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Early late Visean ammonoid faunas from the Jadar Block (NW Serbia)

DIETER KORN[1], DIVNA JOVANOVIĆ[2], MATEVŽ NOVAK[3] and MILAN N. SUDAR[4]

[1]Museum für Naturkunde, Leibniz Institute at the Humboldt University Berlin, Invalidenstraße 43, 10115 Berlin, Germany; dieter.korn@mfn-berlin.de
[2]Geological Institute of Serbia, Rovinjska 12, 11000 Belgrade, Serbia; djdivna@gmail.com
[3]Geological Survey of Slovenia, Dimičeva 14, SI-1000 Ljubljana, Slovenia; matevz.novak@geo-zs.si
[4]Department of Paleontology, Faculty of Mining and Geology, University of Belgrade, Kamenička 6, PO Box 62, 11000 Belgrade, Serbia; sudar@eunet.rs

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Abstract: The outcrop at Milivojevića Kamenjar in Družetić (Jadar Block, Vardar Zone, NW Serbia), which exposes a fossiliferous limestone olistolith, is one of the key sites for Carboniferous stratigraphy and paleogeography in the Balkan Peninsula. Its age has been debated several times, and re-examination of the succession was required. Based on ammonoids and conodonts, an interval spanning from the latest Devonian to the basal Serpukhovian is represented. From the early late Visean portion of the section, the new ammonoid genus and species *Ubites filipovici* gen. nov. et sp. nov. is described. *Entogonites tetragonus* (Kullmann, 1962), a formerly misinterpreted ammonoid species, is revised.

Key words: Mississippian, Visean, Jadar Block, Vardar Zone, NW Serbia, biostratigraphy, taxonomy, Ammonoidea.

Introduction

Paleozoic ammonoid faunas are known from only a few places in the Balkan Peninsula. The longest known of these is the occurrence of early late Visean ammonoids at Prača near Sarajevo, from which Kittl (1904a) described the peculiar *Entogonites grimmeri*. This strange ammonoid, which possesses tetrangularly coiled inner whorls, has been subsequently discovered in many places (e.g. Rhenish Mountains, British Isles, Anti-Atlas of Morocco, Alaska, Great Basin of Utah) and serves as an important index species for the intercontinental correlation of early late Visean (Mississippian) sediments.

Entogonites was also collected at Milivojevića Kamenjar site in Družetić village near Valjevo, but these records were misinterpreted by J. Kullmann in Stevanović & Kullmann (1962), who considered these specimens to be homeomorphic and therefore not related to *Entogonites*. Instead, these fossils were erroneously attributed to the late Bashkirian genus *Gastrioceras*, for which J. Kullmann (op. cit., p. 88) introduced the new subgenus *Branneroceratoides*.

The outcrop in the Družetić area (Fig. 1) is important for a number of reasons. It is the richest Carboniferous ammonoid locality in the Balkan Peninsula, situated in a region, which is not fully understood in terms of its paleogeographic position between Laurussia and Gondwana. It contains two productive ammonoid horizons, allowing precise biostratigraphic assignment and thus a correlation with time equivalent faunas from Northern and Western Europe, North Africa, the Urals, Novaya Zemlya, etc. The succession is fully composed of limestones, enabling the sampling of conodonts and thus the chance to study a second fossil group for biostratigraphy.

In a series of papers the results of a re-study of the ammonoid and conodont faunas from the Milivojevića Kamenjar section and age determination, based on the current state of knowledge, will be presented (e.g. Korn et al. in print). In this first paper some of the newly determinated ammonoids from the "upper ammonoid horizon" will be described, and also the new stratigraphic position of this important fossil horizon will be established.

Geographical position, geological context, and general stratigraphy of the outcrop in Družetić

The Paleozoic sedimentary rocks exposed in the area of Družetić village belong to the Jadar Block, which is geographically located on the southern margin of the Pannonian Basin: mostly in north-western Serbia, southern Srem, and partially westward over the Drina River in eastern Bosnia (Fig. 1). The name of this tectonostratigraphic unit, which is now a part of the Vardar Zone, derived from the "Jadar development of Paleozoic" (Simić 1938).

The Jadar Block is an isolated, exotic block terrane, where Dinaridic features predominate. It was incorporated into the Vardar Zone before the Late Cretaceous (Karamata et al. 2000; Karamata 2006, etc.). It is surrounded by the Vardar Zone Western Belt, except for the south-easternmost part, where it is in direct contact with the Kopaonik Block and Ridge Unit, which is also a part of the Vardar Zone (Fig. 1). In this area, deposition of sediments took place during the Variscan and early Alpine evolution with obvious similarities to time-equivalent successions of the "Bükkium" (NE Hungary), the Sana-Una terranes (NW Bosnia and Herzegovina), and even the Carnic Alps (Protić et al. 2000; Filipović et al. 2003).

Carboniferous formations of the Jadar Block, as part of the late Variscan sedimentary cycles, comprise both autochtho-

