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The northernmost occurrence of the Lower Berriasian ammonite *Pseudosubplanites grandis* (Štramberk Limestone, Outer Western Carpathians, Czech Republic)

ZDENĚK VAŠÍČEK[1], PETR SKUPIEN[2] and JAKUB JIRÁSEK[2]

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

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Abstract: The first finding of the index ammonite *Pseudosubplanites grandis* (Mazenot, 1939) in the Lower Berriasian Štramberk Limestone (Outer Western Carpathians, northeastern Czech Republic) is important from the point of view of both the paleogeographical distribution of this species and of more precisely defining the upper boundary of the Štramberk Limestone (Early Berriasian *Berriasella jacobi* Zone) formerly regarded as Late Tithonian in age. From the taxonomical point of view, new data on a non-deformed cross-section of the adult whorl and above all on the shape of the adult suture line of this species have been obtained.

Key words: Outer Western Carpathians, Silesian Unit, Štramberk Limestone, Berriasian, ammonite, *Pseudosubplanites*.

Introduction

Representatives of the genus *Pseudosubplanites* occur relatively abundantly in Berriasian sediments of the European Tethys in a long belt from the Far East, Himalayas, Caucasus, Crimea, north-western Africa, and Mediterranean through Central to Western Europe. However, they have never been known either from classical localities of the Štramberk Limestone in the surroundings of Štramberk, or from so-called exotic blocks with Štramberk-type limestones in the near-by Silesian Unit of the Outer Western Carpathians (Hohenegger 1861). This also applies to the historical and significant Koňákov locality near Český Těšín, which is famous for the occurrence of Berriasian ammonites.

A common feature of specimens of *Pseudosubplanites grandis* introduced in the literature is the imperfect, fragmentary preservation of large shells, often associated with their deformation. Suture lines (if any) are preserved incompletely.

Finding of an incomplete *Pseudosubplanites grandis* shell in the Kotouč Quarry near Štramberk (Figs. 1, 2) represents the first discovery of this species in the Outer Western Carpathians. It is remarkable for the undeformed cross-section of the whorl, for knowledge of an incomplete, but well preserved outer adult suture line and for some other morphological details, as well as for delimitation of the upper boundary of the Štramberk Limestone in its type area.

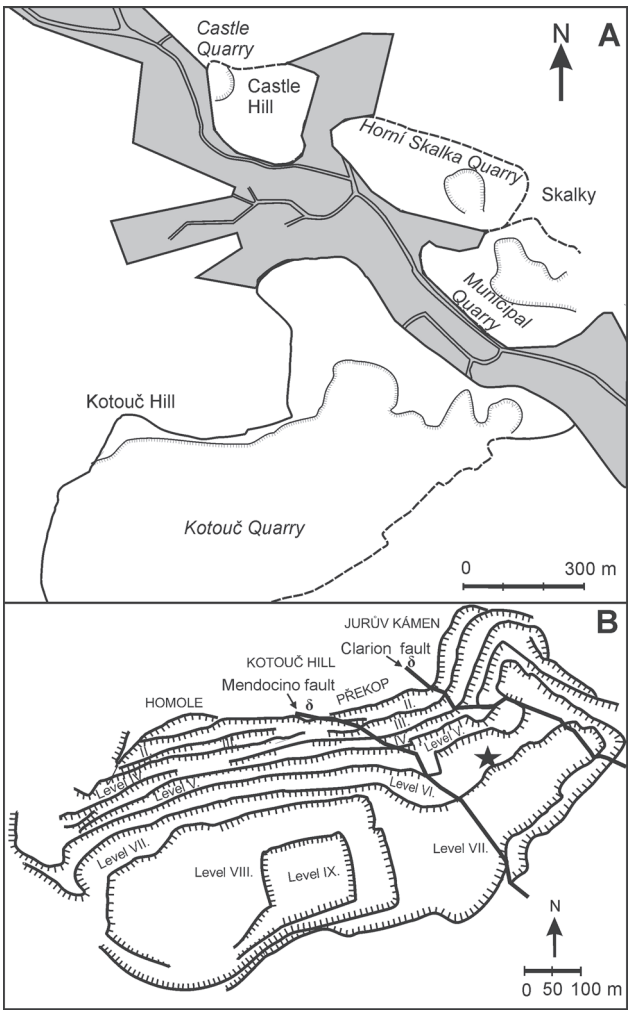

Fig. 1. Topographic situation of bodies of Štramberk limestones in the surroundings of Štramberk (Fig. A) and location of the place of finding the ammonite (marked with an asterisk) on level 6, Kotouč Quarry (Fig. B).

