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EARLY BERRIASIAN AMMONITES FROM THE ŠTRAMBERK LIMESTONE IN THE KOTOUČ QUARRY (OUTER WESTERN CARPATHIANS, CZECH REPUBLIC)

Zdeněk VAŠÍČEK[1] & Petr SKUPIEN[2]

[1] *Institute of Geonics, Academy of Sciences of the Czech Republic, Studentská 1768, 708 00 Ostrava-Poruba, Czech Republic; e-mail: zdenek.vasicek@ugn.cas.cz*
[2] *Institute of Geological Engineering, VŠB-Technical University, 17. listopadu 15, 708 33 Ostrava-Poruba, Czech Republic; e-mail petr.skupien@vsb.cz*

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Abstract: Over 100 ammonites were collected from a block of bedded shallow-water Štramberk Limestone at a new location at the Kotouč Quarry, near Štramberk (Silesian Unit, Czech Republic). Berriaselline neocomitids, including *Berriasella jacobi*, *B. oppeli*, *Tirnovella allobrogensis*, *T.* cf. *allobrogensis*, *Delphinella consanguinea*, *Pseudosubplanites* cf. *grandis* and *Malbosiceras* cf. *asper*, are the most abundant species in this ammonite association. The olcostephanitid, *Spiticeras blancheti*, is rare. The index species for the Early Berriasian, *B. jacobi*, occurs in large numbers. On the basis of the present study, the upper boundary of the stratigraphic range of the Štramberk Limestone in the type area is dated as early Berriasian (ammonite Berriasella jacobi Zone). Ammonites with ages younger than early Berriasian have never been found in the Štramberk area. The deposition of the Štramberk Limestone in the Štramberk area came to an end during that period.

Key words: Ammonites, Berriasian, Štramberk area, Outer Western Carpathians.

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INTRODUCTION

The fossil-rich Štramberk Limestone (possibly primarily Tithonian to early Berriasian in age) in the Outer Western Carpathians of Moravia (Czech Republic) has attracted the attention of palaeontologists since the first half of the nineteenth century. The first author to mention limestones in this area was Oyenhausen (1822). The term Štramberk Limestone for the light-grey to whitish-grey limestones was introduced by Hohenegger (1849). From approximately 1910 onwards, the quarry at Kotouč Hill has been the main source of material for palaeontological studies. A review of geological and palaeontological papers, addressing the Štramberk Limestone and associated deeper-water Lower Cretaceous deposits from Štramberk and the surrounding area, was presented by Vašíček and Skupien (2004, 2005).

On the basis of the Štramberk Limestone, the Tithonian Stage was defined (see Oppel, 1865; von Zittel, 1870) as the uppermost unit of the Jurassic in the Tethyan Realm. Both of these classic works were based on material from the Hohenegger collection, which was collected almost exclusively from the type area in the Castle Hill (Zámecký vrch) Quarry (Schlossberg Steinbruch), where mining started in 1780. Therefore, this quarry was selected as the type area of the Štramberk Limestone (Houša, 1968). The body of the Štramberk Limestone forming Castle Hill was accessed at the Castle Hill Quarry at a stratigraphic level, which corresponded to the upper part of the lower Tithonian (Houša, 1975, 1990). The ammonite species from this quarry exhibits a uniform lower Tithonian character, documenting this stratigraphic interval. Material in the Hohenegger collection came from other sites, as well. A small portion of this collection was recovered from the Municipal Quarry (Obecní lom, Gemeinde Steinbruch) at Štramberk, which was still rather small in size at the time (opened in 1820). Part of Hohenegger's material was also obtained from sites, comprising the so-called "exotic boulders" of Štramberk Limestone, and taken from different localities in the Podbeskydská pahorkatina Highland. These sites containing "exotic boulders" and the Municipal Quarry at Štramberk yielded species that led to doubts among later authors over the uniformity of the Štramberk Limestone ammonite fauna.

The younger Remeš collection from the Štramberk Limestone shows a somewhat different faunal spectrum, compared to the older collections. This difference is explained by the fact that the Remeš collection was obtained later, between 1870 (when it was initiated by Remeš's father) and about 1930, and thus contains samples from quarries that

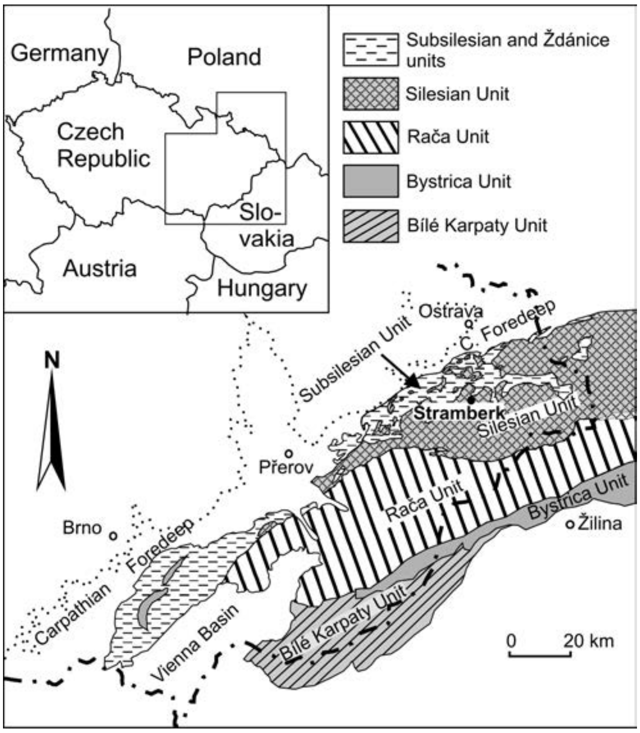


Fig. 1. Tectonic map of the Outer Western Carpathian area in the Czech Republic

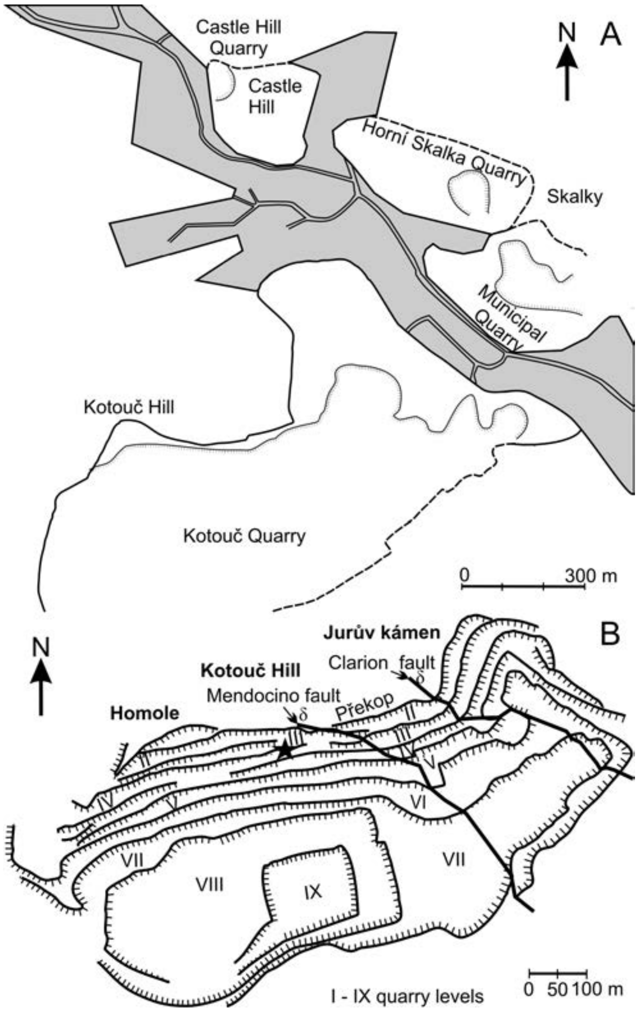


Fig. 2. Location map. **A.** Topographic situation of bodies of Štramberk Limestone in the vicinity of Štramberk. **B.** Location of the section (marked with an asterisk) on the transition between levels 4 (IV) and 3 (III) at Kotouč Quarry

were active at that time, as well as purchases from quarry workers. The Castle Hill Quarry had been almost completely abandoned in the end of 19th century, and the main sources of Štramberk Limestone were the quarry on Kotouč Hill and the Municipal Quarry (Remeš, 1899, 1904). However, the newly opened quarry on Kotouč Hill was the main source of fossils. Here, the Štramberk Limestone was extensively exposed and extracted during the 1900s, throughout nearly its entire stratigraphic range between the early Tithonian and early Berriasian. An early Tithonian age is documented by an ammonite assemblage (e.g., Blaschke, 1911) from the former Gutmann Quarry, opened in the oldest, southwesterly portion of the Homole body of the Kotouč Hill complex in 1881.

