Ammonoidea of the Lower Cretaceous Deposits (Late Berriasian, Valanginian, Early Hauterivian) from Štramberk, Czech Republic

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ABSTRACT: Forty one species of ammonites are described from the Late Berriasian, Valanginian and Early Hauterivian rocks deposited originally on the top of the elevated accumulation of the Štramberk Limestone (Štramberk sector of the Baška elevation; Tithonian to earliest Berriasian) and in the adjacent extrabasinal embayment. In the Late Valanginian and Early Hauterivian and/or later the majority of these rocks were eroded and redeposited. Their ammonite fauna can by studied practically only from such redeposited accumulations (Kopřivnice and Plaňava Formations), with the exception of cases that the ammonite fauna was encountered in the Gloriet limestones filling crevasses in the Štramberk limestones.

The studied ammonite material comprises limestone moulds and pyrite moulds. Limestone remains document Early Valanginian (Pertransiensis and Campylotoxus zones) to early Late Valanginian (Verrucosum Zone) ages of the rocks they come from Gloriet Formation. These rocks were destructed and their faunal content was redeposited into the Kopřivnice Formation in the Late Valanginian. During this process, remains of older rocks (ammonites from the Štramberk and Čupek Formations) were also transported. Pyrite remains of ammonites belong to species which evidence the whole of the Valanginian and the earliest Hauterivian (Radiatus Zone). These dark claystones were formed in an extrabasinal embayment separated from open sea by the Štramberk elevation. Its subsidence in the Early Hauterivian was followed by the exposure, destruction and transport of these rocks by slumping onto the subsided Štramberk elevation.

Besides Tethyan species, also Subboreal elements were encountered (*Platylenticeras*, *Prodichotomites*, *Endemoceras*, a. o.). The geological history of the Štramberk sector of the Baška elevation in the Berriasian to Early Hauterivian is briefly discussed.

KEY WORDS: Ammonoidea, Lower Cretaceous, Late Berriasian, Valanginian, Early Hauterivian, reworked faunas, depositional history, Baška elevation and its lithostratigraphical units at Štramberk.

Introduction

The studied collection of ammonites comes from the Late Berriasian, Valanginian and Early Hauterivian sediments deposited on top of the body of the former coral–*Diceras* bioherms (Tithonian to earliest Berriasian – Štramberk Limestone) or in its close proximity. The relatively rich fauna of these Early Cretaceous rocks is dominated by remains of echinoderms, brachiopods and belemnites. Aptychi and remains of sponges, gastropods, bivalves, corals and other groups are also common but ammonite remains are rather rare. The studied collection of ca. 350 specimens of ammonite remains (of which 312 could be determined at least to generic level) was therefore constituted during forty years of sampling (1956–1995) within investigations of the Štramberk area performed by students of the Institute of Geology AS CR (Academy of Sciences of the Czech Republic). Most of the material was collected in the Kotouč Quarry at Štramberk by the first author. Many finds were obtained also by washing of rock residues from the Blücher Quarry at Štramberk. This material was complemented by older finds, especially those from the Remeš collection and a few specimens from the museum at Štramberk.

The studied ammonite material was found to represent 41 species taxa of which 31 were determined to the species level (of which 16 with some reservations are expressed by open nomenclature abbreviations). Ten taxa were determined to the genus level only (mostly juvenile or poorly preserved specimens).

Material collected by previous collectors is mostly imprecisely localized (referring to Štramberk only). Only in the Remeš collection is the Blücher Quarry at Štramberk given as the sampling site. The character of the material, however, shows that practically all specimens of Early Cretaceous ammonites in older collections come from the Kopřivnice Limestone.

For the map of main individual limestone bodies in the vicinity of Štramberk, with positions of principal quarries, see Text-fig. 24.

Early Cretaceous ammonite material from Štramberk is extremely varied. It is mostly represented by remains found at secondary sites, i.e., redeposited from the original occurrences to younger rocks. Therefore, it generally includes incomplete specimens often bearing signs of transport-related abrasion. The material is derived from three main sources of lithologically contrasting sediments:

a) from the Kopřivnice Limestone (latest Valanginian) into which it was redeposited from disintegrating calcareous deposits of the Čupek (Berriasian) and Gloriet (Valanginian) formations,
b) from black-grey claystones of the Plaňava Formation (Hauterivian) the material of which is largely derived from disin-

tegrating dark Valanginian claystones enclosing ammonites mostly preserved in the form of pyrite moulds; a minor portion is represented by limestone fragments mixed within the slumps during their transport,

c) from solid grey calcareous claystones (Early Hauterivian, rarely Valanginian) forming bodies floating in the Plaňava Formation slumps; they represent more resistant undestroyed portions of the original rock.

The Kotouč Quarry, hosting most of the new sites with ammonites, opened the limestone massif of the Kotouč Hill formed by three closely juxtaposed tectonic blocks of the Štramberk Limestone. Remains of the former cover of the Štramberk Limestone were preserved in depressions on the original surface of each block tectonically overlain by a neighbouring block. Berriasian and Valanginian sediments were only rarely preserved *in situ* on the surface of the Štramberk Limestone (Tithonian to earliest Berriasian) because the latter, originally resting on the top of the Baška elevation, approached the sea level or maybe even emerged several times during the Early Cretaceous times. This resulted in erosion and washing of sediments deposited in apical parts of this complex. Berriasian and Valanginian sediments were, however, preserved within the Štramberk Limestone bodies in deep fissures (sedimentary dykes) that were progressively opened and immediately filled during the Berriasian and Valanginian. The individual generations of their fill are formed by the Čupek Limestone (Berriasian), Gloriet Limestone (Valanginian) and the Kopřivnice Limestone (latest Valanginian). Ammonites have been found rarely also in the fills of the fissures.