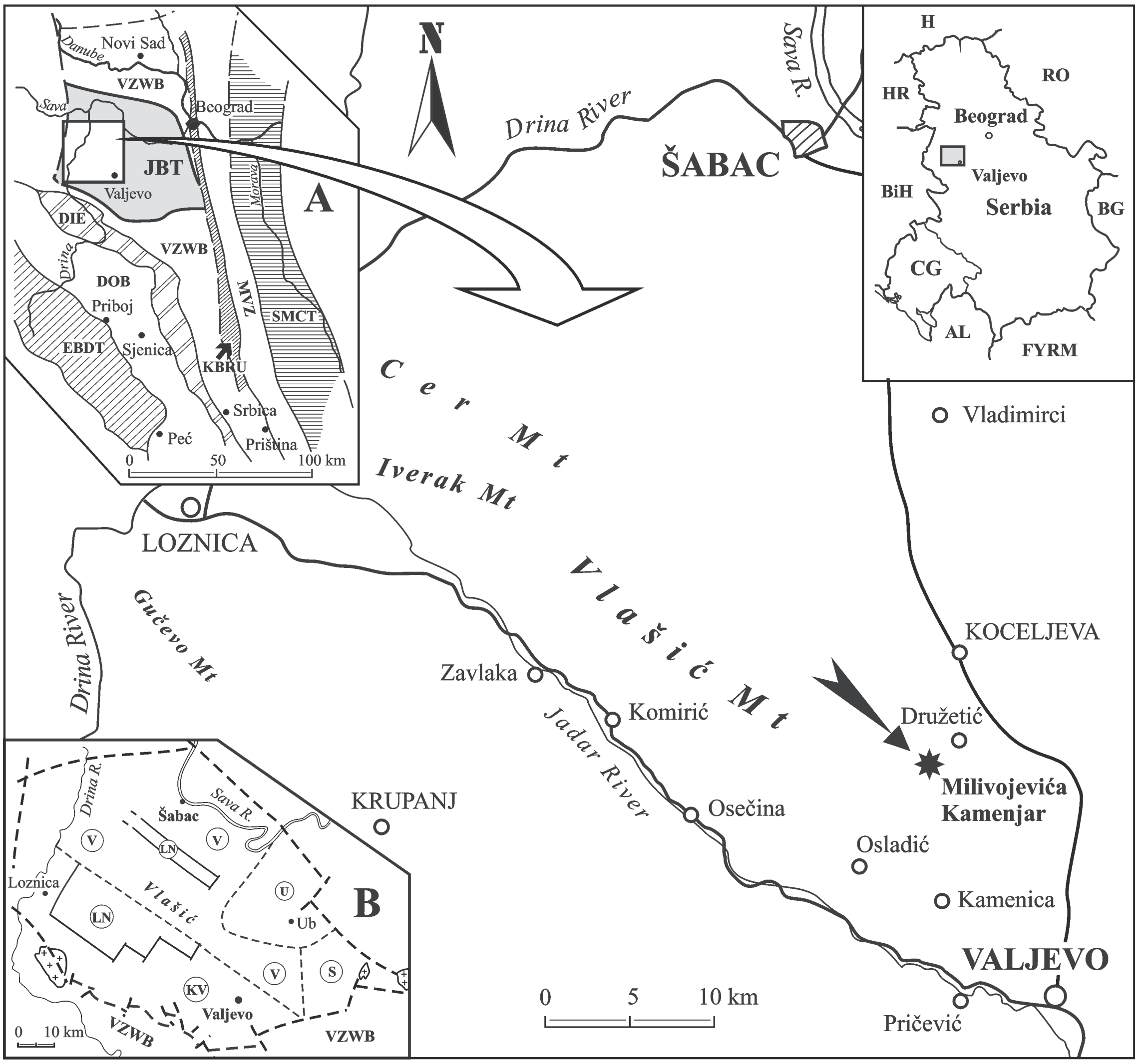

Fig. 1. Location of the Milivojevića Kamenjar section, Jadar Block, Vardar Zone (NW Serbia). **A** — Terranes of part of the Balkan Peninsula (Karamata et al. 2000): SMCT — Serbian-Macedonian Composite Terrane; MVZ — Main Vardar Zone; KBRU — Kopaonik Block and Ridge Unit; VZWB — Vardar Zone Western Belt; JBT — Jadar Block Terrane; DIE — Drina-Ivanjica Element; DOB — Dinaridic Ophiolite Belt; EBDT — East Bosnian-Durmitor Terrane. **B** — Units of the Jadar Block Terrane (simplified from Filipović et al. 2003): KV — Krupanj-Valjevo; V — Vlašić; S — Slovac; U — Ub; LN — Likodra Nappe.

nous and allochthonous marine rocks. The former, developed in the Jadar Autochthon (Krupanj-Valjevo, Vlašić, Slovac, and Ub Units), are divided by structural and facial criteria into clastic flysch (Variscan flysch or Vlašić Formation), pelagic carbonates (Družetić Formation), and molasse sequences (Ivovik Formation, Kriva Reka Formation) (Fig. 2). The rocks of the Jadar Allochthon (Likodra Nappe) are characterized by an apparently continuous succession of deep-water deposits (Variscan flysch) followed by transitional, basinal carbonates (Đulim Formation) and shallow marine carbonate-terrigenous sediments mainly with biohermal characteristics (Rudine Formation, Stojkovići Formation, and Stolice Limestone Formation) (Fig. 2).

One of the main characteristics of the late Variscan succession in the Jadar Block is molasse-type sediments, which are deposited only in the Jadar Autochthon (Filipović 1995; Filipović et al. 2003). The terrestrial debris flow-type sediments of the Ivovik Formation (Krupanj-Valjevo, Vlašić and Ub Units), were formed first and the marine offshore thick fusulinacean carbonates without siliciclastics of the Kriva Reka Formation (only in the Krupanj-Valjevo Unit on the Jadar Paleozoic southern margin) were deposited later. The Ivovik Formation was deposited in the middle parts of the Moscovian (Podolskian). The age of the Kriva Reka Formation is from late Moscovian (Myachkovian) to Early Permian (Asselian). It lies between the olistostrome Ivovik Formation and the transgressive Middle Permian clastics (Bobova Breccia and Cerova Formation) (Filipović et al. 2003) (Fig. 2).

The Ub Unit, as the north-eastern extension of the Jadar Autochthon, occupies a large area on the left side of the Ub River in the Tamnava Basin, where it is mostly covered with Neogene and Triassic sediments. During the Middle Devonian to Early Carboniferous (Mississippian), pelagic limestones of the Družetić Formation were deposited on the intrabasinal