During a visit to the University of Tübingen, within the framework of the Humboldt Fellowships in February 1992, one of us (Z. V.) visited the Bayerische Staatssammlung für Paläontologie und historische Geologie (University of Munich). A classic collection of ammonites from the Štramberk Limestone, monographed by von Zittel (1868), is housed there. At the time, the German colleagues, H. Immel and G. Schairer, had plaster casts made of ten original specimens from von Zittel's collection, representing rather small shells. Some of these casts have now been of assistance in our identification.

New discoveries of ammonite fauna in a block of Štramberk Limestone with conspicuous bedding, from the Kotouč Quarry near Štramberk, form the subject of the present paper. This study provides a systematic assessment of the ammonites and their stratigraphic interpretation. The ammonite fauna is indicative of the lower Berriasian Beriasella jacobi Zone and is the youngest, so far reported from the Štramberk Limestone. It thus allows redefinition of the upper stratigraphic limit of this classic unit in its type area as lower Berriasian, even though most of other (old) collections indicate a Tithonian age.

GEOLOGICAL SETTING

The Štramberk Limestone in its classic form occurs at several quarries (the Kotouč, Municipal, Horní skalka and Castle Hill quarries) in the immediate vicinity of the town of Štramberk (Figs 1, 2) in the form of larger and smaller carbonate blocks, smaller blocks, breccias and conglomerates. The Štramberk Limestone also occurs also within the Cretaceous flysch deposits of the Silesian Unit in the Outer Western Carpathians.

The geology of the Štramberk area and the nature of the megablocks are the subject of controversy. Houša (1990) interpreted the carbonate blocks as tectonic klippen, separated from the carbonate platform during the course of Silesian Nappe overthrust. In his interpretation, the associated deeper-water Early Cretaceous deposits represent material which filled fissures or cavities of different origin or cover original surfaces of limestone bodies.

According to Eliáš (see Eliáš and Stráník, 1963; Eliáš, 1970; Eliáš and Eliášová, 1986), the limestones are embedded in base-of-slope conglomerates and slump bodies within the Cretaceous part of the Těšín–Hradiště Formation (now Hradiště Formation – see Eliáš et al., 2003), constituting an extreme development of the Chlebovice Conglomerate. This accumulation developed between the Tithonian and the Turonian (see also Vašíček and Skupien, 2004; Svobodová *et al.*, 2011).

According to Picha *et al.* (2006), the Štramberk carbonate platform, rimmed by coral reefs, was the source of clastics and large fragments. Gravitational slides and turbidite currents transported both small and large blocks and fragments from the rim (edge) of the platform, as far out as the foot of the adjacent basin. However, during the course of later nappe tectonic transport during the Neogene, large tectonic pieces of the carbonate platform were separated from the softer, less competent rocks, situated on the slopes of the platform. The result is a melange, in which larger blocks from the carbonate platform show the characteristics of klippen. Smaller blocks and debris correspond to clastic sediments at the foot of the platform. These developed in the Early Cretaceous and the early part of Late Cretaceous, in particular.

The Štramberk Limestone is whitish-grey in colour and was deposited in different settings across the carbonate platform and reef complex, including reefal buildups. Biogenic and sparitic limestones (e.g., biosparites, intrasparites and intrabiosparites) are attributed to the core of the reef. The limestone found in some intervals is very coarse to gravelly, as it is formed of whole rudist shells (*Heterodiceras*) and minute coral colonies. In contrast, the limestone in some other intervals is very fine and micritic. However, the commonest type is finely biodetrital limestone.

Traditionally, the Štramberk Limestone was believed to be Tithonian in age, which may be the correct age for the main stage of reef development. However, the calpionellids and ammonites present indicate that the Štramberk Limestone originated during the latest Kimmeridgian–earliest Berriasian (e.g., Houša, 1990; Eliáš and Vašíček, 1995; Houša and Vašíček, 2005). The known calpionellid zonation (Houša and Vašíček, 2005) is indicative of the latest early Tithonian, the entire late Tithonian and the earliest Berriasian in the limestone bodies exposed in the Štramberk area.

The Štramberk Limestone represents sediments formed on a carbonate platform during the Late Jurassic and earliest Cretaceous along the northern Tethyan margin. This carbonate platform was affected by block tectonics during the latest Jurassic–earliest Cretaceous (e.g., Eliáš and Eliášová, 1986). The block accumulations form part of the continental-rise facies of the Baška development, deposited in the flysch trough of the (hypothetical) Baška Cordillera. This uppermost Jurassic to Upper Cretaceous sedimentary succession includes slumps, slides, olistholites and occasional turbidites, which were fed from the Upper Jurassic to the Coniacian carbonate platform on the Baška Cordillera and its slopes, including the Tithonian–Berriasian reef complex.

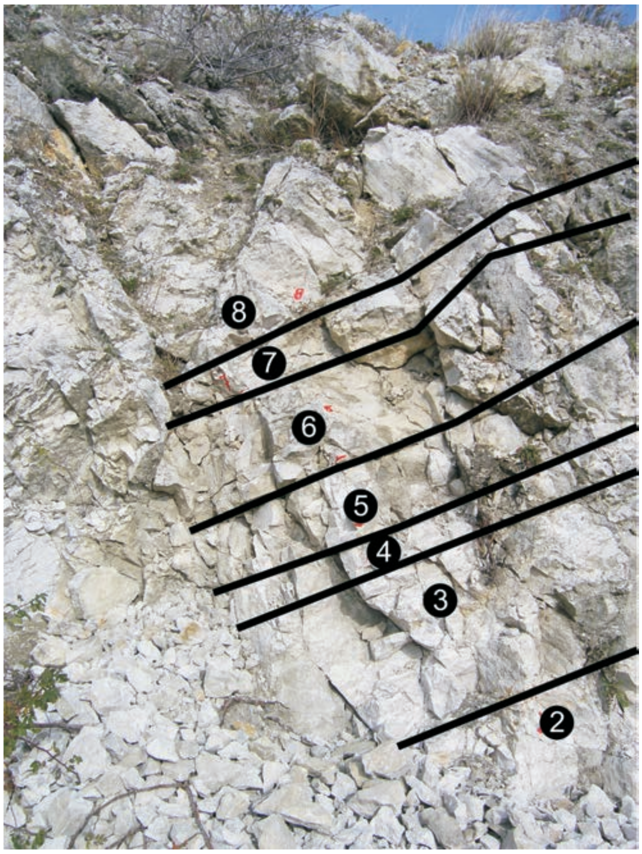


Fig. 3. Photograph of outcrop showing the number of layers

The intervals between gravity flows are represented by hemipelagic sediments. The gradual lateral and vertical transition of the block accumulations into the ambient sediment contradicts the classic theory regarding the tectonic klippen in the Silesian Unit.

DESCRIPTION OF AMMONITE-BEARING LIMESTONES

In the uppermost portion of the exit road, running from level 4 to level 3 at Kotouč Quarry (approximately10 m before end; GPS coodinates: 49°35'1.329"N, 18°6'52.689"E; Fig. 2), there is a block of Štramberk Limestone with conspicuous bedding (orientation of the strata 280/30; Fig. 3), which is found only rarely at other sites in the quarry. Nine layers (in the section marked 0 to 8) have been identified. Their thickness ranges from 20 to 90 cm (see Figs 3, 4). These layers are disrupted by systems of fissures, perpendicular to the bedding. The fissures are filled with calcite sparitic cement. Occasionally, the characteristics of pressure dissolution (stylolites) appear in these layers, which emphasise the boundaries between the layers identified.