Fig. 2. View of the quarry wall, level 6, Kotouč Quarry near the place of finding the ammonite.

Geological setting

The Štramberk Limestone represents sediments developed on an Upper Jurassic and lowermost Cretaceous carbonate platform accompanied by reefs along the northern Tethyan margin. Large megablocks of limestones occur within Cretaceous flysch deposits in the Silesian Unit of the Outer Western Carpathians.

The Štramberk Limestone is traditionally believed to be of Tithonian age. Oppel (1865) identified the Tithonian stratigraphic stage on the basis of the fossiliferous Štramberk Limestone. Although such an age is possibly correct for the main stage of the reef development, calpionellids and ammonites indicate that the Štramberk Limestone represents products of the latest Kimmeridgian to Early Berriasian time span (e.g. Eliáš & Vašíček 1995; Houša & Vašíček 2005).

The Štramberk Limestone in its classical facies outcrops in several quarries in the immediate vicinity of the town of Štramberk in carbonate megablocks, big boulders, breccias and conglomerates. These limestones are white-grey in colour and they were originally deposited in different settings of the carbonate platform, including the reef complex.

Our ammonite find comes from the middle part of the 6th level of the Kotouč Quarry (Figs. 1, 2) from the debris on the level bottom. The Kotouč Quarry is located in the western part of the Kotouč Hill in Štramberk, consisting of block accumulations and forming the uppermost Jurassic (Tithonian) to Cenomanian or Lower Turonian succession. Accumulations of reef limestones are associated with different clayey limestones and claystones (grey and green-grey, red and dark grey). Houša (1975) distinguished three major bodies of the Štramberk Limestone accumulations separated by the Mendocino and Clarion faults in the Kotouč Quarry. Owing to the nature of occurrence of the Štramberk Limestone, exact age determination and section documentation are difficult.

Taxonomy

The terminology used for description of the taxon follows Wright et al. (1996). Suture-line terminology follows Wedekind (1916) as put forward by Kullmann & Wiedmann (1970) and revised in part by Korn et al. (2003): E — external lobe, A — adventive lobe (=lateral lobe, L, in former nomenclature), U — umbilical lobe. For shell dimensions we use abbreviations: D — diameter of shell, H — whorl height and B — whorl breadth.

As for the basic systematics, we adhere on the superfamily level to the concept of Wright et al. (1996) and Klein (2005). In accordance with the International Code of Zoological Nomenclature (1999), we use the suffix –oidea for the category of superfamily. The taxonomy by Arkadiev & Bogdanova (2012), in which berriasellids are classified into the superfamily Olcostephanaceae Pavlow, 1892 (on the basis of a proposal by Kvantaliani et al. 1999, based on the development of the suspensive lobe U), is not accepted here.

In order to keep this paper as short as possible, the synonymy contains only basic and recent references or those being important to the discussion.

Superfamily: **Perisphinctoidea** Steinmann, 1890
Family: **Neocomitidae** Salfeld, 1921
Subfamily: **Berriasellinae** Spath, 1922

Genus: *Pseudosubplanites* Le Hégarat, 1971

Type species: *Pseudosubplanites berriasensis* Le Hégarat, 1973. Lower Berriasian, south-eastern France.

The genus *Pseudosubplanites* recently received attention from Arkadiev (2003a), Bogdanova & Arkadiev (2005) and also Arkadiev & Bogdanova (2012). Arkadiev (2003a) recalled that Nikolov & Sapunov (1977) had determined a new subgenus *Hegaratella* in the framework of the genus *Pseudosubplanites*; the subgenus is supposed to be distinguished from the type subgenus by the absence of polygyrate ribs and by the indistinct ventral furrow. Arkadiev (2003a) and Klein (2005) respected the subgenus *Hegaratella*. For the subgenera *Pseudosubplanites* and *Hegaratella*, Nikolov with Sapunov (1977) even created a new subfamily Pseudosubplanitinae in the framework of the family Berriasellidae (see also Nikolov 1982). Kvantaliani (1999) stated that there are no substantial reasons or documentation supporting the singling out of this subfamily. Nevertheless, Cantú-Chapa (2012) in his contribution raised *Hegaratella* to the generic level in the framework of the subfamily Psudosubplanitinae, in the family Berriasellidae (but in the superfamily Perisphinctaceae). His justification of the independent genus is based on differences in the adult suture-line between *Hegaratella* and *Pseudosubplanites*; in the case of the latter genus he relies on an only insufficiently preserved suture-line of *P. grandis*, illustrated by Mazenot (1939: pl. 22, fig. 6b). In order to get the full picture we state that Tavera Benitez (1985) classified *Pseudosubplanites* and *Hegaratella* as subgenera of the genus *Berriasella* Uhlig, 1905. In additon, Bogdanova & Arkadiev (2005) originally regarded *Hegaratella* as a subgenus of *Berriasella.*