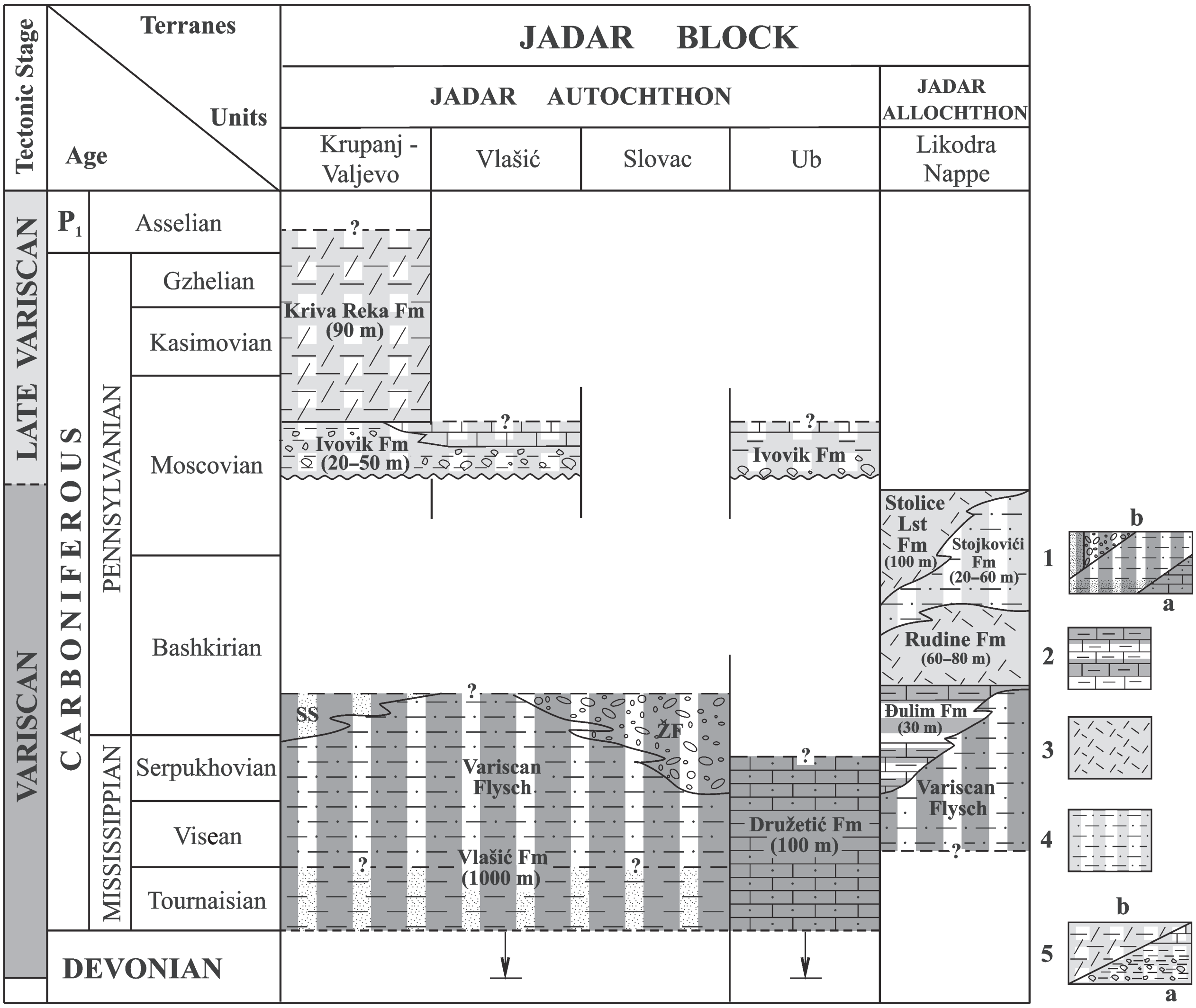

Fig. 2. Carboniferous formations developed in the Jadar Block during the Variscan (only Carboniferous part) and late Variscan sedimentary cycles (modified and simplified from Filipović et al. 2003). Abbreviations and legend: **SS** — Stupnica Sandstone Formation; **ŽF** — Županjac Fm; **1a** — bathyal, pelagic carbonates (Družetić Fm); **1b** — flysch (turbidites), flysch-like sediments (Variscan Flysch, Vlašić Fm, Stupnica Sandstone Fm, Županjac Fm); **2** — open shelf, basinal, platform slope carbonates (Đulim Fm); **3** — shallow marine carbonates (Rudine Fm, Stolice Limestone Fm); **4** — intertidal and shallow subtidal clastics (Stojkovići Fm); **5** — molasse-type sediments; 5a — (Ivovik Fm), 5b — (Kriva Reka Fm).

rise. Subsequently, mountain massifs of the Ub Unit were formed in connection with the Asturian orogeny. They follow transgressively over the mentioned pelagic limestones as the products of gravity sliding (siltstones with limestone clasts and olistoliths) followed by alternations of massive, bedded and thin-bedded silty limestones with woody plant remains. These deposits were named the Ivovik Formation according to their analogous developments with the same Formation in the Krupanj-Valjevo Unit (Filipović 1995). In the Ub Unit the deposition finished with these sediments.

In the wider area of the village of Družetić, 24 km north of Valjevo near the road Valjevo-Koceljeva-Šabac and on the north-eastern slopes of the Vlašić Mountains (NW Serbia) (Fig. 1), the older, olistostromal part of the Ivovik Formation is developed. It is made up of a siltstone matrix with clasts and olistoliths of Devonian and Mississippian limestones of the Družetić Formation. In previous investigations, Devonian limestones were found at many places in NW Serbia (Filipović et al. 1975), and even in Družetić, they were treated as autochthonous. According to recent data they are in fact olistoliths and belong to the younger Ivovik Formation (Filipović 1995).

The best data of the latest Devonian and Mississippian parts of the Družetić Formation are derived from the inverse olistolith in the Milivojevića Kamenjar section, which is located on the right side of the Ub River in the south-western area of Družetić village (coordinates: x 4920_{088} y 7405_{925}, 44.4191 N, 19.8128 E; Fig. 3). It is known as the only undisputed locality of a Namurian goniatite fauna in the Balkan Peninsula, where Stevanović & Kullmann (1962) attributed the cephalopod faunas from two fossiliferous horizons to the “upper *Eumorphoceras* Stufe” (E_2) within the older part of Namurian A. A record of *Dombarites*, determined by Kullmann and mentioned in Veselinović & Filipović (1989)