Description of the layers identified from the bottom up (the thickness of layers given is the maximum value):

Layer 0 has a maximum thickness of 25 cm. The lowest-lying layer was exposed by excavation at the bottom below the quarry face. The limestone is detrital throughout the

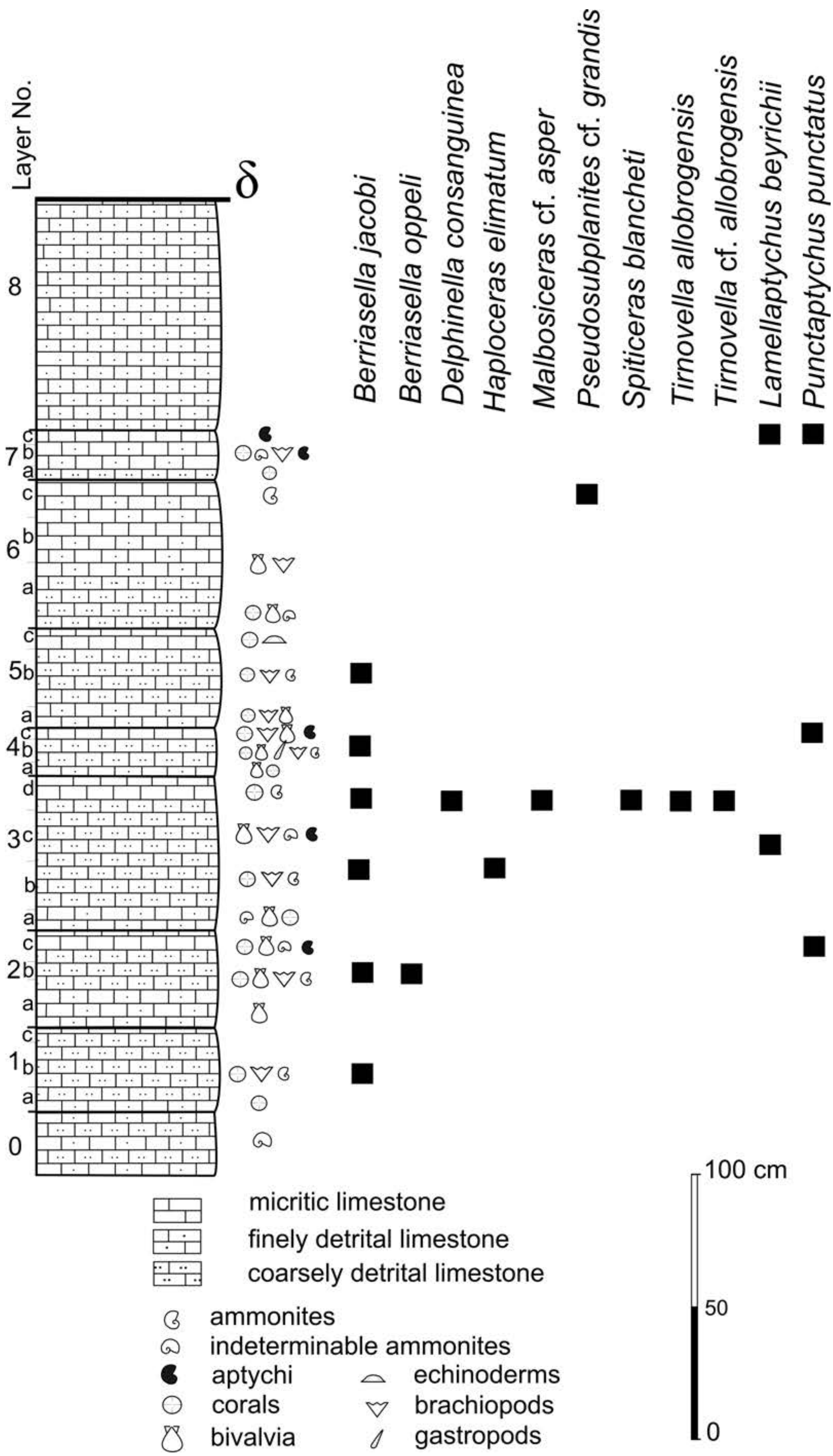


Fig. 4. Lithological column and range chart of ammonites of the section marked in Fig. 2

entire thickness, and more fine-grained layers alternate with coarse-grained ones. In the middle part, recrystallisation appears. Only a single indeterminate ammonite fragment was found.

Layer 1 (thickness of 32 cm) is composed of four beds: (1a) 8 cm – finely detrital limestone with small corals; (1b) 17 cm – mainly coarsely detrital limestone, containing corals, brachiopods and sporadic ammonites. In the lower part, recrystallisation is apparent; (1c) 5 cm – coarsely detrital, recrystallised and in its uppermost part (2 cm) finely detrital and even muddy.

Layer 2 (thickness of 37.5 cm) is composed of three beds: (2a) 18 cm – finely detrital, containing bivalve debris; (2b) 6 cm – mainly coarsely detrital limestone, containing corals, bivalves, brachiopods and ammonites, and recrystallisation is apparent; (2c) 13.5 cm – finely detrital and muddy in places, containing fragments of corals, bivalves and ammonites.

Layer 3 (thickness of 59 cm) is composed of four beds: (3a) 6 cm – finely detrital, containing bivalves, ammonites and small corals; (3b) 18 cm – rather coarsely detrital, with corals, algae, sponges, serpulids, brachiopods and ammonites. Substantial recrystallisation is apparent; (3c) 19 cm – coarsely detrital limestone, containing ammonites, bivalves and brachiopods, follows; (3d) 16 cm – finely detrital and muddy in places with fragments of small corals and, sporadically, ammonites. Throughout the entire thickness, a total of 70 ammonites were found, all largely fragmentary.

Layer 4 (thickness of 18.5 cm) is composed of three beds: (4a) 6 cm – finely detrital with bivalves and small corals; (4b) 9 cm – coarsely detrital limestone, containing corals, bivalves, gastropods, brachiopods and ammonites (approximately 20 specimens). Substantial limestone recrystallisation is apparent; (4c) 3.5 cm – finely detrital and even muddy in places, with fragments of small corals, brachiopods, bivalves, sponges and, sporadically, ammonoid aptychi.

Layer 5 (thickness of 38 cm) is composed of three beds: (5a) 8 cm – finely detrital, containing bivalves, brachiopods and small corals; (5b) 21 cm – mainly coarsely detrital with corals, brachiopods and ammonites. Recrystallisation of limestone and fossils is apparent; (5c) 9 cm – finely detrital and muddy in places, showing fragments of small corals and echinoid spines.

Layer 6 (thickness of 57 cm) is composed of three beds: (6a) 25 cm – rather coarsely detrital, containing bivalves, serpulids, aptychi and algae. Upwards, the layer changes to finely detrital limestone with small corals; (6b) 17 cm – detrital, displaying debris of bivalve shells in particular, although entire shells of brachiopods occur in places; (6c) 15 cm finely detrital to muddy, and a single ammonite was found in this part. Cup coral colonies appear in places.

Layer 7 (thickness of 20 cm) is composed of three beds: (7a) 6 cm – rather coarsely detrital, containing distinguishable corals and hydrozoans. The growth position is evident in some coral colonies; (7b) 9 cm – finely detrital, harbouring distinguishable corals, aptychi, ammonites and brachiopods; (7c) 5 cm – finely detrital to muddy, showing a considerable number of aptychi.

Layer 8 (variable thickness of up to 90 cm) the limestone of this layer is finely organodetrital, lacking any macrofossils, and does not change in character throughout its thickness. The uppermost layer outcropping is delimited at the top by a marked fault and the bottom of level 3.

MATERIAL AND AMMONITE PRESERVATION

The newly collected material, more than 100 ammonites, consists particularly of fragmentarily preserved, ribbed specimens of small size. Most frequently, one-third of the ultimate whorls is well preserved, whereas the remaining parts of the specimens are corroded to varying degrees, especially on the venter. In addition, the outer surfaces are usually matrix covered. The continuation of a more mature part of the specimens is in some cases preserved only as its outer outline. The preserved portion usually retains the recrystallised calcitic original shell. The thickness of the original shell is occasionally encrusted by microbial periphyton or by mineral crusts. In some cases, the original shell came loose from its internal filling during extraction; thus rather short portions are imperfectly preserved as inner moulds. In these, the relicts of suture lines are poorly preserved to a small extent. In some cases, shells or parts of their whorls were not filled in. In the exposed cavities of such whorls, tiny calcite crystals are usually visible. The parts of whorls that are not filled are usually broken, as seen both on the surfaces and in cross-sections of some shells. Overall, the majority of shells exhibit well preserved original non-deformed cross-sections or whorl shapes, comparable to those from the classic French localities (Toucas, 1890; Mazenot, 1939) and pyritized shells from Tunisia (Arnould-Saget, 1953). Most of the shells studied expose only one side. Thus, the whorl width cannot be measured directly, but it can, in some cases, be estimated relatively accurately from their half-width. The umbilicus and thus, the younger whorls are usually filled with sediment, similar to the interspaces between the ribs. Preparation of the shells, using a mechanical preparation needle, was usually only successful in part.