The material studied is provisionally kept in the Institute of Geology AS CR in Prague. It is, however, planned to be removed to the collections of the Silesian Museum in Opava.

Material preservation

Early Cretaceous ammonite material from Štramberk, represented by over 300 specimens, is extremely variable. It comes generally from three categories of lithologically different sediments:

a) calcareous deposits mostly grey-green or red in colour, corresponding largely to the Čupek Limestone (Berriasian), Gloriet Limestone (Valanginian) and Kopřivnice Limestone (latest Valanginian), but partly also to grey limestones (Gloriet Formation);

b) dark grey to black shale deposits, in which ammonites have been mostly preserved in the form of pyritized internal moulds; they form slump bodies of the Plaňava Formation in which the original claystone was leaf-like disintegrated and the pyritized ammonite remains were completely released and transported together with the disintegrated claystone;

c) solid grey calcareous pelites in which rests of ammonites are preserved in the form of sculpture moulds or also possessing the original shells, which are strongly crushed on the bedding planes; blocks of these claystones of different size float in the slump bodies of the Plaňava Formation.

Calcareous specimens are usually fragmentarily preserved in the form of internal moulds or sculpture moulds. They are most commonly represented by fragments of whorls of the medium stage of growth, usually bearing traces of lower- or higher-degree reworking and redeposition. In some cases, the internal moulds show preserved suture-lines.

The other, more numerous group coming from pelites poses a category of juvenile to minute (almost embryonic) pyritized moulds (the latter only several millimetres in maximum diameter), which are sometimes undeformed but more frequently also deformed.

Shell diameters and some other dimensional characteristics of shells cannot be measured in fragmentarily preserved calcareous whorls. Dimensional characteristics of shells compressed onto the bedding planes of dark pelites have been strongly altered by the deformation.

Specimens preserved in the form of pyritized internal moulds often bear preserved suture-lines on their early whorls. Their detailed incision is sometimes adversely affected by weathering. Most suture-lines belong to the category of juvenile suture-lines showing low differentiation; in some specimens, however, the rather simple denticulation may result from corrosion of the mould surface. Juvenile suture-lines are commonly not figured in professional literature, as suture-lines of adult specimens are usually described. Some of the herein figured juvenile suture-lines, having no parallels in the literature, can be therefore hardly correlated with others at present.

The poor preservation of the herein described material, much like the juvenile to embryonic growth stages with juvenile suture-lines, make the precise determination of shells extremely difficult. The determination is also uneased by the fact that many of the forms are represented by only a single fragment or a single juvenile specimen. With respect to the above mentioned unfavourable properties of the unique material gathered, which could not be collected bed by bed, the submitted paper does not deal with a detailed analysis of the systematics; instead, it rather aims at a most detailed determination of the material using all available literature data.

Taxonomy

Classification of the material studied from the Štramberk Early Cretaceous deposits follows the taxonomic classification of ammonites in the last edition of the Treatise (Wright et al., 1996); however, a more advanced concept of Reboulet (1996) was adhered to in some cases. Protancyloceratids and bochianitids are attributed to the superfamily Perisphinctoidea in agreement with the concept of Cecca (1997), and not among ancyloceratids as suggested by Wright et al. (1996). Phylloceratids, neglected by the Treatise, are classified according to the primary proposal of Wiedmann (1964) and Joly (1993). Species determinations are based mostly on the data in Company (1987), Reboulet (1996) and others.

In systematic part, we do not repeat the complete lists of synonyms, which have been published by previous authors. Instead, abbreviated lists of synonyms are mostly presented, referring to the most significant author(-s) dealing with the species described in the last few years.

Unfortunately, some of the determinations had to be restricted to the genus level or limited to open nomenclature only, due to the many adverse conditions mentioned in the preceding chapter.

Measurements and descriptions employed commonly accepted abbreviations. The dimensions measured on shells (in mm) are designated by the following symbols in paragraph Measurements: D – shell diameter, H – whorl height, U – umbilicus width (diameter) and B – whorl width. Ratios H/D, U/D and B/D are given in parentheses behind the respective parameters.

Sutural lobes are designated by the following symbols: E – external lobe, L – lateral lobe, U (U_2,U_3…) – umbilical lobes, I – internal lobe.

Suborder PHYLLOCERATINA Arkell, 1950
Superfamily Phylloceratoidea Zittel, 1884
Family Phylloceratidae Zittel, 1884
Subfamily Phylloceratinae Zittel, 1884
Genus *Phylloceras* Suess, 1865
Subgenus *Phylloceras* Suess, 1865
Type species: *Ammonites heterophyllus* Sowerby, 1820.

Phylloceras (Phylloceras) serum Oppel, 1868

Pl. 1, Figs. 1, 2, Text-fig. 1

1868 *Phylloceras serum* Oppel in Zittel; Zittel, p.66, pl.7, figs.5 a–c, 6 a–c
?1966 *Hypophylloceras* cf. *perlobatum* (Sayn); Rawson, p. 72, pl. 72, figs. 1–3, text-fig. 1a
1968 *Phylloceras (Phylloceras) serum* Oppel; Wiedmann and Dieni, p. 20 (cum syn.)
1983 *Phylloceras (Hypophylloceras) serum* (Oppel); Vašíček, p. 93, pl. 1, fig. 1 (cum syn.)
1993 *Hypophylloceras* aff. *perlobatum* (Sayn); Avram and Gradinaru, p. 671, pl. 1, fig. 2, pl. 2, fig. 1, pl. 3, fig. 2, ?pl. 1, fig. 1, ?pl. 3, fig. 1