In accordance with the latest opinions and reasons stated by Arkadiev & Bogdanova (2012), we consider *Pseudosubplanites* to be a genus (which need not be divided into two

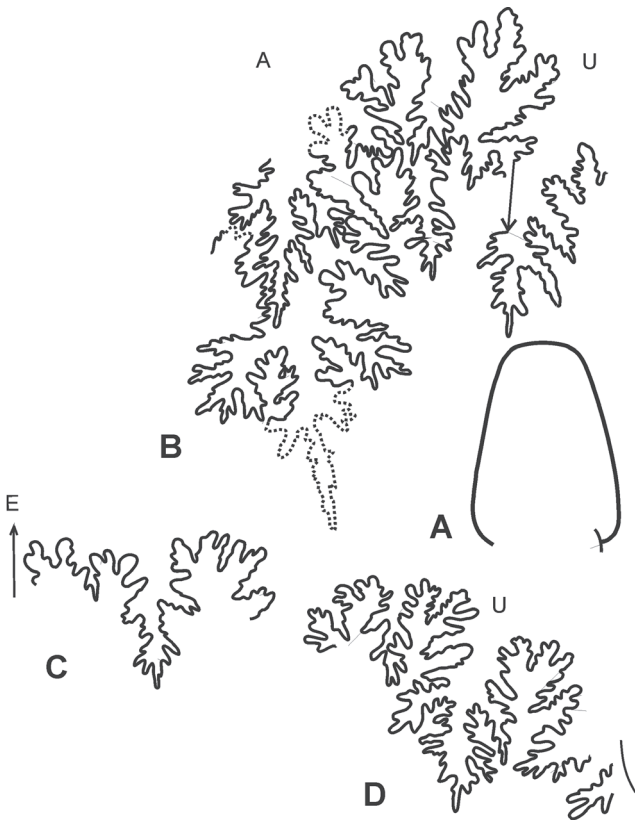

Fig. 3. Cross-section of the ultimate whorl of *Pseudosubplanites grandis* (Mazenot) at whorl height Wh = 45 mm (Fig. **A**) and composite outer suture-line at Wh = 46 mm (Fig. **B**), Wh = 40 mm (Fig. **C**) and Wh = 35 mm (Fig. **D**).

subgenera), belonging to the family Neocomitidae and the subfamily Berriasellinae.

Pseudosubplanites grandis (Mazenot, 1939)
Figs. 3, 4

1939 *Berriasella grandis* n. sp. — Mazenot, p. 133, pl. 22, figs. 3a,b, 6a,b
1968 *Berriasella grandis* Mazenot — Le Hégarat & Remane, p. 25, pl. 5, figs. 6, 7
1973 *Pseudosubplanites grandis* (Mazenot) — Le Hégarat, p. 38, pl. 2, figs. 3, 4, pl. 37, fig. 9
1997 *Pseudosubplanites grandis* (Mazenot) — Glushkov, p. 90, text-fig. 2, figs. 1, 2
2003a *Pseudosubplanites grandis* (Mazenot) — Arkadiev, text-fig. 1, fig. 2
2003b *Pseudosubplanites grandis* (Mazenot) — Arkadiev, p. 30, pl. 1, fig. 7a,b (= Glushkov, 1997)
2005 *Pseudosubplanites* (*Pseudosubplanites*) *grandis* (Mazenot) — Klein, p. 158 (cum syn.)
2005 *Pseudosubplanites grandis* (Mazenot) — Bogdanova & Arkadiev, p. 493, figs. 4A, 6F, 7J,K (= Glushkov, 1997)
2006 *Pseudosubplanites grandis* (Mazenot) — Arkadiev et al., pl. 3, fig. 7a,b (= Glushkov, 1997)
2012 *Pseudosubplanites grandis* (Mazenot) — Arkadiev & Bogdanova, p. 174, text-fig. 62a, text-fig. 64, fig. 6, pl. 12, figs. 1a,b, 2a,b (= Glushkov, 1997)

Preservation: The specimen is found in a comparatively rough organodetritic matrix. On the opposite, imperfectly preserved side, a residue of olive green claystone occurs besides limestone.