Only approximately one-third of the shells collected met the necessary requirements for identification as species, i.e., providing at least one measurable diameter of the shell with a measurable whorl height, a measurable umbilicus width and a quantifiable rib density (though usually per half-whorl in the present study), both on the umbilical area and venter.

In collection of the authors, a special category was represented by three imperfectly preserved juvenile shells (with diameters of 12 to 13 mm) that differ from all of the others, owing to the presence of evolute coiling and a style of ribbing with periodic umbilical and lateral tubercles. These are features, indicative of the genus *Spiticeras* Uhlig, 1903, but owing to the poor state of preservation and small size, these characteristics cannot be used for identification above the generic level. The single specimen of *S. blancheti* represents an exception.

The ammonite collection of the present study is deposited at the Nový Jičín Regional Museum (catalogue numbers PL 4145–4163).

TAXONOMY

For the taxonomic descriptions of the ammonites from the Kotouč Quarry, the authors have followed the systematic classification of Wright *et al.* (1996) and Klein (2005). In accordance with the 1999 Code of Zoological Nomenclature (p. 117), the suffix -oidea is used for superfamilies. The classification scheme proposed by Arkadev and Bogdanova (2012), in which Crimean berriasellines were assigned to the superfamily Olcostephanoidea Pavlov, 1892 (or Olcostephanaceae), following the recommendations by Kvantaliani (1999), on the basis of the development of the suspensive lobe U, is not accepted here. Following the basic classification of berriasellines, the authors accept the superfamily Perisphinctoidea.

To keep this contribution as brief as possible, the synonymies presented include only the most recent papers, as well as those that are of regional interest or of importance to the discussion. For the size parameters of ammonite shells, the following abbreviations are used: D – shell diameter (Dmax – maximum preserved diameter), H – whorl height, U – umbilicus width and B – whorl width (where measurable). Ratios of the parameters measured to shell diameter (H/D, U/D, B/D) or the ratio of whorl width to whorl height (B/H) are indicated in brackets. With regard to the fact that some authors (e.g., Kvantaliani *et al.*, 1999) reported the ratio of whorl height to whorl width (H/B), rather than the B/H ratio, the present authors give this as well. Rib density near the umbilicus (UR) and ventrolaterally (VR) are given per half-whorl.

Class AMMONITIDA von Zittel, 1884
Subclass AMMONITINA von Zittel, 1884
Superfamily PERISPHINCTOIDEA Steinmann, 1890
Family OLCOSTEPHANITIDAE Haug, 1910
Subfamily SPITICERATINAE Spath, 1924

Genus *Spiticeras* Uhlig, 1903
Type species: *Ammonites spitiensis* Blanford, 1864 (Berriasian, India), by subsequent designation of Roman (1938, p. 398)

Spiticeras blancheti Djanélidzé, 1922
Fig. 5A, B

partim 1868 *Ammonites Groteanus* Oppel – von Zittel, p. 90, pl. 16, figs 3a–c, 4. [*non* fig. 1a–c = *Spiticeras celsum* Oppel; *non* fig. 2a, b = *Spiticeras zitteli* Djanélidzé].

1922 *Spiticeras psudogroteanum* var. *Blancheti* n. sp. – Djanélidzé, p. 96, pl. 3, fig. 2a–c; text–fig. 21.

1953 *Spiticeras* (*Spiticeras*) *pseudogroteanum* Djanélidzé var. *Blancheti* Djanélidzé – Arnould-Saget, p. 99, pl. 8, figs 9a–c, 10a–c.

2005 *Spiticeras pseudogroteanum blancheti* Djanélidzé – Klein, p. 58.

Material: A single fragment (PL 4145) of a composite mould with a fairly well-preserved third of the ultimate whorl and with the continuation of the innermost part of the ultimate whorl, only observable in the shell outline. Only a small part of the venter is retained. The entire umbilical area is poorly preserved.

Description: The shell is small and evolute, with whorls that are a little wider than high. The greatest whorl width occurs in the umbilical area. Initially, the relatively flat flanks of the ultimate whorl are inclined to the venter, into which they pass gradually. The venter is quite wide and rounded.

On the ultimate whorl, a wide and quite deep constriction that is nearly straight and inclined to the aperture can be seen (not clearly visible in the photograph). Adapertural of this constriction, near the umbilicus, only four simple, rather strong ribs are preserved. From each of these ribs, 3–4 weaker ribs split on the flanks at a short distance. Owing to the imperfect preservation of the umbilical area, the basal part appears to bear weak umbilical and stronger lateral tubercles, although this cannot be clearly distinguished. The ribs are prorsiradiate and cross the venter without interruption, showing a hint of a chevron.

Measurements: The shell had an estimated maximum diameter of approximately 27 mm. Due to the state of preservation, the umbilicus cannot be measured. D = 24.3 mm, H = 7.6 (0.31) and B = *c.* 10. 2 (0.42); B/H = 1.34, H/B = 0.745.

Remarks: The size parameters are equivalent to measurements noted by Arnould-Saget (1953). Evolute shells with whorls with a width greater than height and umbilical and lateral tubercles on juvenile whorls are characteristic of the genus *Spiticeras.* With regard to the data furnished by Djanélidzé (1922, p. 98), the present authors believe, in contrast to previous authors, that, from a nomenclatorial point of view, the specimens described cannot be classified as a subspecies (*S. pseudogroteanum blancheti*), but instead represent a distinct species, *S. blancheti*.

Distribution: From the point of view of modern stratigraphy, the position of *S. blancheti* has not been considered in detail for quite some time. A specimen illustrated by von Zittel (1868, pl. 16, fig. 3), as well as all related specimens, come from Koňákov near Český Těšín and, thus, are not from Štramberk. According to literature data (see synonymy), the species occurs in France and Tunisia, as well as in the Silesian Unit in the Czech Republic. With reference to the associated ammonites from Kotouč Quarry described below, the present species can be assumed to be characteristic of the lower Berriasian (ammonite Berriasella jacobi Zone).

Occurrence: Layer 3, along the exit road from level 4 to level 3, at Kotouč Quarry.

Family NEOCOMITIDAE Salfeld, 1921
Subfamily BERRIASELLINAE Spath, 1922

Genus *Berriasella* Uhlig, 1905
Type species: *Ammonites privasensis* Pictet, 1867 (Berriasian, southeast France), by subsequent designation of Roman (1938, p. 324)

The genus *Berriasella*, similar to related genera, has been described inconsistently in a wide and variable manner since studies by Mazenot (1939). In subsequent decades, this situation remained unchanged. Tavera-Benitez (1985) subdivided this genus into four subgenera, while Wright *et al.* (1996) favoured two subgenera and Klein (2005), in accordance with Tavera-Benitez, four. Amended characteristics of the genus *Berriasella* have recently been provided by Arkadev and Bogdanova (2004, 2012). In principle, the concept of subgenera is abandoned here.

In the diagnosis of *Berriasella*, it is stated that the genus includes discoidal shells with faintly arched flanks and a rounded venter. The umbilicus is wide and stepped. Ribbing is thin, consisting of simple and bifurcated ribs. On the venter, the ribs are interrupted by a furrow that is distinct on juvenile whorls and less clear or absent on the ultimate whorl.

This is the generic concept of *Berriasella* employed here.

Berriasella jacobi Mazenot, 1939
Fig. 5C, D, G–I

* 1939 *Berriasella Jacobi* n. sp. – Mazenot, p. 54, pl. 4, figs 1a–b, 2a–b, 3a–b, 4. [*non* fig. 5 = *Lemencia subjacobi* Donze and Enay].
2005 *Berriasella* (*Berriasella*) *jacobi* Mazenot – Klein, pp. 170–171 [*cum syn.*].
2012 *Berriasella jacobi* Mazenot – Arkadev and Bogdanova, p. 144, pl. 4, figs 4–6 [*cum syn.*].