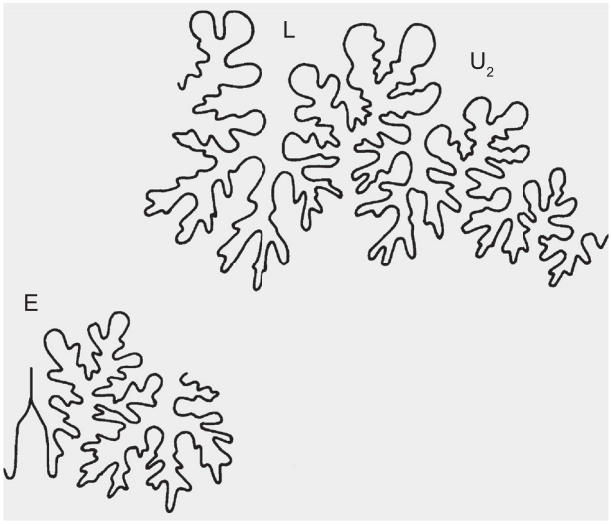
Material. Five juvenile specimens preserved in the form of pyritized internal moulds, with partly preserved suture-lines (spec. 116, 118, 276, 287 and 401) and other minute juvenile specimens (spec. 442 a.o.) whose pertinence to the species is somewhat dubious.

Description. Involute shells with a narrow to almost minute umbilicus, even in juvenile growth stages, high and slender whorls, weakly arched flanks and a low umbilical wall. Ventral side rounded but narrow. Dense, thin ribs on the surface, weakly arched towards the mouth, best visible on outer half of whorl.

Measurements. The largest shell, impossible to measure in more detail, has a diameter of 21 mm (spec. 287); diameters of other shells do not exceed 15 mm. Spec. 401 with D = 14.4 mm has H = 8.7 (0.60), U =1.1 (0.08), B = 5.0 (0.35). Juvenile spec. 442 (cf.) with D = 6.2 mm has H = 3.1 (0.50), U = 0.85 (0.14), B = 2.5 (0.40).

Suture-line. Juvenile suture-lines show very complex differentiation. They are characterized by a relatively shallow lobe E, with median saddle forming one-half of its height. Lobe L, much like the preserved parts of lobes U, are asymmetrical; the first lateral saddle is tetraphyllic.

Remarks. External morphology and ornamentation of *P. serum* are strongly reminiscent of shells from the group of *P. thetys* (d'Orbigny); as a result, *P. thetys* was often considered a descendant of *P. serum*. Nevertheless, as legitimately pointed out by Wiedmann (1964, p. 174), their morphological relationship is merely apparent: their suture-lines are so different from each other



■ **Text-fig. 1.** *Phylloceras (Phylloceras) serum* Oppel. Lobe E and paired lobes of the neighbouring suture-line at H = 5.5 mm. Spec. 401, site Š-65 (Plaňava Formation).

that phylogenetically younger shells from the group of *P. thetys* (with less complex suture-lines) clearly belong to a different subgenus – to *Hypophylloceras* Salfeld.

Distribution. According to Wiedmann and Dieni (1968), *P. serum* has been reported from the Tithonian to Barremian of the Mediterranean region. Rawson (1966) reported a related, if not identical, form from the Early Cretaceous of England, which is important from paleogeographic point of view.

Occurrence. *P. serum* occurs in the Plaňava Formation, sites Š-12, Š-24b, Š-44, Š-54 and Š-65.

Subgenus *Hypophylloceras* Salfeld, 1924
Type species: *Phylloceras onoense* Stanton, 1896.

Phylloceras (Hypophylloceras) ex gr. *thetys* (d'Orbigny, 1841)

Pl. 1, Figs. 4–6, Text-fig. 2

1841 *Ammonites Thetys* d'Orb.; d'Orbigny, p. 174, pl. 53, figs. 7–9
1964 *Phylloceras (Hypophylloceras) thetys thetys* (d'Orb.); Wiedmann, p. 176 (cum syn.)
1966 *Phylloceras (Hypophylloceras) thetys* (d'Orb.); Wiedmann, p. 74, pl. 1, figs. 6, 7a, b, text-fig. 11c

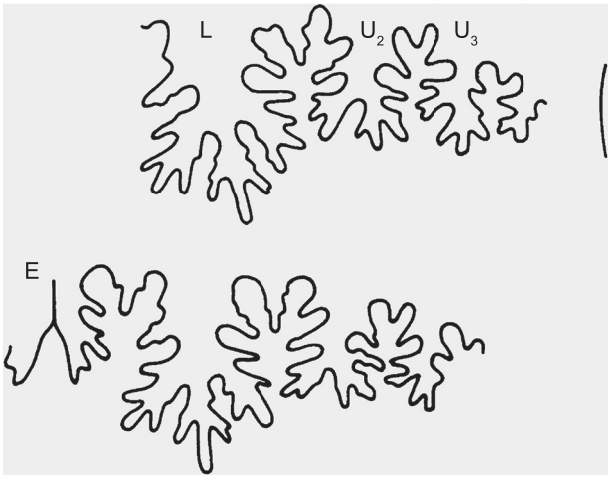
Material. A rather heterogeneous set of juvenile shells mostly preserved in the form of pyritized internal moulds (7 shells including spec. 117, 278, 311, 402) and a single corroded mould of medium stage of growth (spec. 403) with suture-lines.

Description. Initial growth stage of shells characterized by semi-evolute to evolute whorls. The whorls become more involute during shell growth. Umbilicus still broad and open even in post-juvenile stage on the largest shell (spec. 403), clearly showing a spiral of early whorls. Narrow whorls weakly arched, of only medium height. Umbilical wall low and steep, separated from flanks. Ventral side narrow. Very thin radial ribs present on the surface of shells (with only two exceptions). Ribbing of juvenile shells is, however, so fine that it could not be photographed.