The specimen is incomplete, with less than half of the large shell remaining (spec. PL 4144), but it has a quite favourably preserved ultimate whorl (Fig. 3A) and imperfectly preserved two preceding whorls deformed to the bedding surface. Almost all of the non-deformed ultimate whorl is preserved as a steinkern with visible suture-lines corroded in various degrees (Fig. 3B–D). In several places on the venter, the relics of the original, quite thick-walled shell have been preserved.

Description: Shell semi-evolute, with medium high whorls, the height of which is greater than the whorl width. The ultimate whorl has a quite low, almost vertical umbilical wall. A short, rounded zone separates it from the whorl flanks.

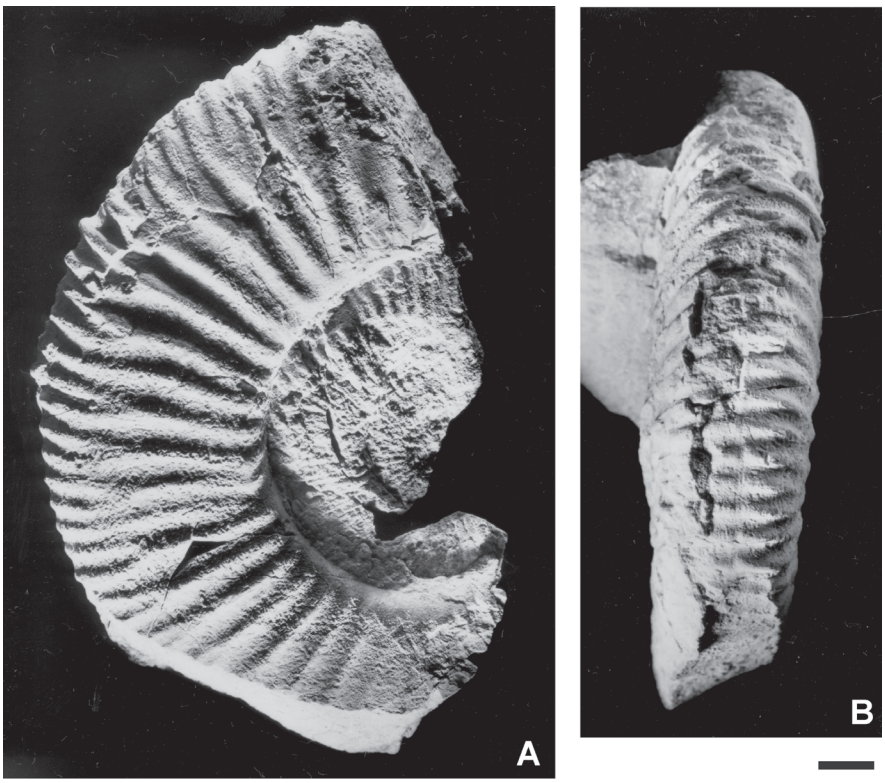

Fig. 4. Lateral view (Fig. A) and ventral view (Fig. B) of *Pseudosubplanites grandis* (Mazenot). Scale represents 10 mm. (Before taking the photos, the shell was whitened with ammonium chloride. Photos: K. Mezihoráková, Ostrava. The photographed specimen is deposited in the Regional Museum of National History in Nový Jičín under catalogue number PL 4144.)

The flanks are slightly vaulted. The greatest whorl width is there near the base of the whorl. A narrow, rounded part separates the flanks from the venter. The venter is quite narrow, only slightly arched.

The shell bears quite strong ribs slightly bent towards the aperture, exhibiting a negligible S-shaped curvature. Rib interspaces are about twice the rib width. The ribs begin above the line of coiling. On the flanks and on the venter, ribs are equally strong. At about two thirds of the whorl height, almost all ribs bifurcate. On the earliest preserved part of the ultimate whorl, a siphonal furrow or rather notch is there on the steinkern in the siphonal area. In the further continuation of the whorl, where the original shell is preserved, the notch cannot be seen. Ribs cross the venter without interruption; towards the aperture they are only slightly bent. Sporadically, simple, i.e. non-bifurcated ribs occur.