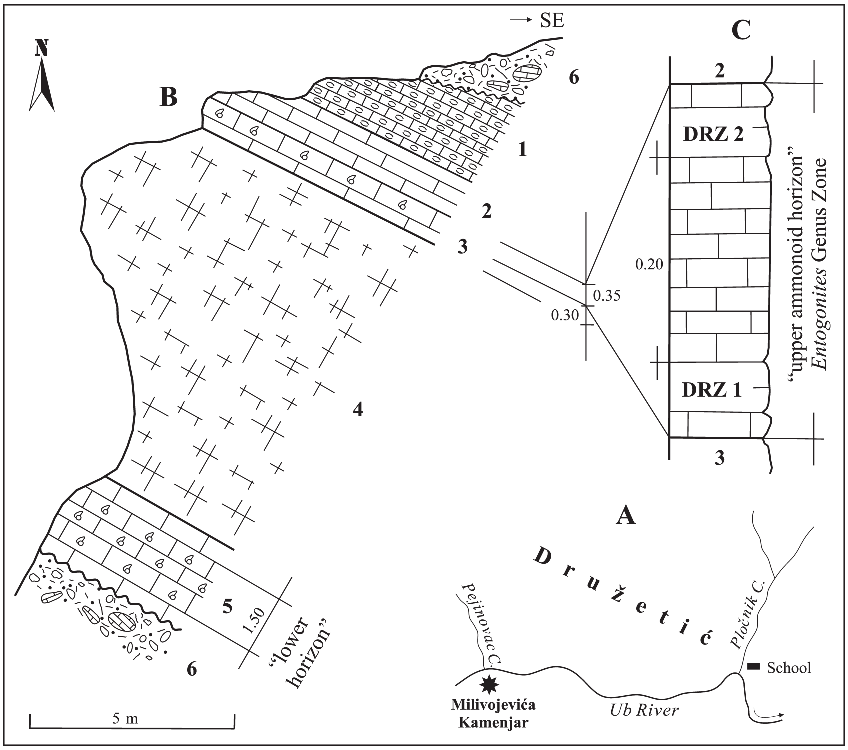

Fig. 3. Milivojevića Kamenjar section (modified from Filipović 1995, Filipović et al. 2008, and incorporating the new data). **A** — Sketch of the geographical position in the area of Družetić village (Jadar Block, Vardar Zone, NW Serbia). **B** — Section of the Milivojevića Kamenjar olistolith. Legend: Unit 1 — Dark grey nodular limestones with thin shaly beds (Famennian according to Filipović 1995); Unit 2 — Grey bedded nodular limestones (Tournaisian according to Filipović 1995); Unit 3 — Grey bedded limestones with ammonoids (Namurian "upper fossiliferous layer" according to Stevanović & Kullmann 1962; early late Visean according to our investigation); Unit 4 — Grey massive, thick-bedded and bedded limestones (Visean according to Filipović 1995); Unit 5 — Grey bedded limestones with ammonoids (Namurian "lower fossiliferous layer" according to Stevanović & Kullmann 1962; Lower Serpukhovian according to Filipović 1995; latest Visean to earliest Serpukhovian in this paper); 6 — Podolskian olistostromal deposits of the Ivovik Formation (Filipović 1995). **C** — Detail of the upper part of unit 3 ("upper ammonoid horizon", *Entogonites* Genus Zone of the early late Visean (middle Asbian) in this paper).

as well as Djordjijevski-Kalambokis et al. (1990) may be Serpukhovian in age, but the specimen could not be traced. Later, Ruzhencev & Bogoslovskaya (1971) noted some mistakes within the original determinations (of some species and genera), which made a revision of the ammonoid fauna and of the whole section necessary.

The rock succession of the Milivojevića Kamenjar section

At Milivojevića Kamenjar in Družetić, approximately 15 meters of sedimentary rocks, almost exclusively carbonates, are exposed. The bedding planes dip 10 to 25° in a south-western direction. The succession can be subdivided into five units, in descending order (i.e. stratigraphically from older to younger) in the outcrop (Fig. 3):

1. Dark grey, nodular limestones (>2 m) with a high clay content, in part only poorly exposed. The limestone nodules and their macrofossil content are strongly deformed.

2. Grey bedded, also nodular limestones with a minor clay content (0.95 m).

3. Partly fossil-rich dark grey bedded limestones (0.65 m), which possess a high dolomite content. Two fossil samples (DRZ 1 and DRZ 2 separated by a distance of about 20 cm) were taken from the "upper" (i.e. stratigraphically older) portion of the unit. Particularly sample DRZ 2 is a coquina of a mass occurrence of ammonoids, but most of the specimens larger than 10 mm are crushed.

4. Light grey, thick-bedded or almost non-bedded non-fossiliferous micritic limestones (8.60 m).

5. Grey, well-bedded micritic nodular limestones (2.80 m) with a minor clay content. In this unit, five ammonoid samples from the middle 1.50 m were obtained. The occurrence of the macrofossils is patchy, and in some cases coquinas packed with ammonoids occur in more sparitic portions of the section.

The stratigraphy of the Milivojevića Kamenjar section

The discussion about the stratigraphic age of the fossiliferous limestone occurrences at the Milivojevića Kamenjar site in Družetić began parallel to the description of the outcrop. On the basis of the two ammonoid faunas, Stevanović & Kullmann (1962) postulated that the entire outcrop belongs in the Namurian ("obere *Eumorphoceras* Stufe"). Doubts were cast by I. Filipović, who found Late Devonian microfossils (styliolinids, ostracods) in the nodular limestones such as the horizons immediately "above" the massive limestones of the section. These arguments were dismissed by Stevanović & Kullmann (1962, footnotes on p. 50 and 66), who insisted on a Namurian age of the beds under discussion.

Subsequent investigations and studies of conodonts from the section undermined the original statement that only Namurian sedimentary rocks exist in the limestones of the Milivojevića Kamenjar section. First, Spasov & Filipović (1967) found besides Namurian conodonts also Late Devonian (Famennian) conodonts above the "upper fossiliferous layer". Detailed, but rather different results were presented by Scharfe (1977, p. 26), who found Famennian, Tournaisian, and Visean conodonts in the same section; he stated "Aufgrund von Conodonten konnte das Namur in Družetic aber bisher nicht nachgewiesen werden".

After this, detailed stratigraphic results from the Milivojevića Kamenjar site were realized by investigations of conodonts (Stojanović-Kuzenko & Pajić in Filipović

1995). Following olistrostromal deposits of the Ivovik Formation, the "uppermost" parts of the limestone olistolith of 16 m thickness consist of latest Famennian nodular limestones with conodonts from lower-middle parts of the *Siphonodella praesulcata* Zone. Downward are Tournaisian bedded limestones, from which *Siphonodella sulcata*, *S. duplicata* and *S. sandbergi* zone conodonts were determined. The latest Tournaisian conodont zone with *Scaliognathus anchoralis* was found in the following parts of the grey bedded limestones near the second, "upper fossiliferous layer", which is, according to Stevanović & Kullmann (1962), Namurian in age. Below it, the next, largest part of the olistolith (thickness 12 m) is made up of massive, thick-bedded and bedded limestones where the next conodont zones of Visean age were determined: *Gnathodus texanus*, *Gnathodus bilineatus*, and *Lochriea nodosa*. The final, "lowermost" parts of the section, i.e. the "lower fossiliferous layer" of Stevanović & Kullmann (1962), contains conodonts of the *Kladognathus–Gnathodus girtyi* group Zone. It belongs to the lower part of the Serpukhovian (Stojanović-Kuzenko & Pajić in Filipović 1995).

At this moment new and more detailed investigations of the conodonts are in progress.

The ammonoid faunas from Milivojevića Kamenjar section

Carboniferous ammonoids from the Milivojevića Kamenjar section in Družetić were first discovered in 1956 by P. Stevanović, who called the beds with these fossils cephalopod limestone (Stevanović 1962). J. Kullmann then studied the ammonoids; and then together with Stevanović published an extensive monograph paper (Stevanović & Kullmann 1962) and interpreted the faunas according to their stratigraphic age. According to this study, two ammonoid horizons were distinguished (Fig. 4):

A "lower horizon" (which is in fact the stratigraphically younger, uppermost Visean to lower Serpukhovian horizon) was characterized by the following species:

"*Prionoceras (Irinoceras) stevanovici*",
"*Rhymmoceras gracilentum*",
"*Proshumardites (Proshumardites) serbicus*",
"*Proshumardites (Trigonoshumardites) wocklumerioides*",
"*Pronorites uralensis uralensis*".