Measurements. Two examples can be given among shells with missing (secondarily?) ornamentation and with markedly broad

umbilicus. The first shell (indexed 1) is juvenile (spec. 402), the second (spec. 403) belongs to the medium stage of growth (its Dmax ~15 mm): D1 = 7.9 mm, H = 3.4 (0.43), U = 2.75 (0.19), B = 2.8 (0.35); D2 = 13.6 mm, H = 6.6 (0.485), U = 2.2 (0.16), B = 4.6 (0.34). The third, juvenile shell with preserved ribbing and a clearly narrower umbilicus (spec. 117) has D = 8.9 mm: H = 4.8 (0.54), U = 1.2 (0.13), B = 3.3 (0.37).

Suture-line. Suture-line has a rather weak incision in general. Lobe E is rather shallow, one-half of its height is formed by a smooth median saddle. Lobe L1 is trifid and relatively symmetrical. Lobes U are asymmetrical. Saddles are weakly articulated, diphylloid.



■ **Text-fig. 2.** *Phylloceras (Hypophylloceras)* ex gr. *thetys* (d'Orbigny). Neighbouring suture-lines at H = 4.8 mm. Spec. 403, site Š-46 (Plaňava Formation).

Remarks. The first notable feature of juvenile shells are evolute inner whorls of the same type as figured by Wiedmann (1966, pl. 1, figs. 6, 7), or Sayn (1901, pl. 1, fig. 5), under the name *Hypophylloceras thetys*. With the shell growing, overlapping of whorls becomes more prominent. Umbilici in the present material are either narrower or somewhat broader. The largest shell, however, with no ornamentation preserved, maintains a relatively broad umbilicus until reaching its maximum diameter of 15 mm. It cannot be excluded that this shell represents a new subspecies.

The second characteristic feature with most of the material is the very fine, though not always preserved, ribbing on shell surfaces. This feature, the evolute early whorls, and the relatively simple suture-line of the same type as figured by Sayn (1901, text-fig. 2), are typical for *P. (H.) thetys*, particularly for its type subspecies *H. thetys thetys*. A certain heterogeneity in the width of umbilicus, the relatively broad umbilicus in a specimen of medium stage of growth, and the indistinct ornamentation prevent a definite determination. The above mentioned morphological features combined with the simple incision of the suture-line exclude the possible placement of the material within the group of *Phylloceras serum*, as has been already pointed out in the discussion above.

Distribution. As implies from the data of Wiedmann (1964, p. 176), the type subspecies, differing from the younger subsequent subspecies of *H. thetys* in its cross section of the whorl, i.e., a narrower umbilicus, ranges from the Valanginian to the Barremian. A similar range was given by Reboulet (1996) for its typical representatives.

Occurrence. The pyritized rests come exclusively from the Plaňava Formation, sites Š-12, Š-45, Š-46, Š-55 and Š-65.

Phylloceras (Hypophylloceras) sp. juv.

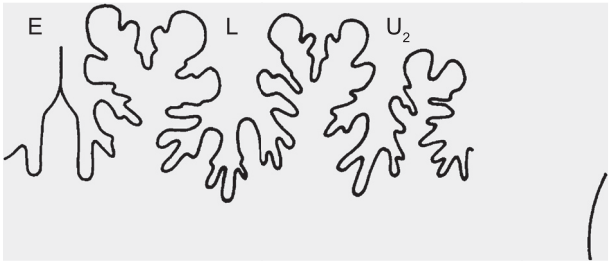
Pl. 1, Figs. 7, 8, Text-fig. 3

Material. Five juvenile internal moulds of small sizes, some with preserved suture-lines (spec. 281, 319, 404–406).

Description. Small involute shells with high whorls, relatively weakly arched flanks, and rounded but relatively narrow ventral side. Umbilicus narrow to minute. Shells smooth.

Measurements. Shell diameters do not exceed 13 mm. Measurements of two specimens yielded analogous parameters (larger spec. 404, smaller spec. 281). D1 = 12.6 mm, H = 7.1 (0.56), U is minute, B = 5.8 (0.46); D2 = 11.0 mm, H = 6.0 (0.55), U = 1.0 (0.09), B = 5.1 (0.46).

Suture-line. The suture-line has a rather weak incision. Trifid, weakly asymmetrical lobe L is the deepest. Lobe E is approximately halfway filled with the median saddle. Main saddles are diphylloid.



■ **Text-fig. 3.** *Phylloceras (Hypophylloceras)* sp. juv. Outer suture-line at H = 6 mm. Spec. 281, site Š-12 (Plaňava Formation).

Remarks. The weakly incised suture-line with lobe E occupied by a high median saddle resembles the suture-line of the specimens described above under the name *Hypophylloceras* ex gr. *thetys*. The described material differs from *H. thetys* especially in the involute shells, broader whorls, or the absence of the ornamentation.

Occurrence. The described material (pyritized internal moulds) comes from the Plaňava Formation, sites Š-12 and Š-56.

Genus *Partschiceras* Fucini, 1920

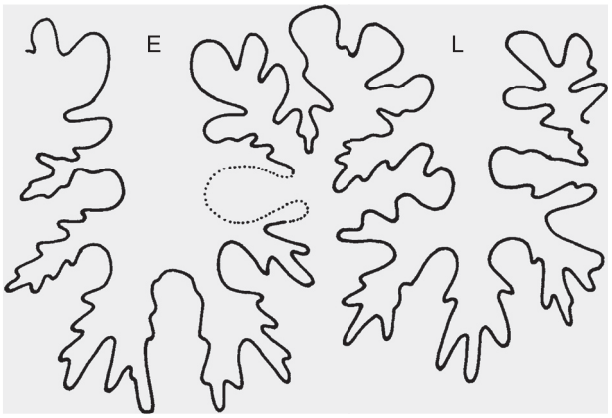
Type species: *Ammonites partschi* Stur, 1851.

?Partschiceras sp.

Pl. 1, Fig. 11, Text-fig. 4

Material. Only a single phragmocone with suture-lines, preserved in the form of a pyritized internal mould, subjected to deformation in its terminal part (spec. 119).