Measurements: With regard to the incompleteness of the shell, parameters measured commonly are not available. We estimate that the complete shell would have a diameter of about 140–150 mm. At the whorl height H = 43.5 mm, B is about 30 mm; B/H is about 0.69.

Suture-line: Suture-lines visible on almost the whole ultimate whorl are more or less corroded. With reference to the fact that the suture-lines are those of the adult shell, the suture-lines are very strongly dissected and close to each other, so that adjacent suture-lines merge into one suture-line in places. Merely in several places, in discontinuous parts, the suture-lines are preserved favourably to such a degree that they can be illustrated. The relatively most complete outer suture-line is the last suture-line; however, owing to the fact that it is not preserved on the outer half of the whorl it is not quite clear whether the suture-line is really the last one, ending the phragmocone, or whether it is only a suture-line preserved as the last one. According to the increasing rib interspaces at the end of the shell, it can, however, be assumed that after this suture-line, there is the beginning of the living chamber.

The most complete suture-line at the whorl height of 46 mm is illustrated here together with the first following suture-line that is more perfect in the preservation of the adventive lobe (A). The external lobe (E) has not been preserved on any suture-line. Only in one place, merely a part of the adjacent first saddle at the whorl height of 40 mm has been preserved. On the steinkern, any suture-line is not preserved near the line of coiling. At the whorl height of about 35 mm, the second lateral lobe and the periumbilical saddle are preserved. By combining all three above-mentioned parts, an almost complete outer adult suture-line could be depicted. Some details in these parts are not preserved either; but they can usually be derived from the adjacent last but one or periumbilical suture-line.

The preserved part of the outer suture-line consists of two strong lateral saddles, deep adventive lobe, deep next lobe and an incomplete periumbilical region. The first two saddles are wide; only the upper part of the first of them is preserved. They are divided by a narrow and deep secondary lobe into two main asymmetric parts. As for the saddles, the internal branch is stronger than the external branch. Both the main partial saddles are further dissected by smaller partial lobes. The adventive lobe (A) is trifid. It is very deep; the axial part of it is narrow, extending as far as about the upper third of the lobe of the following suture-line. The second lobe (U) is formed in quite a similar way. The incomplete suture-line in the periumbilical region differs from the preceding part. A quite low saddle formed more simply is found here; two obliquely inclined incomplete partial lobes reach it in the direction from the line of coiling.

Our specimen has probably the best preserved and almost complete (although not complete) outer adult suture-line.

Remarks: The characteristic features of our large-sized non-deformed shell are the somewhat larger height of the ultimate whorl than the width of it and the strong bifurcated ribs on the flanks of the shell that are sporadically intercalated with simple ribs. The steinkern bears an indistinct, narrow siphonal notch, in which the interruption of the ribs can be indicated. In a short following part, where the ribs of the original shell are preserved on the venter, neither the furrow, nor the interruption of ribs is visible. The adult outer suture-line has preserved on the flank two strong two-branched lateral saddles and two deep trifid lobes.

The Štramberk specimen corresponds well morphologically to the holotype of *P. grandis* (see Mazenot 1939: pl. 22, fig. 6a) and especially to the specimen of Le Hégarat (1973: pl. 37, fig. 9), depicted again later by Nikolov (1982: pl. 3, figs. 1, 2). In contrast to the above-mentioned specimens, our finding documents better the cross-section of the whorl, when the majority of specimens illustrated in the literature have whorls more (Mazenot's holotype in pl. 22, fig. 3b) or less deformed to the bedding surface (Bogdanova & Arkadiev 2005: text-fig. 4A).

Distribution: *Pseudosubplanites grandis* is known in the European continent from the Early Berriasian in the Caucasus, Crimea, Bulgaria, Romania and south-eastern France.