An "upper horizon" (which is in fact the older, lower upper Visean horizon) yielded the following species:

"*Cravenoceras cowlingense*",
"*Gastrioceras (Branneroceras) branneri branneri*".

Finally, five species were reported to occur in both horizons:

"*Cravenoceras arcticum subinvolutum*",
"*Nuculoceras crenistriatoide*",
"*Gastrioceras (Branneroceratoides) tetragonum*",
"*Eoasianites europaeus*",
"*Metacanites chancharensis*".

This last category requires discussion. According to the new investigation of the Milivojevića Kamenjar site, not a single species was found to occur in both horizons. The significant stratigraphic difference between the two assemblages, which was not recognized by Stevanović & Kullmann (1962), makes it very unlikely that there are species, which are present in both of them. It appears that in some cases, as in "*Gastrioceras (Branneroceratoides) tetragonum*", mixing of samples in the outcrop caused the erroneous record of this species in the "lower horizon". In other cases, misinterpretations may be responsible. The species putatively occurring in both horizons were possibly the reason why J. Kullmann (in Stevanović & Kullmann 1962, p. 65) concluded that "the difference between the two beds, according to their faunas, is insignificant" ("… Unterschied zwischen diesen beiden Schichten in faunistischer Hinsicht unbedeutend."). It is possibly the reason why J. Kullmann did not recognise the Visean age of the "upper horizon".

In the faunal list of Stevanović & Kullmann (1962) it is visible that names of species from very different regions have been used, the South Urals (3 species), Novaya Zemlya (1), Northern England (1), and the American Midcontinent (1). A further six species have been newly described. On the basis of this, J. Kullmann concluded that the closest relationships are noticeable with the Urals (op. cit., p. 68), but also stated that the fauna from Družetić has an intermediate position between the "epicontinental and geosynclinal facies" of the Carboniferous occurrences in Europe.

Newly collected material

Two field sessions were carried out to resample the Milivojevića Kamenjar section in Družetić. The aim of the fieldwork was to obtain precise bed-by-bed collected material of the two fossil horizons that were described by Stevanović & Kullmann (1962). Both horizons, which are separated by 9.70 meters of rocks largely without macrofossils, were recognized in the section and could even be subdivided, with the "lower horizon" providing five successive samples within a range of 1.50 m (samples DRZ A to DRZ E in stratigraphically ascending order), and the "upper horizon" separated in two units 20 cm apart (with sample DRZ 2 being the stratigraphically older horizon and sample DRZ 1 the younger; Fig. 3).

The two samples DRZ 1 and DRZ 2 differ slightly in their ammonoid spectrum. *Entogonites* and *Ubites* gen. nov. occur in both, but with significantly different numbers. The older sample DRZ 2 contains *Ubites filipovici* gen. nov. et sp. nov. as the predominant species, whereas *Entogonites* is very rare. Sample DRZ-1 yielded *Ubites* gen. nov. in very low numbers, but *Entogonites* is very abundant. Apart from the species *E. tetragonum*, which is revised here, two other species of the genus occur. These will be described in a subsequent paper.

A very precise age determination can be made on the basis of the occurrence of *Entogonites*. The genus is particularly known from the Rhenish Mountains of Germany, where its stratigraphic occurrence is best documented (Nicolaus 1963; Korn 1988; Korn & Horn 1997). The two successive species *E. nasutus* and *E. grimmeri* are index species of two successive biozones in the early Asbian (early late Visean). *E. grimmeri* shows a co-occurrence with the oldest species of *Goniatites*, *G. hudsoni* Bisat, 1934 in only one single nodular horizon.

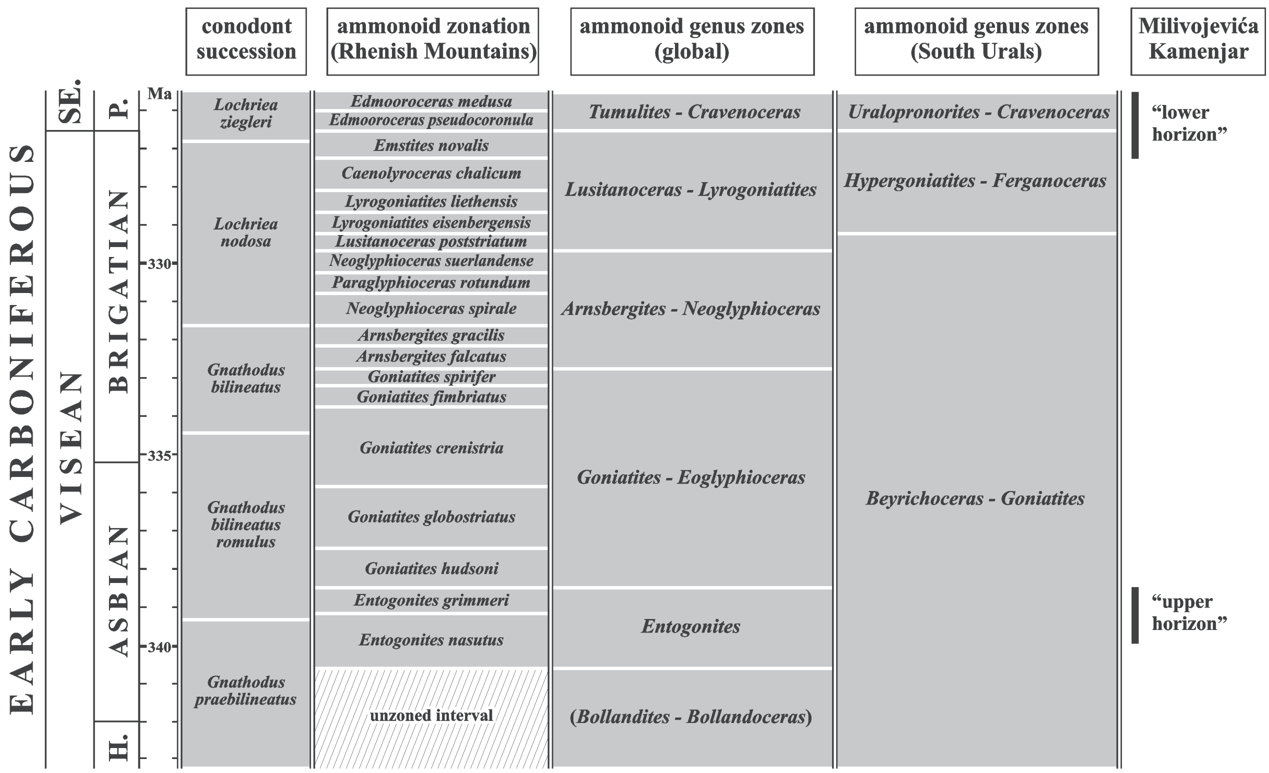

Fig. 4. Visean and partly Serpukhovian chronostratigraphy, estimated geochronological scale (after Korn & Kaufmann 2009), conodont succession, ammonoid zonation for the Rhenish Mountains and their duration, global and South Urals ammonoid genus zones (after Ruzhencev & Bogoslovskaya 1971; Korn et al. 2007), and position of the ammonoid-bearing horizons in the Milivojevića Kamenjar olistolith. **SE.** — Serpukhovian; **H.** — Holkerian; **P.** — Pendleian.