Description. Shell involute, rather small. Whorls strongly arched, whorl widths about equal to their heights. Whorls forming a funnel-shaped, basically minute umbilicus. Ventral side flatly rounded and rather narrow. Dense thread-like growth lines visible under the microscope. Indistinct, narrow, periodical furrows, resembling indistinct constrictions visible in lower halves of whorls; numerous but more widely spaced than the growth lines. Presence of weak simple subradial ribs cannot be excluded near the mouth.
Measurements. At D = 11.4 mm, the following parameters were measured on the undeformed part: H = 6.5 (0.57), B = 6.3 (0.55). Maximum diameter of the deformed shell is about 26 mm.
Suture-line. Incomplete outer suture-line possesses only a better preserved lobes E and L. Lobe E is the deepest element, with a rather low median saddle on its bottom. Lobe L is weakly asymmetrically trifid. Saddles are tetraphyllic.



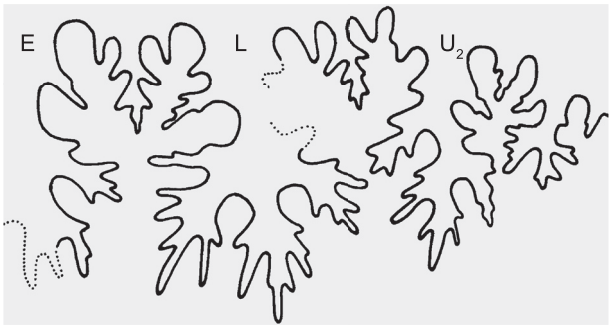
■ **Text-fig. 4.** *?Partschiceras* sp. Lobes E and L at H = 6.5 mm. Spec. 119, site Š-12 (Plaňava Formation).

Remarks. The suture-line with a deep lobe E, the detailed differentiation of lobe E as well as the character of the saddles, indications of radial ribs at the end of the shell, and the width of the whorls most probably suggest the genus *Partschiceras* (see, e.g., the suture-line in *Partschiceras eichwaldi occidentale* Wiedmann in Wiedmann, 1964, text-fig. 55). The poor preservation and the juvenile stage of the shell from Štramberk do not allow a more detailed determination.
Distribution. Early Cretaceous partschiceratids are generally reported to have first appeared in the Hauterivian. Besides the Hauterivian, also the Late Valanginian was indicated for *P. winkleri* (Uhlig) by Immel (1987).
Occurrence. The only pyritized specimen comes from the Plaňava Formation, site Š-12.

Subfamily Ptychophylloceratinae Collignon, 1956
Genus *Ptychophylloceras* Spath, 1927
Type species: *Phylloceras Feddeni* Waagen, 1875.

Ptychophylloceras semisulcatum (d'Orbigny, 1841)

Pl. 1, Figs. 9, 10, Text-fig. 5
1987 *Ptychophylloceras semisulcatum* (d'Orbigny); Immel, p. 60, pl. 1, fig. 10 (cum syn.)
1993 *Phylloceras semisulcatum* (d'Orbigny); Fatmi and Rawson, fig. 3e, figs. 4e, f, fig. 5c
1996 *Ptychophylloceras semisulcatum* (d'Orbigny); Reboulet, p. 188, pl. 35, figs. 14–19 (cum syn.)
Material. Sixteen juvenile pyritized internal moulds, often with imperfectly preserved suture-lines (e.g., spec. 81, 90–92, 104, 108, 109, 273–275, 277, 280, 284), a single fragment of a large pyritized whorl with incomplete outer suture-line (spec. 407) and four calcareous moulds (spec. 110, 329, 351, 408).
Description. Shells involute, with weakly arched to flat whorls and with rounded, relatively narrow ventral side. Umbilicus narrow but not minute. A rosette of 6 to 7 short and distinct constrictions, strongly concave relative to the mouth, visible around umbilicus. In their continuation (on best preserved specimens), thin intervals of constrictions, strongly inclined towards the mouth, reach towards the ventral side, crossing the ventral side with a slight arch – in a similar weakened form as on the flanks. A short, relatively strong rib occasionally indicated on front side of constrictions on the ventral side. Shells usually covered with fine growth lines.
Measurements. The following values were measured on the two best preserved specimens (smaller spec. 109, larger spec. 275). D1 = 13.2 mm, H = 7.1 (0.54), U = 1.3 (0.10), B = 5.6 (0.42); D2 = 21.8 mm, H = 11.7 (0.54), U = 2.0 (0.09), B = 9.4 (0.43).
Suture-line. An imperfectly preserved lobe E with a small median saddle is present on the fragment of a large shell (Š-12). This lobe is probably somewhat shallower than lobe L. Lobe L is trifid, weakly asymmetrical; other lobes are also trifid but clearly asymmetrical. The saddles are deeply incised.



■ **Text-fig. 5.** *Ptychophylloceras semisulcatum* (d'Orbigny). Outer suture-line of an adult whorl at H = 16.7 mm. Spec. 407, site Š-12 (Plaňava Formation).