Material: More than 20 fairly well-preserved shells and about 30 of fragments. The best-preserved specimens include PL 4146, with a sediment-filled original shell. Its ultimate whorl, which is slightly deformed, is well preserved. Near the aperture, a short portion of the venter is exposed. Furthermore, this group of specimens includes a juvenile one, PL 4149. The largest specimen, PL 4151, has a diameter of approximately 45 mm. Other specimens are PL 4150–4152, PL 4147 and PL 4148.
Description: The shells are semi-involute, with rather narrow whorls of median height and a quite narrow umbilicus. The whorls are slightly vaulted. The greatest whorl width occurs in the lower quarter of the whorl. From there, the flanks gradually and continuously incline to the venter. The flanks are curved over the low umbilical wall and pass into the umbilicus. The flanks pass to the relatively flat, narrow venter.

The ribbing is somewhat variable. On juvenile whorls, ribs in the lower half of the whorl appear to be sparser, whereas in the subsequent small portion, they show thickening. After this region, the ribs again appear to be sparsely arranged. The initially quite thin ribs gradually strengthen in accord with shell growth, and the interspaces between the ribs increase. Overall, the ribs are slightly S shaped; they begin along the line of coiling as simple ribs and along the line of coiling, they are curved adaperturally within a short section. At approximately mid-whorl height, almost all ribs bifurcate narrowly. On the venters of all juveniles and some apparently adult specimens, ribs are interrupted. In some shells with a relatively large diameter, the ventral furrow is missing, whereas in others, the ribs are weakened on the venter.

Measurements (in mm) and ratios are in Table 1.

Overall, it appears that juvenile shells exhibit somewhat higher whorls than more adult shells.
Remarks: The present specimens are microconchs. These shells are somewhat variable in terms of the parameters measured, which is most likely linked to their natural variability, including that growth and shell diagenesis. The umbilical width is close to values found in the type material (U/D = 0.27–0.31) as reported by Mazenot (1939) and in material described by Arkadev and Bogdanova (2012) from Crimea, but not to those indicated by Tavera-Benitez (1985), who presented values corresponding to a quite wide umbilicus. In contrast, rib density per half whorl remains in principle constant with shell growth.

Berriasella jacobi differs from other berriasellines by having a narrower umbilicus. According to Arkadev and Bogdanova (2012), this species should also differ, in displaying a higher degree of whorl convexity.
Distribution: *Berriasella jacobi* is an index species for the base of the Berriasian. This species occurs over a considerable area covering almost the entire Tethys, from the Himalayas through all of Mediterranean Europe to northwest Africa. However, many specimens illustrated in the literature are preserved only fragmentarily, usually as quite deformed shells, and thus, their identification is sometimes controversial. In the Carpathian area, specimens described by Wierzbowski and Remane (1992) belong to this category.
Occurrence: The first abundant finds of this species from the Štramberk Limestone came from a small classic region near the town of Štramberk. Shells of this species were found in layers 1 to 5, i.e., essentially throughout the entire section studied.

Berriasella oppeli (Kilian, 1889)
Fig. 5E, F, J

partim 1868 *Ammonites Calisto* d'Orb. – von Zittel, p. 100, pl. 20, figs 1a–c [lectotype], 2, 3a–c, 4. [*non* fig. 5a, b].
* 1889 *Perisphinctes Oppeli* n. sp. – Kilian, p. 662.
partim 1939 *Berriasella Oppeli* (Kilian) – Mazenot, p. 49, pl. 3, figs 1a–c, 2a–c, 3a, b, 6a, b, 8a–c. [*non* figs. 4a, b, 5a, b].
2005 *Berriasella* (*Berriasella*) *oppeli* (Kilian) – Klein, p. 173 [*cum syn.*].
2012 *Berriasella oppeli* (Kilian) – Arkadev and Bogdanova, p. 147, pl. 5, fig. 3.

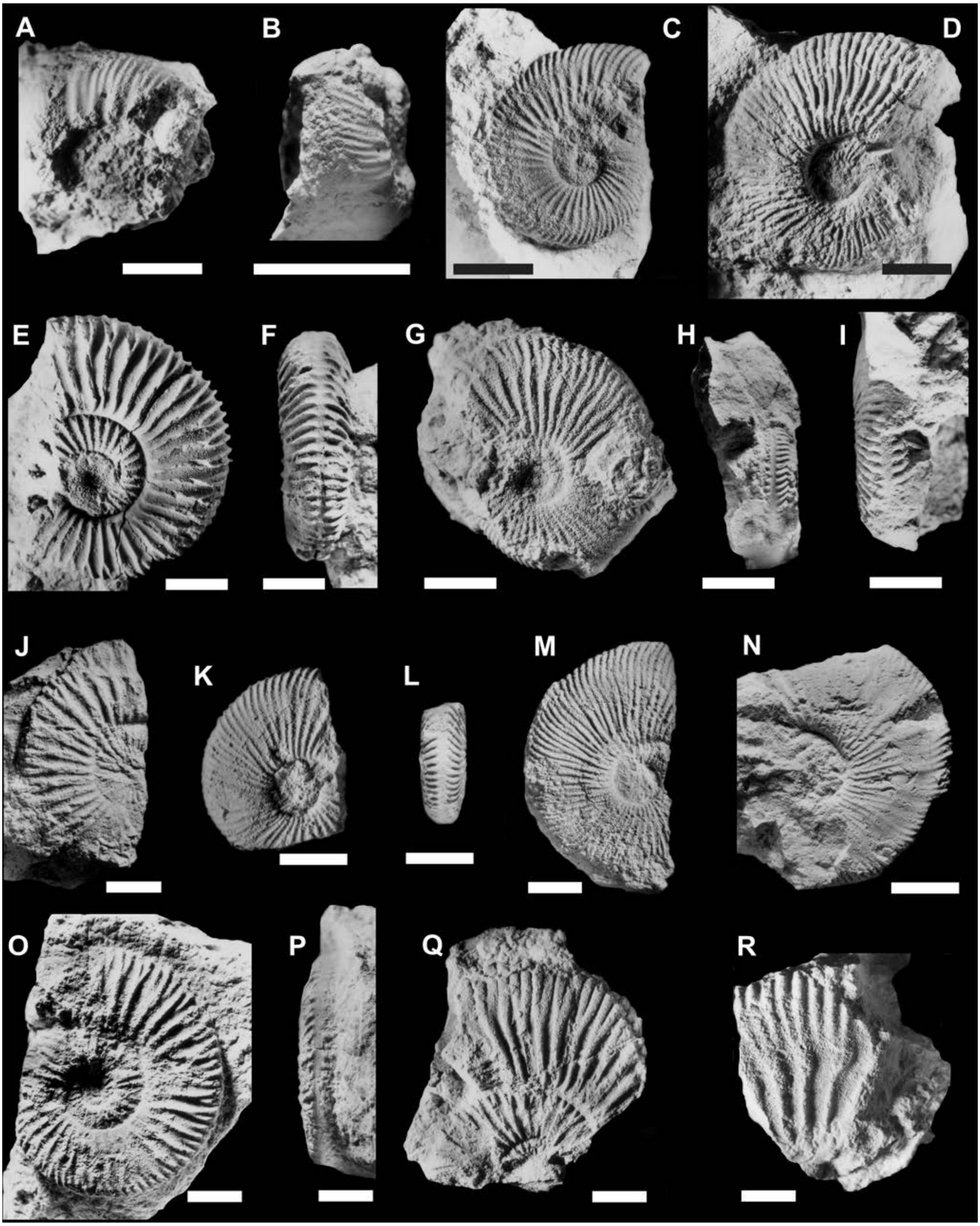
Material: A favourably preserved composite mould with a near-complete ultimate whorl and half of the preceding whorl, stored in the collections of the Silesian Museum at Opava (specimen 17/80-1980-3181) and a fragment (less than half a whorl) with a recrystallised original shell (PL 4153).
Description: The shells are semi-evolute. The ultimate whorl is not high, its height being somewhat greater than its width. The whorls are slightly vaulted and in the upper three-quarters of the shell height, they incline towards the venter. The greatest width occurs at approximately mid-height. The venter, which is not wide, is moderately arched and slightly flattened in the siphonal area. The umbilical wall is low and slightly rounded.