The North African species *Entogonites saharensis* can be found in the body chambers of the species *Goniatites lazarus* Korn, Klug & Mapes, 2005, together with species of the genera *Maxigoniatites*, *Bollandoceras*, and *Calygirtyoceras* (Korn et al. 2007), which form a characteristic assemblage of the early late Visean.

Occurrences of *Entogonites* in Alaska and Utah (Gordon 1957) largely confirm these results. *E. borealis* occurs in the two regions with *Goniatites americanus* Gordon, 1971. Taking all this data into account, there is no doubt that samples DRZ 1 and DRZ 2 from Družetić possess an early late Visean age.

The main results of the new investigations of the outcrop are (Fig. 4):

(1) The "lower" and the "upper horizon" contain completely different ammonoid species and genera; there is not a single species, which occurs in both horizons. It can even be stated that the faunas are so different from one another that a confusion of the two is impossible even in surface collected material.

(2) The "lower" and the "upper horizon" are lithologically markedly different, the "lower horizon" is a dense and fine-grained light grey nodular limestone with occasional fossil content and the "upper horizon" is a coarse-grained dolomitic limestone packed with ammonoids in two clearly separable coquinas. These features also make it very easy to separate the two horizons.

(3) The "lower horizon" is the stratigraphically younger of the two horizons.

(4) The "upper horizon" is early late Visean (middle Asbian) in age, the "lower horizon" belongs to latest Visean (uppermost Brigatian) and the early Serpukhovian (Pendleian).

(5) The "lower horizon" (latest Visean to early Serpukhovian) shows close relationships to time equivalents of the Cantabrian Mountains and South Urals.

(6) Sample DRZ 2 (the stratigraphically older) of the "upper horizon" contains a fauna composed of *Ubites* gen. nov. (which is the most abundant genus in this sample), very rare *Entogonites*, *Beyrichoceras*, *Bollandites*(?), and yet undetermined prolecanitid ammonoids.

(7) Sample DRZ 1 contains very abundant specimens of *Entogonites* (*E. tetragonum* as well as one or two additional species of the genus) and prolecanitids. *Ubites* gen. nov. is rare in this sample.

(8) Samples DRZ A to DRZ E contain, among others, the ammonoid genera *Dombarites* and *Ophilyroceras* as well as prolecanitid and pronoritid species.

Systematic paleontology (D. Korn, M. Sudar)

Order: **Goniatitida** de Haan, 1825
Superfamily: **Girtyocerataceae** Wedekind, 1918
Family: **Entogonitidae** Ruzhencev & Bogoslovskaya, 1971

Family definition: Girtyocerataceae with strong radial ornament consisting of sharp ribs, which frequently dichotomize and form a ventrolateral projection and a deep ventral sinus. Inner whorls tetrangularly coiled in many species.

Included genera:
Entogonites Kittl, 1904b
Tetragonites Kittl, 1904a [homonym of *Tetragonites* Kossmat, 1895]
Kittliella Frech, 1906 [synonym of *Entogonites* Kittl, 1904]
Ubites gen. nov.

Discussion: *Entogonites* is still an enigmatic genus in the Early Carboniferous ammonoid faunas, and its phylogenetic relationships are not resolved. Traditionally, the genus has been placed near *Nomismoceras*, based on the thinly discoidal, relatively widely umbilicate conch, the ornament with rather high ventrolateral projection, and the suture line with rounded adventive lobe.

With the discovery of the new genus *Ubites*, *Entogonites* can be connected phylogenetically with other Early Carboniferous ammonoids, suggesting that *Nomismoceras* is probably not a close relative. *Ubites* gen. nov., which possesses an ornament like *Entogonites* but an ontogeny with an evolute ribbed juvenile stage and closure of the umbilicus in the later ontogenetic stage (similar to *Calygirtyoceras*), may link the family Entogonitidae with ammonoids such as the Girtyoceratidae. The family Entogonitidae is therefore tentatively placed in the superfamily Girtyocerataceae.

Genus: *Entogonites* Kittl, 1904

Type species: *Tetragonites Grimmeri* Kittl, 1904a (by monotypy).

Genus definition: Entogonitidae with simple ontogeny. Adult whorls slightly narrower umbilicate; inner whorls tetrangularly coiled.

Included species:
borealis: *Entogonites borealis* Gordon, 1957, p. 53; Alaska
grimmeri: *Tetragonites Grimmeri* Kittl, 1904, p. 677; Bosnia and Herzegovina
nasutus: *Pericyclus nasutus* Schmidt, 1941, p. 151; Harz
saharensis: *Entogonites saharensis* Korn, Klug & Mapes, 2005, p. 363; Anti-Atlas
tetragonus: *Gastrioceras (Branneroceratoides) tetragonum* Kullmann, 1962, p. 88; NW Serbia.

Entogonites tetragonus (Kullmann, 1962)
Fig. 5

1962 *Gastrioceras (Branneroceratoides) tetragonum* n. sp. Kullmann in Stevanović & Kullmann, p. 88–90, pl. 2, figs. 2–6

Holotype: Specimen SLM 4063/38 (Natural History Museum Belgrade), illustrated by Stevanović & Kullmann (1962) on pl. 2, fig. 2.

Type locality and horizon: Milivojevića Kamenjar site in Družetić (NW Serbia); "upper horizon", *Entogonites* Genus Zone.