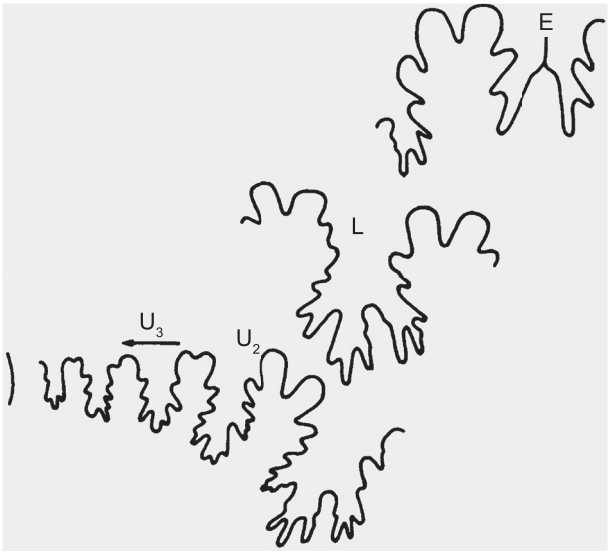
Remarks. Altogether three subspecies generally distinguished within *P. semisulcatum* cannot be identified among the juvenile material from Štramberk. The size parameters, the ornamentation and also the suture-line (see, e.g., text-fig. 5 in Sayn, 1901) are indicative of the given species.
Distribution. Berriasian to early Late Valanginian (ammonite *Neocomites peregrinus* Zone) is the range reported by Reboulet (1996) for *P. semisulcatum* from the Vocontian Trough.
Occurrence. Relatively abundant in the Plaňava Formation (pyritized internal moulds), sites Š-12, Š-45, Š-46, Š-56. Calcareous moulds come from sites Š-11, Š-58 a Š-65 (calcareous clasts in Plaňava Formation).

Subfamily Calliphylloceratinae Spath, 1927
Genus *Sowerbyceras* Parona & Bonarelli, 1895
Subgenus *Gyrophyllites* Wiedmann, 1964
Type species: *Phylloceras lateumbilicatum* Pervinquière, 1907.

Sowerbyceras (Gyrophyllites) calypso (d'Orbigny, 1841)

Pl. 1, Figs. 13, 14, Text-fig. 6
1976 *Holcophylloceras(?) calypso* (d'Orbigny); Patrulius and Avram, p. 162, pl. 1, fig. 3 (cum syn.)
1983 *Calliphylloceras calypso* (d'Orbigny); Vašíček, p. 94, pl. 1, figs. 2, 3 a, b (cum syn.)
1993 *Salfeldiella (Gyrophyllites) calypso* d'Orbigny); Joly, p. 53, pl. 11, figs. 6 a, b (cum syn.)

Material. A single well-preserved pyritized internal mould, the whole of which belongs to the phragmocone (spec. 286).
Description. Shell involute, with narrow and high whorls. Flanks of the whorls weakly arched, ventral side rounded and narrow. Umbilical wall low and steep. Umbilicus relatively broad. Six deep constrictions visible on whorl flank, strongly biconcavely arched (near umbilicus and even more prominently on ventral side). Thin growth lines indicated between constrictions.
Measurements. At D = 20.6 mm, H = 11.6 (0.56), U = 2.7 (0.13), B = 8.3 (0.40). Value B is somewhat higher due to the imperfect preservation of the whorl in the interval of measurement.
Suture-line. The outer suture-line shows a relatively weak incision. It is characterized by a shallow lobe E, of the height of which one-half is occupied by the median saddle. Lateral lobes and saddles are narrow. The lobes are asymmetrical, the saddles are diphylloid.



■ **Text-fig. 6.** *Sowerbyceras (Gyrophyllites) calypso* (d'Orbigny). Three neighbouring suture-lines from lobe E to lobes U at H = 9.5 mm. Spec. 286, site Š-45 (Plaňava Formation).

Remarks. The suture-line is similar to that figured by Sayn (1901, text-fig. 4). Sayn also pointed out that the suture-line illustrated by d'Orbigny (1841, pl. 52, fig. 9) is not precise.
Distribution. *S. (G.) calypso* has been reported from a wide range from the Tithonian to the Valanginian.

Occurrence. The only specimen comes from the Plaňava Formation, site Š-45.

Suborder LYTOCERATINA Hyatt, 1889
Superfamily Lytoceratoidea Neumayr, 1875
Family Lytoceratidae Neumayr, 1875
Subfamily Lytoceratinae Neumayr, 1875
Genus *Lytoceras* Suess, 1865
Type species: *Ammonites fimbriatus* Sowerby, 1817.

Lytoceras cf. *subfimbriatum* (d'Orbigny, 1841)

Pl. 1, Fig. 15
1996 *Lytoceras subfimbriatum* (d'Orbigny); Reboulet, p. 193, pl. 37, figs. 6, 7, pl. 38 , figs. 5–7 (cum syn.)

Material. Three imperfectly preserved, mostly fragmentary pyritized sculpture moulds, belonging to adult stages of growth (spec. 77, 78, 409).
Description. Shells evolute, with circular to slightly wider cross sections of whorls. A shallow furrow for the preceding whorl visible on dorsal side. Ornamentation formed by thin, indistinctly undulating ribs, spaced more widely at the beginning of whorl than its end.
Measurements. Whorl height of H = 12.3 mm in spec. 77 corresponds to B = 13.4 (B/H = 1.09).
Remarks. The inhomogeneous ribbing with respect to rib density, and the cross section of the whorl are indicative of *L. subfimbriatum*. Incompleteness of the whorl together with the fact that no main ribs are visible preclude a definite determination.
Distribution. According to Reboulet (1996), typical representatives of the species come from the Late Valanginian and Early Hauterivian of the Mediterranean region.
Occurrence. Plaňava Formation, site Š-12.

Genus *Protetragonites* Hyatt, 1900
Type species: *Ammonites quadrisulcatus* d'Orbigny, 1841.

Protetragonites quadrisulcatus (d'Orbigny, 1841)

Pl. 1, Fig. 12
1976 *Protetragonites quadrisulcatus* (d'Orbigny); Patrulius and Avram, p. 164, pl. 2, fig. 3 (cum syn.)
1983 *Protetragonites quadrisulcatus* (d'Orbigny); Vašíček, p. 97, pl. 2, fig. 3 (cum syn.)

