *Sabaudia capitata* ARNAUD-VANNEAU, *Ammobaculites* sp., *Nezzazatinella* sp., *Pseudotextulariella* sp., *Dobrogelina* sp., numerous miliolids (?*Quinqueloculina* sp. and others); *Boueina* sp.

MS 3038. Bioclastic wackestone/packstone; fragments of bivalves, crinoids, echinoid spines, corals; microgastropod; *Palorbitolina lenticularis* (BLUMENBACH), *Debarina hahounerensis* FOURCADE, RAOULT & VILA, *Choffatella decipiens* SCHLUMBERGER, *Pseudocyclammina* cf. *lituus* (YOKOHAMA), *Praereticulinella cuvillieri* DELOFRE & HAMAOUI, *Nezzazatinella* sp., *Everticyclammina* sp., *Sabaudia* sp., *Neotrocholina* sp.; *Vermiporella*? *tenuipora* CONRAD.

MS 3039. Bioclastic wackestone/packstone with coral; fragments of bivalves, crinoids, echinoid spines; *Palorbitolina lenticularis* (BLUMENBACH), *Debarina hahounerensis* FOURCADE, RAOULT & VILA, *Mayncina bulgarica* LAUG, PEYBERNES & REY, *Neotrocholina* cf. *aptiensis* IOCHEVA, *Sabaudia capitata* ARNAUD-VANNEAU, *Daxia* sp., *Ammobaculites* sp., *Nezzazata* sp., miliolids, *Lenticulina* sp.

MS 3040. Bioclastic packstone; fragments and detritus of bivalves, corals, *etc.*; microgastropod; *Reophax*? *giganteus* ARNAUD-VANNEAU, *Mayncina bulgarica* LAUG, PEYBERNES & REY, *Choffatella decipiens* SCHLUMBERGER, *Neotrocholina* cf. *friburgensis* GUILLAUME & REICHEL, *Pseudocyclammina* sp., *Sabaudia* sp., *Quinqueloculina* sp. and numerous other miliolids, *Lenticulina* sp.; *Boueina* sp.

MS 3041. Bioclastic packstone/wackestone; fragments and detritus of bivalves, corals, *etc.*; *Palorbitolina lenticularis* (BLUMENBACH), *Reophax*? *giganteus* ARNAUD-VANNEAU, *Mayncina bulgarica* LAUG, PEYBERNES & REY, *Choffatella decipiens* SCHLUMBERGER, *Sabaudia* cf. *briacensis* ARNAUD-VANNEAU, *Sabaudia* cf. *capitata* ARNAUD--VANNEAU, *Pseudocyclammina* cf. *lituus* (YOKOHAMA), *Martinottiella jucunda* ARNAUD-VANNEAU, *Earlandia*? *conradi* ARNAUD VANNEAU, *Nezzazata* sp., *Lenticulina* sp.

MS 3042. Bioclastic packstone/wackestone; fragments and detritus of bivalves, corals, *etc.*; *Palorbitolina lenticularis* (BLUMENBACH), *Mayncina bulgarica* LAUG, PEYBERNES & REY, *Choffatella decipiens* SCHLUMBERGER, *Pseudocyclammina lituus* (YOKOHAMA), *Sabaudia briacensis* ARNAUD-VAN-

NEAU, *Sabaudia* cf. *capitata* ARNAUD-VANNEAU, *Martinottiella jucunda* ARNAUD-VANNEAU, *Lenticulina* sp.

MS 3043. Bioclastic packstone/grainstone; fragments and detritus of bivalves, corals, *etc*.; *Mayncina bulgarica* LAUG, PEYBERNES & REY, *Sabaudia briacensis* ARNAUD-VANNEAU, *Sabaudia minuta* (HOFKER JR.), *Martinottiella jucunda* ARNAUD-VANNEAU, *Neotrocholina aptiensis* IOCHEVA, *Daxia* sp., *Nezzazata* sp., *Rumanoloculina* sp., *Quinqueloculina* sp. and other miliolids, *Trocholina* sp.

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MS 3000. Biolithoclastic wackestone /packstone; tiny organic debris, predominantly from bivalves, gastropods, *etc*.; *Earlandia*? *conradi* ARNAUD-VANNEAU, *Nautiloculina* sp., *Bolivinopsis* sp.

MS 3001. Lithobioclastic wackestone/packstone; tiny organic debris, predominantly from bivalves, gastropods, *etc*.; *Polystrata album* (PFENDER) DENIZOT, "*Epimastopora*" sp.; *Vermiporella*? *tenuipora* CONRAD.