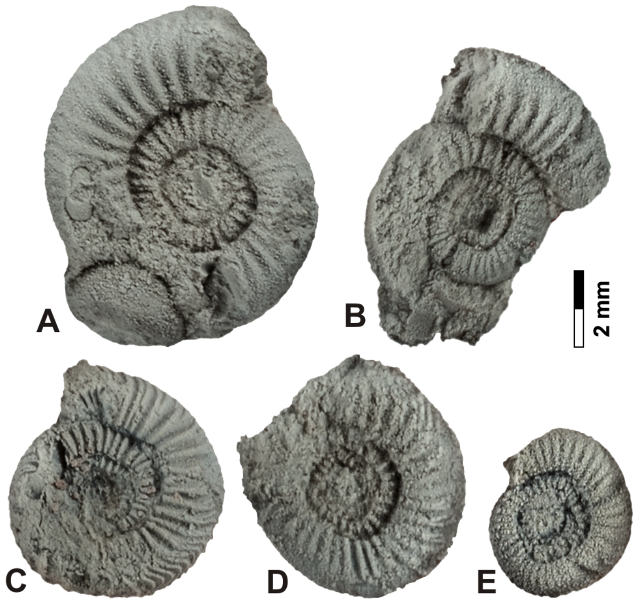

Fig. 5. *Entogonites tetragonus* (Kullmann, 1962) from sample DRZ 1 at Milivojevića Kamenjar section in Družetić; all ×5. **A** — Specimen MB.C.19128.1. **B** — Specimen MB.C.19128.2. **C** — Specimen MB.C.19128.3. **D** — Specimen MB.C.19128.4. **E** — Specimen MB.C.19128.5.

Material: Thirty paratypes in the Natural History Museum Belgrade and 25 newly collected specimens; conch diameter up to 9.5 mm.

Diagnosis: Species of *Entogonites* with a thinly discoidal conch (ww/dm = 0.35–0.40), moderately wide to wide umbilicus (uw/dm = 0.40–0.50) and broadly rounded venter at 8 mm conch diameter. Aperture moderately low (WER = 1.80–1.90). Inner whorls with moderate tetrangular coiling. Shell ornament with 35 moderately strong, rounded and ventrolaterally dichotomizing ribs. Ventrolateral projection of ribs low, ventral sinus moderately deep.

Description: Specimen MB.C.19128.1 is a rather well-preserved specimen with 8.5 mm conch diameter. It is thinly discoidal and evolute (ww/dm = 0.36; uw/dm = 0.46) and possesses a moderately high aperture (WER = 1.83). The inner whorls are inconspicuously tetrangularly coiled. About 30 rounded ribs can be counted on the last volution; they extend in a linear course across the inner flank and bifurcate on the outer flank. The apertural branch forms a rather high ventrolateral projection, and forms a shallow sinus on the venter.

The other, smaller specimens are similar in conch shape and ornament. Some of them, such as specimen MB.C.19128.2 (7 mm dm) and MB.C.19128.5 (4.2 mm dm) possess constrictions extending parallel to the riblets (Table 1). The tetrangularly coiled stage ends at about 6 mm conch diameter.

Remarks: The species is the type species of the subgenus *Gastrioceras (Branneroceratoides)* Kullmann (in Stevanović & Kullmann 1962), which therefore has to be put in synonymy with *Entogonites*.

E. tetragonus differs from *E. grimmeri* in the poorer development of the tetrangular coiling of the inner whorls. The rib-

Table 1: Conch dimensions (in mm) and proportions for reference specimens of *Entogonites tetragonus* (Kullmann, 1962).

	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
specimen MB.C.19128.1	8.51	3.05	2.47	3.88	2.22	0.36	1.23	0.46	1.83	0.10
specimen MB.C.19128.2	6.96	2.75	1.95	3.41	–	0.40	1.41	0.49	–	–
specimen MB.C.19128.6	6.62	2.45	1.92	3.31	1.77	0.37	1.28	0.50	1.86	0.08
specimen MB.C.19128.3	5.83	2.62	1.65	2.69	1.35	0.45	1.59	0.46	1.69	0.18
specimen MB.C.19128.4	5.74	2.42	1.79	2.44	–	0.42	1.35	0.43	–	–
specimen MB.C.19128.7	4.84	2.02	1.35	2.35	0.99	0.42	1.50	0.49	1.58	0.27
specimen MB.C.19128.5	4.15	1.66	1.22	1.97	0.92	0.40	1.36	0.47	1.65	0.25
specimen MB.C.19128.8	2.26	0.99	0.72	0.98	0.53	0.44	1.38	0.43	1.71	0.26

lets in *E. tetragonus* are, in comparison to *E. grimmeri*, a lot less sharp. *E. nasutus* has also only weakly tetrangular inner whorls, but has a much narrower umbilicus than *E. tetragonus*, *E. borealis* has a narrower umbilicate than *E. tetragonus*, and *E. saharensis* possesses sharper ribs with higher ventrolateral projections.

Genus: *Ubites* gen. nov.

Derivation of name: After the River Ub in NW Serbia.

Type species: *Ubites filipovici* gen. nov. et sp. nov.

Genus definition: Entogonitidae with complex ontogeny. Inner whorls evolute, adult whorls with narrower umbilicus caused by stronger whorl overlap. Inner whorls circularly coiled.

Included species:

filipovici: *Ubites filipovici* gen. nov. et sp. nov.; NW Serbia

pseudocyclus: *Nomismoceras pseudocyclus* Campbell, Brown & Coleman, 1983, p. 97; Queensland.

Remarks: *Ubites* gen. nov. differs from *Entogonites* in the normally coiled inner whorls and in the ontogenetic development, which shows an adult stage in which the uw/dm ratio is significantly reduced.

Ubites filipovici gen. nov. et sp. nov.
Fig. 6

1962 *Gastrioceras* (*Branneroceras*) *branneri branneri* Smith — Kullmann in Stevanović & Kullmann, p. 86–87, pl. 2, fig. 1

Derivation of name: After Dr. Ivan Filipović, in recognition of his contribution to the geology and stratigraphy of the Paleozoic rocks in Serbia.

Holotype: Specimen MB.C.19130.1 (Museum für Natürkunde, Berlin), illustrated in Fig. 6A.

Type locality and horizon: Milivojevića Kamenjar section, Družetić (NW Serbia); sample DRZ 2 ("upper horizon"), *Entogonites* Genus Zone.

Material: 35 specimens; conch diameter up to 16.5 mm.