Material. Fifteen juvenile to adult pyritized internal moulds (spec. 10, 18, 19, 21, 28, 29, 32, 76, 79, 260, 270 and others) and less than ten fragmentarily preserved calcareous whorls (spec. 20, 52–56, 326 and others).
Description. Shells evolute, with circular cross sections of whorls. Juvenile shells apparently smooth. Four prominent thin radial constrictions present on later whorls. Dense growth lines visible between constrictions on the best preserved specimens.
Measurements. In spec. 76, the following parameters were measured at D = 26.8 mm: H = 9.0 (0.335), U = 12.3 (0.46), B = 9.0 (0.335).
Distribution. *P. quadrisulcatus* has been reported to range from the Early Tithonian to the Valanginian; however, it probably extends to the Hauterivian, too.

Occurrence. *P. quadrisulcatus* is present in all types of Early Cretaceous sediments at Štramberk. In the Plaňava Formation (pyritized internal moulds), it occurs in sites Š-12, 25, 44, 45, 46; its occurrence in the Kopřivnice Limestone is documented by the collection of Remeš; one specimen (spec. 333) originates from the Čupek limestone; non-typical is the occurrence in grey limestone from site Š-58 (spec. 326).

Suborder AMMONITINA Hyatt, 1889
Superfamily Haploceratoidea Zittel, 1884
Family Haploceratidae Zittel, 1884
Genus *Neolissoceras* Spath, 1923
Type species: *Ammonites Grasianus* d'Orbigny, 1841.

Neolissoceras grasianum (d'Orbigny, 1841)

Pl. 2, Figs. 1, 2

1996 *Neolissoceras grasianum* (d'Orbigny); Reboulet, p. 164, pl. 34, figs. 1–14 (cum syn.)

Material. Two imperfectly preserved juvenile pyritized internal moulds (spec. 410, 411) and 7 fragmentarily preserved calcareous moulds (spec. 150–153, 155, 292, a.o.).

Description. Shells involute to semi-involute, with flat parallel flanks of whorls, bounded by an indicated edge against flat ventral side. Umbilical area funnel-shaped, bounded by a similar way.

Measurements. The following parameters were measured on the juvenile shell (spec. 410) at D = 12.8 mm: H = 7.0 (0.55), U = 1.2 (0.09), B = 5.2 (0.41).

Remarks. As indicated by the results of Company (1987) and Avram and Gradinaru (1993) and others, *N. grasianum* is a higly variable species as to its size, which was periodically reflected by separation of forms with narrow umbilicus under a separate species *(Haploceras neocomiense* Jekelius, 1915 or *H. subgrasianum* Drushcic & Kudrjavcev, 1960). As there exists a continuous line of specimens with different umbilicus widths having no stratigraphic significance, the erection of these species is not justified (an example of a specimen with extremely narrow umbilicus is given herein, too). The principal diagnostic feature discriminating *N. grasianum* from the related species is therefore the funnel-shaped umbilicus and a flat ventral side, both being separated from flat flanks. Still, the specific features may not be well developed, especially in juvenile stages. This applies particularly to the distinction from the below described species *V. salinarium* (Uhlig), which probably has narrower whorls than *N. grasianum* in the juvenile stage. Only at diameters of 10–12 mm, a keel appears on the ventral side of *V. salinarium*, permitting an unequivocal differentiation between the two species.

Distribution. The common species of *N. grasianum* ranges from the Berriasian to the end of the Hauterivian, according to the literature.

Occurrence. The Plaňava Formation (pyritized rests) in sites Š-12 and Š-46, the Kopřivnice Limestone with no closer localization, and limestones of the Gloriet type in site Š-1.

Genus *Vergoliceras* Atrops et Reboulet, 1996
Type species: *Haploceras salinarium* Uhlig, 1888.

Vergoliceras salinarium (Uhlig, 1888)

Pl. 2, Figs. 3–8, Text-fig. 7

1995 *Haploceras (Neolissoceras) salinarium* (Uhlig); Michalík et al., p. 290, pl. 4, figs. 1, 2 (cum syn.)

1996 *Neolissoceras salinarium* (Uhlig); Reboulet, p. 166, pl. 33, figs. 16–32 (cum syn.)

Material. Eight juvenile pyritized internal moulds, partly with preserved suture-lines (spec. 133, 296, 412–414, a.o.), a single calcareous phragmocone with a suture-line (spec. 138), one phragmocone with remains of the original shell (spec. 148) and 3 fragments of adult whorls preserved in the form of corroded calcareous internal moulds, highly probably corresponding to the body chamber (spec. 162–164).

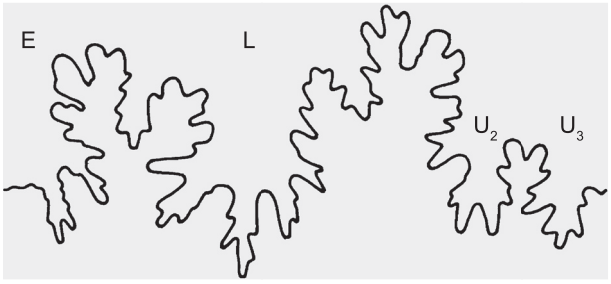
Description. Shells semi-involute, usually small, with high and slender whorls, a relatively narrow umbilicus and a rounded ventral side. Lateral walls of the whorl slightly arched, relatively abruptly but gradually passing to rather low, obliquely inclined umbilical wall; lateral walls also passing gradually to outer, rather narrow, rounded ventral side. An indistinct keel present on ventral side at diameters of around 10 mm. Keel much more distinct on body chambers of fragmentary calcareous moulds.

Whorls basically entirely smooth. Growth lines, weakly convex towards mouth, indicated only on some pyritized internal moulds and on fragments of original shell of the calcareous mould.

Measurements. Maximum diameters of complete shells reach approximately 18 mm.