MS 3002. Bioclastic grainstone; tiny organic debris of bivalves, echinoderms (small echinoid spines, *etc*.), algae, *etc*.; microgastropods.; *Palorbitolina lenticularis* (BLUMENBACH), *Mayncina bulgarica* LEUG, PEYBERNES & REY, *Charentia cuvillieri* NEUMANN, *Nezzazata* sp., *Pseudotextulariella* sp.; *Polystrata album* (PFENDER) DENIZOT.

MS 3003. Bioclastic wackestone/packstone; tiny organic debris of bivalves, echinoderms (echinoid spines, *etc*.), algae, *etc*.; microgastropods.; *Palorbitolina lenticularis* (BLUMENBACH), *Sabaudia capitata* ARNAUD-VANNEAU, *Sabaudia minuta* (HOFKER), miliolids, *Neotrocholina* sp.

MS 3004. Bioclastic grainstone; fine organic debris, bioclasts of molluscs and tiny benthic foraminifera.

MS 3005. Bioclastic grainstone; fine organic debris, bioclasts of molluscs and tiny benthic foraminifera; *Bolivinopsis* sp.

MS 3006. Bioclastic wackestone; fragments of rudists and other bivalves; microgastropods; *Nautiloculina* sp., *Neotrocholina* sp.

MS 3007. Bioclastic wackestone; fragments of rudists and other bivalves; microgastropods; *Neotrocholina* cf. *friburgensis* GUILLAUME & REICHEL.

MS 3008. Bioclastic packstone/wackestone; fragments of rudists, stromatoporoids, *etc*.; *Charentia cuvilllieri* NEUMANN, *Nezzazata* sp., *Neotrocholina* sp.; different algal structures (e.g. cyanobacterias, *etc*.).

MS 3009. Bioclastic packstone**;** fragments of rudists, stromatoporoids, *etc*.; *Charentia cuvillieri* NEUMANN, *Sabaudia* sp.; *Terquemella* sp.

MS 3010. Bioclastic packstone; fragments and detritus of rudists and other bivalves, gastropods, crinoids, echinoids (*e.g*. spines, *etc*.), stromatoporoids, and others; *Palorbitolina lenticularis* (BLUMENBACH) and other undeterminable orbitolinids; *Mayncina bulgarica* LEUG, PEYBERNES & REY, *Charentia cuvillieri* NEUMANN, *Nautiloculina* sp.; large algal nodule, *Coptocampylodon fontis* PATRULIUS.

MS 3011. Bioclastic wackestone/packstone; fragments and detritus of rudists and other bivalves, gastropods, crinoids, echinoid spines, stromatoporoids, and others; *Nautiloculina* cf. *bronnimanni* ARNAUD-VANNEAU & PEYBERNES, *Charentia cuvillieri* NEUMANN, *Choffatella decipiens* SCHLUMBERGER, *Neotrocholina* cf. *friburgensis* GUILLAUME & REICHEL, *Nezzazata* sp., *Sabaudia* sp., *Neotrocholina* sp.; *Polystrata album* (PFENDER) DENIZOT, *Coptocampylodon fontis* PATRULIUS, "*Epimastopora*" sp.

MS 3012. Bioclastic wackestone; *Palorbitolina lenticularis* (BLUMENBACH), *Sabaudia minuta* (HOFKER), *Debarina* sp., *Quinqueloculina* sp., *Pyrgo* sp. and other miliolids, *Neotrocholina* sp.; *Terquemella* sp.

MS 3013. Bioclastic wackestone; *Mayncina bulgarica* LEUG, PEYBERNES & REY, *Debarina* sp., *Quinqueloculina* sp., *Pyrgo* sp. and other miliolids, *Neotrocholina* sp.; *Polystrata album* (PFENDER) DENIZOT, *Coptocampylodon fontis* PATRULIUS.

MS 3014. Bioclastic wackestone; fragments and tiny debris of rudists, *etc*.; microgastropod; cyanobacterias, *Polystrata album* (PFENDER) DENIZOT.

MS 3015. Bioclastic wackestone/packstone; fragments and tiny debris of rudists, *etc*.; *Mayncina bulgarica* LEUG, PEYBERNES & REY, *Choffatella decipiens* SCHLUMBERGER; cyanobacterias, *Polystrata album* (PFENDER) DENIZOT.

MS 3016. Bioclastic wackestone/packstone; detritus of macrofauna (*e.g*., rudists, *etc*.); *Mayncina bulgarica* LEUG, PEYBERNES & REY, *Charentia cuvillieri* NEUMANN, *Ammobaculites* sp.; *Terquemella* sp.

MS 3017. Bioclastic wackestone/packstone; detritus of macrofauna (*e.g*., rudists, *etc*.); *Charentia* cf. *cuvillieri* NEUMANN; *Neomeris* sp.