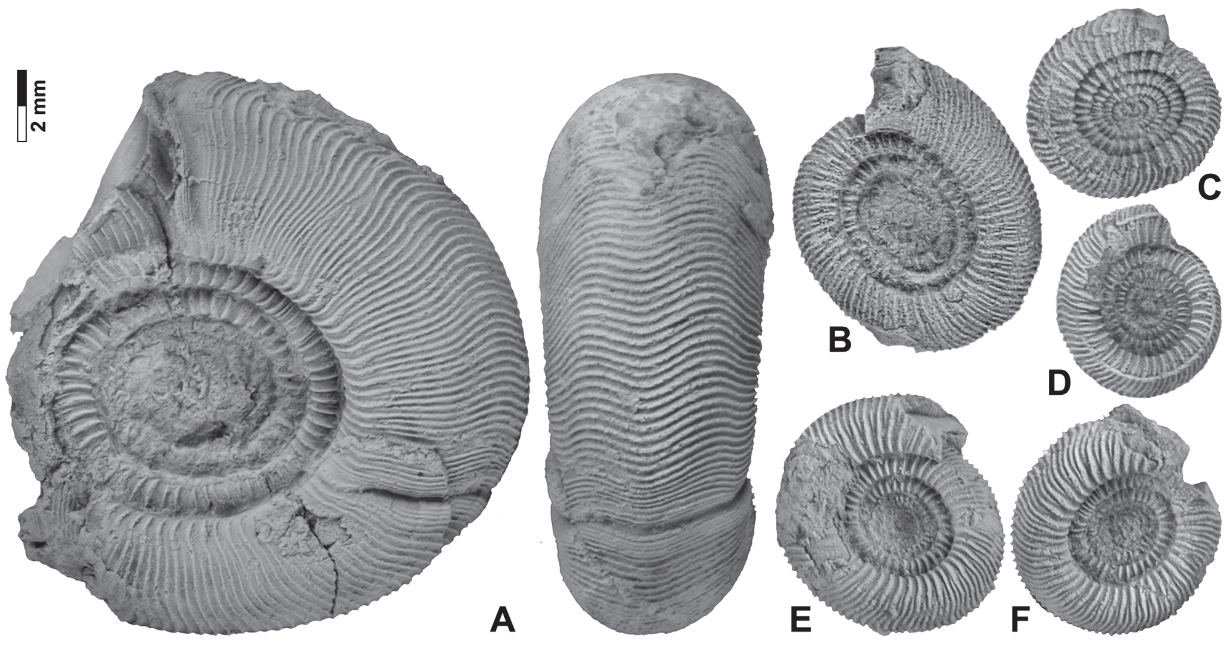

Fig. 6. *Ubites filipovici* gen. nov. et sp. nov. from sample DRZ 2 (A–E) and sample DRZ 1 (F) at Milivojevića Kamenjar section in Družetić; all ×5. **A** — Holotype MB.C.19130.1. **B** — Paratype MB.C.19130.2. **C** — Paratype MB.C.19130.3. **D** — Paratype MB.C.19130.4. **E** — Paratype MB.C.19130.5. **F** — Paratype MB.C.19129.

Table 2: Conch dimensions (in mm) and proportions for reference specimens of *Ubites filipovici* gen. nov. et sp. nov.

	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
holotype MB.C.19130.1	16.35	6.91	5.12	7.12	3.41	0.42	1.35	0.44	1.60	0.33
paratype MB.C.19130.6	8.91	3.35	2.29	4.64	1.63	0.38	1.46	0.52	1.50	0.29
paratype MB.C.19130.2	8.08	3.28	2.31	4.15	1.58	0.41	1.42	0.51	1.55	0.32
paratype MB.C.19130.5	6.83	3.45	1.75	3.48	–	0.51	1.97	0.51	–	–
paratype MB.C.19128	6.02	3.11	1.68	2.92	–	0.52	1.85	0.49	–	–
paratype MB.C.19130.7	5.76	–	1.44	3.17	1.01	–	–	0.55	1.47	0.30
paratype MB.C.19130.4	5.57	2.49	1.24	3.16	0.96	0.45	2.01	0.57	1.46	0.23
paratype MB.C.19130.3	5.45	2.56	1.41	3.01	0.94	0.47	1.82	0.55	1.46	0.33

Diagnosis: Species of *Ubites* gen. nov. with a thinly discoidal, evolute conch (ww/dm = 0.35–0.45; uw/dm = 0.50–0.55) at 8 mm dm; conch thinly discoidal, evolute (ww/dm = 0.40; uw/dm = 0.47) at 16 mm dm. Aperture low (WER = 1.50–1.60) in the adult stage. Shell ornament sharp biconvex riblets; inner whorls with sharp dichotomizing ribs. Ventrolateral projection of riblets low in the adult stage, ventral sinus moderately deep.

Description: Holotype MB.C.19130.1 is an incomplete, slightly distorted specimen with 16 mm conch diameter (Table 2); it demonstrates a rapid ontogenetic change from the evolute juvenile stage into the adult morphology. This change takes place within only one volution, in which the whorl height becomes significantly larger. At 16 mm dm, the flanks are slightly flattened and the umbilical margin is subangular. The last volution shows the excellently preserved shell ornament, consisting of sharp riblets, of which three stand within one millimeter. Every second of these riblets is intercalated near the umbilical margin; the main riblets begin on the umbilical wall and form a sharp elongate node on the umbilical margin. The riblets form a shallow sinus on the umbilical margin, a low projection in the inner flank area, a very shallow sinus on the midflank, a low ventrolateral projection, and a moderately deep ventral sinus. Parallel to the growth lines extend two shell constrictions standing approximately 120° apart. They begin in the inner flank area and extend with the same depth across flanks and venter.

The smaller paratype MB.C.19130.2 (8.1 mm conch diameter) represents the juvenile growth stage, in which the conch is still evolute (uw/dm = 0.51). The whorls are wide (ww/wh = 1.42) and crescent-shaped in this stage, and flanks and venter are regularly rounded. The shell ornament shows about 50 sharp riblets; between these, finer intercalatory riblets begin in the inner flank area. The riblets extend almost linearly across the inner flanks, bend forward to form a moderately high ventrolateral projection, and then turn back for a moderately deep ventral sinus.

Small specimens such as paratype MB.C.19130.4 (5.6 mm conch diameter) display a similar conch morphology and shell ornament. This specimen is more widely umbilicate (uw/dm = 0.57) than the larger ones.

Remarks: Kullmann (in Stevanović & Kullmann 1962) had only two small specimens, and he attributed these, because of the dichotomizing ribs, to the North American Morrowan (late Bashkirian) index species *Branneroceras branneri*. This determination did not consider the small size of the Serbian specimens, which superficially resemble juveniles of *Branneroceras branneri*. The reconstruction of the suture line by J. Kullmann (op. cit., fig. 4a) cannot be confirmed, as the specimen does not show the suture line.

The new species is similar to *U. pseudocyclus* (Campbell, Brown & Coleman, 1983), but that species has, at 16 mm diameter (i.e. the same size as the holotype of *U. filipovici* gen. nov. et sp. nov.), less sharp riblets with a more linear course across flanks and venter. The umbilicus is wider in *U. pseudocyclus* (uw/dm = 0.47, in contrast to 0.42 in *U. filipovici* gen. nov. et sp. nov.). *U. pseudocyclus* co-occurs, at the type locality Mundubbera (Queensland), with species of the genera *Irinoceras*, *Bollandites*, *Maxigoniatites*, and *Cantabricanites*, which can be taken as evidence for an early late Visean age such as *U. filipovici* gen. nov. et sp. nov.

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