Discussion

The Štramberk specimen supplements substantially the knowledge of morphology of the non-deformed whorl of *Pseudosubplanites grandis*. What is significant from the point of view of systematics is the preservation of its adult suture-line. A single hitherto illustrated incomplete outer suture-line of *P. grandis* (Mazenot 1939: pl. 22, fig. 6b) of the holotype of size similar to that of our specimen is unambiguously drawn in a very simplified fashion. This suture-line is later taken as one of the main diagnostic features of the genus *Pseudosubplanites* when compared with *Hegaratella* (Arkadiev 2003a: text-fig. 1, fig. 2; Cantú-Chapa 2012: text-fig. 2). As for Cantú-Chapa (2012), the basic suture-line of *Hegaratella* was the suture-line of the specimen of Arkadiev (2003a: text-fig. 5), designated as *Pseudosubplanites* (*Hegaratella*) *jauberti* (Mazenot, 1939), or that of the same specimen in Bogdanova & Arkadiev (2005: text-fig. 11), designated as *Berriasella (Hegaratella) jauberti* (Mazenot). The suture-line of still the same specimen of the given species appears later in Arkadiev & Bogdanova (2012) under the name *P. jauberti* (Mazenot). If we compare the suture-line of the last mentioned species with the suture-line of the Štramberk specimen of *P. grandis* (see Fig. 3), it is evident

that both the suture-lines, formation of their adult saddles and periumbilical suture-lines can be taken as very close. If we omit the different widths of whorls of both the species, the common feature of both could also be a siphonal furrow (or notch) on the venter, which can be seen, however, only on the steinkern and not on the original shell of *P. grandis.* The presence of the siphonal notch has never been mentioned in the representatives of *P. grandis,* which may be a result of deformation or imperfect preservation of the shell. This species, known earlier only by the bifurcation of ribs and the unknown siphonal furrow, was thus always regarded as a representative of the genus or subgenus *Pseudosubplanites.* If we summarize our new knowledge of morphology and suture-lines, then it is not probable that the division in the framework of the genus *Pseudosubplanites* into the subgenera *Pseudosubplanites* and *Hegaratella* is realistic.

Pseudosubplanite grandis was earlier considered in the literature as a zone species, or a subzone species of the higher part of the Early Berriasian (e.g. Hoedemaeker & Bulot 1990). Since the year 1990, the international team for the Lower Cretaceous zonation based on ammonites has recognized merely the unsubdivided *Berriasella jacobi* ammonite Zone for the Early Berriasian.

For a long time, the division into a lower zone or subzone with *Berriasella jacobi* and a higher subzone with *Pseudosubplanites grandis* (e.g. Arkadiev 2003b; Arkadiev et al. 2006; Arkadiev & Bogdanova 2012) has been used for the Early Berriasian in the Crimea.

According to Le Hégarat & Remane (1968), *Pseudosubplanites grandis* is accompanied by *Calpionella alpina,* belonging to the higher part of the calpionellid Zone B, namely the *Calpionella alpina* Zone.

The occurrence of *P. grandis* in the Kotouč Quarry in the Štramberk limestones of that place thus indicates the upper part of the Early Berriasian ammonite Zone *Berriasella jacobi* sensu Reboulet et al. (2011). Younger carbonate deposits in the area of Štramberk, designated later as Čupek limestones (Houša in Houša & Vašíček 2005: p. 34), belong to the middle Berriasian. Our find thus determines the upper boundary of stratigraphic range of the occurrence of Štramberk limestones in the type area.

Occurrences of Štramberk limestones, or Štramberk-type limestones, stated in the literature, that are stratigraphically younger than the Early Berriasian and that are usually quite lithologically different, and that extend partly into the Valanginian, can also be found in places a considerable distance from the type area of Štramberk. Therefore they cannot be regarded as Štramberk-type limestones of equivalent age (see e.g. Ivanova & Kolodziej 2010).

Conclusion

The finding of *Pseudosubplanites grandis* in the Štramberk Limestone in the Kotouč Quarry near Štramberk represents the northernmost occurrence of the given species in Europe. The lower stratigraphic boundary of the Štramberk limestones that occur in the type area of Štramberk in a complicated tectonic setting is not quite clear. The upper boundary of the stratigraphic range of the Štramberk limestones in the type area is newly dated by our finding of *Pseudosubplanites grandis.* It indicates the Early Berriasian, namely the higher part of the *Berriasella jacobi* ammonite Zone. This favourably preserved find also makes the knowledge of the non-deformed cross-section of the adult whorl more accurate and above all contributes to the knowledge of the adult suture-line of this species. With regard to the similar formation of the suture-line of *P. grandis* and the suture-lines of species assigned to *Hegaratella,* we think that the division of the genus *Pseudosubplanites* into the subgenera *Pseudosubplanites* and *Hegaratella* is unsubstantiated.

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