MS 3018. Bioclastic grainstone/packstone; detritus of bryozoans, echinoderms, bivalves, *etc*.; *Palorbitolina lenticularis* (BLUMENBACH), *Mayncina* cf. *bulgarica* LEUG, PEYBERNES & REY, *Charentia cuvillieri* NEUMANN, *Choffatella decipiens* SCHLUMBERGER, *Everticyclammina* sp., *Sabaudia* sp., *Neotrocholina* sp.; *Lenticulina* sp.; *Boueina* sp.

MS 3019. Bioclastic grainstone/packstone; detritus of bryozoans, echinoderms (*e.g*. echinoid spines, *etc*.), and others; *Palorbitolina lenticularis* (BLUMENBACH), *Mayncina bulgarica* LEUG, PEYBERNES & REY, *Choffatella decipiens* SCHLUMBERGER, *Sabaudia briacensis* ARNAUD-VANNEAU, *Pfenderina globosa* FOURY, *Neotrocholina aptiensis*

IOCHEVA, *Ammobaculites* sp., *Sabaudia* sp., *Dobrogelina* sp., miliolids, *Trocholina* sp., *Neotrocholina* sp., *Lenticulina* sp.; *Boueina* sp., *Clypeina* sp., *Terquemella* sp.

Резиме

Ургонски кречњаци касног барема и раног апта југоисточних падина Кучајских планина (Карпато-балканиди, источна Србија)

У оквиру распрострањених и фацијално разноврсних доњокредних седимената Кучајског терана Карпато-балканида источне Србије нарочито су карактеристичне творевине баремског и аптског ката и посебан тип њиховог развића познат под именом ургон, ургонска фација или ургонско развиће. На два локалитета у атару села Фаца Вајали које се налази у околини Бољевца, на југоисточним падинама Кучајских планина, извршена су детаљна седиментолошка и микропалеонтолошка истраживања једног њиховог дела.

Резултати проучавања су указали да је он искључиво изграђен од биокластичних варијетета кречњака у којима су, уз бројне макро и микрофосиле, констатована четири типа микрофација: MFT 1 тј. биокластични векстони са прелазом ка пекстонима, грејнстонима или флоутстонима; MFT 2 тј. биокластични векстони са прелазом ка пекстонима; MFT 3 тј. биокластични грејнстони и MFT 4 тј. орбитолински пекстони. Такође је одређен и један тип подфација – МФТ 2А тј. биокластични векстони са прелазом ка пекстонима, ређе баундстонима. Кречњаци из MFT 1 и 3 налазе се у танко до дебело банковитим трошним до делимично распаднутим, песковито-лапоровитим, и сиво-жућкастим кречњацима са целим облицима фосила. У дебело банковитим до масивним сивим кречњацима у којима је макрофауна, најчешће рудистна, присутна искључиво у пресецима заступљени су кречњаци MFT 2 и 2А. Орбитолински пекстони (MFT 4) појављују се у оба типа биокластичних кречњака у проучаваним локалитетима села Фаца Вајали.

За дефинисање депозиционих средина истраживаних ургонских кречњака коришћене су и палеоеколошке особине утврђених микрофосила, међу којима су нарочито бројни фораминифери, а ређе алге. Скоро искључиво су присутне бентоске форме док су причвршћени фораминифери доста ретки. Међу првима се запажају аглутинантни (међу којима су нарочито бројни орбитолиниди), кречњачко порцелански (имперфоратни) тј. милиолиди и др., као и кречњачко перфоратни облици. Цијанобактерије, црвене и зелене (примерци фамилија Udoteaceae и Dasycladaeae) алге су подређене.

Интерпретација целокупне депозиционе палеосредине истраживаног дела ургонских кречњака Фаца Вајали показала је да су они стварани у морској средини веома плитког субтајдала и/или мало дубљег интертајдала. Ове, пре свега инфралиторалне до делимично, али ређе и литоралне палеосредине, са више или мање израженом динамиком воде, највероватније заузимају просторе везане за спољну ивицу платформе, или за њену унутрашњост, тј. такође за унутрашње отворене, до више или мање заштићене делове платформне лагуне. Сви присутни палеоекосистеми и недовољно консолидовани депонати у наведеним срединама су у великој мери били подложни брзом разлагању што је условило да у истраживаним деловима ургонских кречњака локалитета Фаца Вајали данас искључиво наилазимо на биокластичне варијетете кречњака и фрагментиране фосиле.

У оквиру веома богате микроасоцијације фораминифера и алги прецизно су дефинисана вертикална распрострањења утврђених фораминиферских врста што ипак није омогућило раздвајање творевина баремског и аптског ката. Утврђена је каснобаремска и раноаптска старост овог дела ургонских кречњака при чему већи део интервала припада зони *Palorbitolina lenticularis*.