The ribs begin as simple ribs at approximately mid-height of the umbilical wall, where they are curved concavely. The spaces between individual ribs are rather large in the lower part of the flanks. At two-thirds of the whorl height, the ribs bifurcate quite narrowly. The anterior bifurcated one runs in the direction of the simple ribs, whereas the posterior is deflected in the opposite direction. Apart from the direction of the posterior ribs, all of the ribs

Table 1

Measurements (in mm) and ratios of *Berriasella jacobi* Mazenot, 1939

Spec. No.	D	H	U	B	B/H	H/B	UR	VR
PL 4149	approx. 23.5	10.6 (0.45)	6.7 (0.29)	c. 6.6 (0.28)	0.62	1.60	22	
PL 4148	max. 31.9	12.6 (0.395)	10.1 (0.32)	c. 10.0 (0.31)	0.79	1.26		
PL 4148	29.8	11.9 (0.40)	9.2 (0.31)				21	41
PL 4147	max. 37.6	16.2 (0.43)	10.6 (0.28)				22	
PL 4147	31.1	13.9 (0.45)	8.4 (0.27)	c. 10.3 (0.33)	0.73	1.35		
PL 4146	37.8	15.5 (0.41)	10.2 (0.27)	c. 11.0 (0.29)	0.71	1.41	22	43



in general are relatively straight and slightly prorsiradiate. On the penultimate whorl, the points of rib bifurcation are clear. In the prevailing portion of the ultimate whorl of the nearly complete specimen, in which more than a half of the ultimate whorl belongs to the body chamber, a narrow siphonal furrow is distinct, interrupting the ribs. Nearing the maximum diameter, this furrow gradually disappears.

Measurements (in mm) and ratios are in Table 2. The incomplete smaller shell (spec. PL 4153) has a diameter of approximately 40 mm.

Fig. 5. The Berriasian amonites from the Štramberk Limestone. Prior to photography, all specimens were coated with ammonium chloride. Photographs: K. Mezihoráková, Ostrava. Scale bars equal 10 mm. **A**, **B.** *Spiticeras blancheti* Djanélidzé, 1922; A – lateral view. On the left, abapertural to the part with ribs, there is a distinct constriction; however, this is not properly visible in the photograph; B – ventral view. PL 4145, layer 3. **C.** *Berriasella jacobi* (Mazenot, 1939), PL 4148, layer 5. **D**, **I.** *Berriasella jacobi* (Mazenot, 1939); D – lateral view showing bifurcate ribbing, I – ventral view near aperture with siphonal furrow, PL 4146, layer 3. **E**, **F.** *Berriasella oppeli* (Kilian, 1889); E – lateral view, F – ventral view. Specimen 17/80-1980-3181, Silesian Museum at Opava; allegedly from the old 3rd level at Kotouč Quarry, quarried in the 1960s. **G**, **H.** *Berriasella jacobi* (Mazenot, 1939); G – lateral view, H – ventral view at the start of ultimate whorl preserved as internal mould with distinct siphonal furrow, PL 4147, layer 4. **J.** *Berriasella oppeli* (Kilian, 1889), PL 4153, layer 2. **K**, **L.** *Tirnovella allobrogensis* (Mazenot, 1939); K – lateral view – note dense ribbing, L – ventral view, PL 4154, layer. 3. **M**. *Tirnovella allobrogensis* (Mazenot, 1939), with shell retained, PL 4155, layer 3; **N**. *Tirnovella* cf. *allobrogensis* (Mazenot, 1939), internal mould, PL 4156, layer 3. **O**, **P.** *Delphinella consanguinea* (Retowski, 1893); O – lateral view with the polygyrate ribbing, P – ventral view with siphonal furrow. PL 4157, layer 3. **Q.** *Pseudosubplanites* cf. *grandis* (Mazenot, 1939), PL 4158, layer 6. **R.** *Malbosiceras* cf. *asper* (Mazenot, 1939), PL 4159, layer 3

Remarks: The size parameters of the nearly complete shell from the Silesian Museum are close to those of the lectotype of *B. oppeli* (in von Zittel, 1868, pl. 20, fig. 1a–c). A characteristic feature, in contrast to other berriasellids, is the somewhat sparse ribbing and a long apparent siphonal furrow.

Distribution: The lower Berriasian (Berriasella jacobi Zone) in Tunisia, Spain, France, Romania and at Koňákov in the Silesian Unit. In Bulgaria and Crimea, *B. oppeli* occurs in the Berriasella jacobi Zone as well as in the overlying Occitanica Zone.

Occurrence: The specimen from the Silesian Museum, labelled as *Berriasella carpathica* (Zittel), comes from the old, long-exploited level 3 at Kotouč Quarry. The incomplete specimen of the present study was found in Layer 2, along the exit road between level 4 and level 3.

Genus *Tirnovella* Nikolov, 1966

Type species: *Berriasella alpillensis* Mazenot, 1939 (Berriasian, southeast France), by original designation of Mazenot (1939, p. 73)

Tirnovella allobrogensis (Mazenot, 1939)

Fig. 5K–M

* 1939 *Neocomites allobrogensis* n. sp. – Mazenot, p. 210, pl. 33, fig. 4a, b.
1965 *Neocomites suprajurensis* Mazenot – Houša, p. 532, fig. VIII–282.
2005 *Tirnovella allobrogensis* (Mazenot) – Klein, p. 254 [*cum syn*.].
2012 *Tirnovella allobrogensis* (Mazenot) – Arkadev and Bogdanova, p. 159, pl. 7, figs 7–9 [*cum syn*.].

Material: Four incomplete specimens, the best-preserved being PL 4155. Its incomplete ultimate half whorl, with original recrystallised shell retained, exhibits an imperfectly preserved venter and a small part of the preceding whorl. Shell diameter can only be measured approximately. The last quarter is body chamber. Furthermore, a fragment of a juvenile shell (PL 4154) is available.

Description: The shells are semi-involute to involute, with high and narrow whorls and a narrow umbilicus. The umbilical wall is low and obliquely inclined. The flanks are slightly arched. Their maximum width occurs near the umbilical shoulder. The lower part of the whorl is quite flat, and the flanks only begin to incline to the venter somewhat more markedly at mid-whorl height. The venter is not preserved.

The dense, thin ribbing consists of ribs that are approximately equally strong along their entire length. On the umbilical wall, the ribs are curved slightly concavely in relation to the aperture. On the flanks, the ribs are rather straight initially; then, at approximately mid-whorl height, they are very slightly S-shaped, and in the upper two-thirds, they are markedly prorsiradiate. A portion of the ribs bifurcate near the umbilicus. In the lower third to half of the whorl height, a greater portion of the ribs bifurcate narrowly.

On the opposite, imperfectly preserved side of the larger specimen, the original shell is not preserved. In the inner mould, a weakening and gradual disappearance of the ribbing is clearly visible.

Measurements: PL 4155 has a maximum diameter of approximately 44 mm. At this diameter, H = c. 21.0 (0.48), U = c. 10.4 (0.24), B = c. 10.0 (0.23), B/H = c. 0.48 and H/B = c. 2.1. However, these parameters are approximate at best. In one quarter of the ultimate whorl, at a shell diameter of 44 mm, there are 13 ribs near the umbilicus and 28–29 ribs ventrolaterally, i.e., approximately 26 ribs near the umbilicus and approximately 56 ribs on the circumference per half whorl.

The juvenile shell, PL 4154, has an estimated maximum diameter of approximately 25 mm. At another point on the shell close to the maximum diameter, H = 12.8 mm, B = 6.8 mm, B/H = 0.53 and H/B = 1.88.

Remarks: *Tirnovella allobrogensis* is morphologically close to *T. suprajurensis* (Mazenot, 1939). The basic difference between them appears to be shell size, as *T. allobrogensis* most likely represents a microconch and *T. suprajurensis* a macroconch. Regarding shell diameter, the limit between the two species is approximately 65 mm (Mazenot, 1939, p. 210).

Table 2

Measurements (in mm) and ratios of *Berriasella oppeli* (Kilian, 1889)

Spec. No.	D	H	U	B	B/H	H/B	UR	VR
Sil. Mus. 3181	48.4	17.8 (0.37)	18.6 (0.38)	c. 15.6 (0.32)	c. 0.88	1.14	19	37
	45.0	16.5 (0.37)	17.2 (0.38)	c. 15.5 (0.34)				
		15.0		13.5	0.90	1.11		

The shells are thinly and densely ribbed. Data on density and number of ribs, reported by Arkadev and Bogdanova (2012, p. 159: 35 ribs near the umbilicus and 80 ribs on the circumference per whorl at a shell diameter of 31.5 mm), are evident for a half-whorl, rather than an entire whorl (see, e.g., specimen in their pl. 7, fig. 9). In addition, *T. occitanica* (Pictet, 1867) and *T. subalpina* (Mazenot, 1939), in which the ribbing is stronger and ribs bear weak umbilical tubercles, appear to be relatively closely related to *T. allobrogensis*.

The well-preserved specimen from the Štramberk Limestone illustrated by Houša (1965), referred to as *Neocomites suprajurensis,* evidently represents one of the largest and most perfectly preserved microconchs of *T. allobrogensis*.

Distribution: This species is, according to Arkadev and Bogdanova (2012), known from the lower Berriasian Berriasella jacobi Zone, specifically from its higher part, i.e., the Grandis Subzone from the Crimean Mountainous, as well as from the Berriasella jacobi Zone in the Caucasus, Bulgaria, southeast France, Spain and North Africa.

Occurrence: Layer 3, exit road from level 3 to level 4, Kotouč Quarry.

Tirnovella cf. *allobrogensis* (Mazenot, 1939)
Fig. 5N

Material: A single incomplete and rather poorly preserved internal mould, showing indistinct relicts of sutures (PL 4156).

Description: The specimen is involute, with high, narrow whorls and a narrow umbilicus. The whorl flanks are quite flat and gradually inclined to the venter, which is quite narrow, only slightly arched and separated from the flanks relatively clearly.

The ribbing is thin and dense. The majority of ribs near the umbilicus are simple, with a subset bifurcating at the umbilicus. On the flanks, further rib bifurcation can be seen. This bifurcation is less distinct because at close to half the whorl height, the ribbing is weakened considerably, extending nearly to the venter. On the transition of the flanks to the venter, the ribs again become distinct. On the venter near the aperture, the ribs are interrupted in a quite wide smooth zone. In a short section on the opposite side, near the aperture, the original shell is preserved. In that section, the ribs run across the venter in a wide arc without interruption.

Measurements: In view of the incompleteness of the shell, the measured values are only approximate. At a D of approximately 39 mm, H = c. 17.8 (0.47) and U = c. 9.9 (0.26).

Remarks: The present shell is close in terms of size to *T. allobrogensis.* However, it differs in exhibiting markedly weakened ribbing early on the flanks of the ultimate whorl, similar to the Crimean specimens assigned by Arkadev and Bogdanova (2012, pl. 9, figs 1, 2) to *Tirnovella occitanica* (Pictet, 1867). One of their specimens (pl. 9, fig. 1) conforms to the description of "*Hoplites" occitanicus* by Retowski (1893, pl. 11, fig. 9). The specimens described by Retowski (1893) later became the type material of *Pseudoneocomites retowskyi*. This has a chequered nomenclature having been reported by Sarasin and Schöndelmayer (1901, p. 72), as *Hoplites Retowskyi*, then *Neocomites retowskyi* by Mazenot (1939, p. 211) and Druschic (1960, p. 289) and, subsequently, *Pseudoneocomites retowskyi* (see Hoedemaeker, 1982, p. 68; Klein, 2005, p. 265). Bogdanova *et al.* (1999) argued that Hoedemaeker (1982) did not describe the type species in detail and thus, it was difficult to determine the species concept of *P. retowskyi* and the content of the genus *Pseudoneocomites*. However, the Crimean specimen referred to above should not be attributed to the index species, *Tirnovella occitanica*. Additional material is needed from Crimea for clarification.

The weakening of the ribs on the flank of our specimen is evidently connected to its preservation as an internal mould. A similar feature is seen on one of the preserved surfaces of PL 4155 (described above as *T. allobrogensis*). However, the reverse side, with the preserved original shell, does not exhibit any rib weakening. Weakening of the ribs in *Pseudoneocomites retowskyi* from Crimea occurs initially only at a shell diameter of approximately 60 mm. The identification of PL 4156 as *P. retowskyi* is therefore unlikely.

Occurrence: Layer 3 along the exit road from level 3 to level 4 at Kotouč Quarry (together with *T. allobrogensis*).

Genus *Delphinella* Le Hégarat, 1971
Type species: *Hoplites delphinensis* Kilian, 1889 (Berriasian, southeast France), by original designation of Nikolov (1966, p. 639)

Delphinella consanguinea (Retowski, 1893)
Fig. 5O, P

?*partim* * 1893 *Hoplites consanguineus* n. sp. – Retowski, p. 268, pl. 12, figs 1a, b. [?non fig. 2].
1939 *Berriasella consanguinea* (Retowski) – Mazenot, p. 79, pl. 7, fig. 4a–c.
2005 *Delphinella consanguinea* (Retowski) – Klein, p. 184 [*cum syn*.].

Material: A single internal mould, representing the ultimate half-whorl of variable preservation (PL 4157).

Description: The specimen is semi-evolute, with narrow whorls of medium height. The umbilicus is quite wide. The ultimate whorl is slightly arched. The very low umbilical wall is inclined obliquely towards the line of coiling and is not limited sharply from the flanks. The greatest whorl width occurs at approximately mid-height. From there, the whorl inclines very gradually to the venter. The venter is narrow, flat and smooth and it is sharply separated from the flanks.

The ornament consists of S-shaped, altogether prorsiradiate ribs. The ribs start indistinctly as simple ribs in the vicinity of the line of coiling. In the area of the umbilical wall, the ribs are curved convexly. At approximately mid-height, the ribs bifurcate. At the point of bifurcation, there is a lateral tubercle, which is initially weak and longitudinally elongated; subsequently, tubercles become somewhat stronger. The original simple ribs continue as anterior bifurcated ribs. The posterior ribs are rursiradiate but prorsiradiate thereafter. In the ventral region, between the bifurcated ribs, one rib is occasionally inserted. These short ribs efface near the point of rib bifurcation. On the boundary between the flanks and venter, the ribs end abruptly in the indicated ventrolateral tubercles. The venter is relatively narrow and flat, with a smooth, relatively wide, shallow siphonal furrow. The final portion of the ultimate whorl exhibits a matrix-covered ventral region, and thus, it is not clear whether the smooth zone in the siphonal region reaches the maximum preserved shell diameter.

Measurements (in mm) and ratios are in Table 3.

Remarks: For the slightly deformed holotype, Retowski (1893) recorded the following dimensions: D = 57.0 mm, H/D = 0.37, U/D = 0.39 and B/D = c. 0.18. *D. consanguinea* is, in contrast to other delphinellids, characterised by a quite wide umbilicus, a relatively wide, smooth zone in the siphonal region and early occurrence of lateral tubercles.

Distribution: So far, this species has been reported exclusively from Crimea and southeast France. The genus *Delphinella* is speciose, especially in Crimea, specifically in the ammonite Berriasella jacobi Zone (Arkadev and Bogdanova, 2012). Although those authors did not mention the Crimean species *D. consanguinea* in their monograph, it can be assumed that its occurrence is confined to the Berriasella jacobi Zone as well.

Table 3

Measurements (in mm) and ratios of *Delphinella consanguinea* (Retowski, 1893)

	D	H	U	B	B/H	H/B	UR	VR
PL 4157	42.8	15.8 (0.37)	17.2 (0.40)					
	36.7	13.4 (0.365)	13.1 (0.35)	c. 8.0 (0.25)	0.60	1.67	16	39

Occurrence: Layer 3, near exit road from level 3 to level 4, at Kotouč Quarry.

Genus *Pseudosubplanites* Le Hégarat, 1971
Type species: *Pseudosubplanites berriasensis* Le Hégarat, 1973 (Berriasian, southeast France), by original designation of Le Hégarat (1971, p. 850). Vašíček *et al.* (2013) have recently presented their concept of the genus *Pseudosubplanites*

Pseudosubplanites cf. *grandis* (Mazenot, 1939)
Fig. 5Q

* 1939 *Berriasella grandis* n. sp. – Mazenot, p. 133, pl. 22, figs 3a, b, 6a, b.
1973 *Pseudosubplanites grandis* (Mazenot) – Le Hégarat, p. 38, pl. 2, figs 3, 4; pl. 37, fig. 9.
2005 *Berriasella* (*Pseudosubplanites*) *grandis* (Mazenot) – Klein, p. 158 [*cum syn*.].
2012 *Pseudosubplanites grandis* (Mazenot) – Arkadev and Bogdanova, p. 174, pl. 12, figs 1, 2; text-fig. 64-6 [*cum syn*.].
2013 *Pseudosubplanites grandis* (Mazenot); Vašíček *et al.*, p. 463, figs 3, 4.

Material: An imperfectly preserved fragment of fairly large size (PL 4158), representing approximately one quarter of the ultimate whorl and half of the penultimate whorl, with recrystallised original shell, plus its external mould.

Description: The shell is semi-evolute to evolute, without high whorls. The whorls are only weakly arched. The greatest whorl width occurs in approximately the lower third. The umbilical wall which passes continuously to the flanks of the ultimate whorl, is low and inclines obliquely to the line of coiling.

The ribs are quite strong and prorsiradiate. They begin as simple ribs at the umbilical wall above the line of coiling. In a short section, the ribs are curved concavely. In approximately the lower third-to-half of whorl height, the ribs bifurcate narrowly. In the lower part of the ultimate whorl, the ribs are thin initially and further strengthen increasingly. In the outer half of the whorl, they are quite wide and flat. One of the ribs preserved on the ultimate whorl remains simple along its entire length. On the penultimate whorl, the points of rib bifurcation are visible.

The maximum height of the ultimate whorl is approximately 23 mm, which could correspond to a shell diameter of approximately 60 mm.

Remarks: *Pseudosubplanites grandis* is characterised by fairly large diameters. The majority of specimens, illustrated in the literature, are relatively fragmentarily preserved [one exception being that described by Le Hégarat (1973, pl. 37, fig. 9)]. A specimen reported by Mazenot (1939, pl. 22, fig. 3) is morphologically closest to fragment in the present study, but in view of the incomplete nature of the find, the authors here use open nomenclature.

Distribution: According to Arkadev and Bogdanova (2012), *Pseudosubplanites. grandis* occurs in the lower Berriasian (Berriasella jacobi Zone) in the Crimean Mountains, Caucasus, Bulgaria, Romania, Hungary, southeast France and Tunisia.

Occurrence: Layer 6, along the exit road from level 4 to level 3 at Kotouč Quarry. Another, substantially better-preserved, specimen of *Ps. grandis*, from level 6 at that quarry, was described by Vašíček *et al.* (2013).

Genus *Malbosiceras* Grigorieva, 1938
Type species: *Ammonites malbosi* Pictet, 1867 (Berriasian, France), by original designation of Grigorieva (1938, p. 102)

Malbosiceras cf. *asper* (Mazenot, 1939)
Fig. 5R

*1939 *Berriasella aspera* n. sp. – Mazenot, p. 84, pl. 9, figs 2a–c, 4a, b.
2005 *Malbosiceras asper* (Mazenot) – Klein, p. 207 [*cum syn*.].

Material: A small fragment of a whorl (PL 4159) of a quite large shell, preserved as a composite mould, of which neither the umbilical area nor the venter are preserved.

Description: The whorl is slightly arched with the maximum width at mid-height; maximum whorl height is 32 mm. Only three prominent primary ribs are preserved. They begin simple, are straight, high, relatively thin and distinctly prorsiradiate. At mid-height, quite strong triangular tubercles occur. From the tubercles, the ribs occur in pairs or triplets. When there are two ribs, a third rib that reaches as far as the level of the tubercles is inserted. The split ribs are blunter than the simple ones.

Remarks: The character of the ribbing is similar to that observed in both *M. asper* and the related *M. chaperi* (Pictet, 1868). In view of the prorsiradiate inclination of the lower part of ribs of the former species, we refer it to that species, albeit with a query.

Distribution: According to Nikolov (1982), *M. asper* occurs in the lower Berriasian (Berriasella jacobi Zone) in France, Bulgaria and possibly Spain.

Occurrence: Layer 3, along the exit road from level 3 to level 4, at the Kotouč Quarry.

DISCUSSION

The Berriasian, as the oldest stratigraphic stage of the Cretaceous System, is currently subdivided (Reboulet *et al.*, 2011) into three internationally accepted ammonite zones. The lowest of these, with *Berriasella jacobi* and corresponding to the lower Berriasian, is not further subdivided into subzones. However, Arkadev and Bogdanova (2012) did use a tripartite subdivision of the Berriasella jacobi Zone in Crimea: a lowest subzone, with *B. jacobi*; a middle subzone with *Pseudosubplanites grandis* and an upper with *Malbosiceras chaperi*. In earlier studies, an independent Grandis Zone has occasionally been indicated in strata overlying the Berriasella jacobi Zone (e.g., Le Hégarat, 1973; Hoedemaeker, 1982). The authors accept the opinion of

Arkadev and Bogdanova (2012) that *P. grandis* appears in the higher part of Berriasella jacobi Zone.

In the middle Berriasian, a zone with *Tirnovella occitanica* has been recognised in recent studies (Reboulet *et al.*, 2011; Arkadev and Bogdanova, 2012). However, in the paper by Reboulet *et al.* (2011), *T. occitanica* is indicated as *Subthurmannia occitanica*. The Occitanica Zone contains three subzones in this case. The one with *Fauriella boissieri* corresponds to the upper Berriasian. Reboulet *et al.* (2011) also assigned this species to *Subthurmannia*.

From a stratigraphic point of view, in the new ammonite association from Kotouč Quarry, berriasellids (*Berriasella jacobi*, *B. oppeli*, *Tirnovella allobrogensis*, *T.* cf. *allobrogensis*, *Delphinella consanguinea*, *Pseudosubplanites* cf. *grandis* and *Malbosiceras* cf. *asper*) are the most significant taxa. The index species, *B. jacobi*, occurs in large numbers, whereas the others are rarer. Other species found only sporadically either are long-ranging (*Protetragonites quadrisulcatus* d'Orbigny, *Haploceras elimatum* Oppel) or their stratigraphic positions according to the literature are not known precisely (i.e., small-sized fragments and juvenile shells of *Spiticeras*).

The following cephalopod taxa are known:

layer 1 – *Berriasella jacobi*;

layer 2 – *Berriasella oppeli*, ?*Neocosmoceras* sp. (PL 4160), *Punctaptychus punctatus*;

layer 3 – *Spiticeras blancheti*, *Spiticeras* sp. juv., *Berriasella jacobi*, *Tirnovella allobrogensis*, *T.* cf. *allobrogensis*, *Delphinella consanguinea*, *Malbosiceras* cf. *asper*, *Protetragonites quadrisulcatus*, *Haploceras elimatum* (PL 4161), *Lamellaptychus beyrichi*;

layer 4 – *Berriasella jacobi*, *Spiticeras* sp. juv., *Protetragonites quadrisulcatus* (PL 4162), *Punctaptychus punctatus*;

layer 5 – *Berriasella jacobi*;

layer 6 – *Pseudosubplanites* cf. *grandis*;

layer 7 – *Punctaptychus punctatus*, *Lamellaptychus beyrichi*.

With regard to the observed succession of identifiable ammonites (which cannot always be found in the higher part of the section and identified with certainty, i.e., *Pseudosubplanites* cf. *grandis* and *Malbosiceras* cf. *asper*), the ammonite association of the section, described in the present study, can be considered to belong to the upper part of the ammonite Berriasella jacobi Zone.

There are no data to indicate a younger age of the Štramberk Limestone in the Štramberk area. However, as noted on the basis of foraminifera from Štramberk-type limestones in the Outer Carpathians (exotic blocks in flysch deposits) and biostratigraphic data on the substrate drilled in the Carpathian Foredeep (all in Poland), shallow-water sedimentation in the northern segment of the Carpathian basin persisted locally into the Valanginian (Ivanova and Kołodziej, 2010, and literature therein).

CONCLUSIONS

In historical collections of ammonites from the Štramberk Limestone at Štramberk and its immediate surroundings, usually only the approximate location, "Štramberk", appears on museum labels. Such specimens are deposited in many regional museums. The prevailing opinion is that these ammonites are of Tithonian age.

The newly collected ammonites from the Kotouč Quarry, described in the present account, come from a block of limestone that, in contrast to the majority of massive Štramberk limestones, exhibits strongly developed bedding. Among this rich collection of ribbed ammonites, belonging to seven species, *Berriasella jacobi* (index species of the lower Berriasian) and *Pseudosubplanites grandis* are of greatest stratigraphic importance. Neither previously was connected to the Štramberk area. An early Berriasian age is also suggested by the other species associated with them. However, in spite of these early Berriasian ammonites, it remains valid to conclude that the majority of older ammonite finds in the Štramberk Limestone are of Tithonian age.

Ammonites postdating the early Berriasian have never been found in the Štramberk Limestone. This suggests that deposition of the Štramberk Limestone in the Štramberk area came to an end during that time.

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