Spec.	D	H	U	B	B/H
296	15.7	8.7 (0.55)	3.0 (0.19)	5.2 (0.33)	(0.60)
148	14.6	7.3 (0.50)	3.2 (0.22)	5.0 (0.34)	(0.68)
412	14.6	8.0 (0.55)	3.0 (0.205)	5.2 (0.36)	(0.65)

Suture-line. The suture-lines are characterized especially by the formation of bipartite saddles. The second lateral saddle is the highest, with its inner branch being dominant. In contrast, the third saddle and other lateral saddles are low. Lobe L is trifid, asymmetrical.



■ **Text-fig. 7.** *Vergoliceras salinarium* (Uhlig). Outer suture-line at H = 9.7 mm. Spec. 296, site Š-12 (Plaňava Formation) .

Remarks. The described shells are actually uniform. Keeled haploceratid shells were invariably attributed to *Neolissoceras salinarium* until recently. Nevertheless, a new haploceratid species *H. extracornutum* was lately erected by Cecca (1995), and placed into a newly defined genus *Vergoliceras* together with *N. salinarium*, based on the peripheral keel. Its juvenile shells show a similar morphology (including the keel) as those of the

former species. Only later do the ribs appear on the flanks of *V. extracornutum*. Also, a special ventral horn-like element of triangular shape appears on shell circumference (at shell diameter of ca. 20 mm). These features clearly separate the two species in adult stage of growth. It cannot be excluded, with respect to the juvenile character of the shells from Štramberk, that some of them pertain to the Italian species; especially those having indistinct lines on the flanks.

Distribution. According to Company (1987), *V. salinarium* is abundant in Spain, ranging from the Early Valanginian (younger part of the *Thurmanniceras pertransiens* Zone and the whole *Busnardoites campylotoxus* Zone) to the base of the Late Valanginian (base of the *Saynoceras verrucosum* Zone). The interval from the first appearance of *V. salinarium* to the appearance of the first representatives of the species *Saynoceras verrucosum* led Company to the definition of the Early Valanginian ammonite *Vergoliceras salinarium* Zone. Bulot and Thieuloy (1995) stated that the first appearance of *V. salinarium* in France was located in the latest Berriasian already, in the *Thurmanniceras otopeta* Zone.

Besides Spain, *V. salinarium* has been also reported from France, Eastern Alps, from the Rumanian and Western Carpathians (the Silesian Unit and the Manín Unit).

Occurrence. *V. salinarium* is present not only in the Kopřivnice Limestone (as reworked fragments from Gloriet limestone), and also in the Plaňava Formation (pyritized internal moulds) in sites Š-12, 45, 46, 54, 55, 65. The last specimen (138, site Š-11a) comes from Valanginian infill of fissures in the Štramberk limestone an is preserved as inner mould formed by grey limestone (Gloriet Formation).

Superfamily Perisphinctoidea Steinmann, 1890
Family Neocomitidae Salfeld, 1921
Subfamily Berriasellinae Spath, 1922
Genus *Subthurmannia* Spath, 1931
Type species: *Subthurmannia fermori* Spath, 1931.

Subthurmannia cf. *boissieri* (Pictet, 1867)

Pl. 2, Fig. 9

1987 *Fauriella boissieri* (Pictet); Company, p. 106, pl. 4, figs. 6, 7, pl. 18, fig. 6 (cum syn.)

Material. A single fragment of about one-fourth of an adult whorl preserved as a calcareous sculpture mould (spec. 199).

Description. Shell semi-involute, with weakly arched adult whorl, gradually tapering towards the ventral side, with maximum arching of whorl reached in about lower third of whorl height. Umbilical wall probably low and steep, sharply separated from whorl flanks. Transition from flanks to ventral wall relatively abrupt but less prominent than transition to umbilical wall. Ventral side relatively narrow and flat.

Ribs numerous, starting from blunt periumbilical tubercles positioned on transition between umbilical wall and whorl flank, usually in pairs. Ribs sigmoidally curved, proverse. All ribs bifurcating at mid-height of whorl, alternatively three ribs developed – one rib inserted. All ribs directed almost perpendicular to siphuncle, terminating in its proximity. Ventral area transected by a narrow smooth zone.

Measurements. At whorl height H = 20.5 mm, B = 14.4 mm (B/H = 0.70).

Remarks. The incompleteness of the find and the rather wider whorl compared to the data of Tavera (1985: B/H = 0.65–0.69) do not allow a definite determination of the specimen studied.

Distribution. According to Company (1987), typical representatives of the species *S. boissieri* usually occur in the Late Berriasian. In France and Spain, they persist until the Early Valanginian (to the base of the *Thurmanniceras pertransiens* Zone).

Occurrence. The only specimen found comes from the green limestones of the Čupek limestone type, site Š-53.

Subfamily Neocomitinae Salfeld, 1921
Genus *Thurmanniceras* Cossmann, 1901
Type species: *Ammonites Thurmanni* Pictet & Campiche, 1860.

Thurmanniceras thurmanni (Pictet & Campiche, 1860)

Pl. 2, Figs. 10, 11, Text-fig. 8

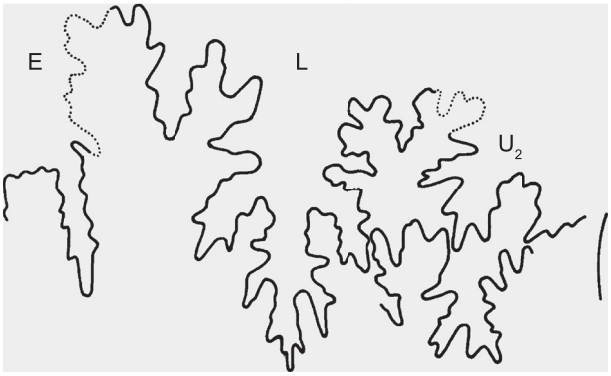
1987 *Thurmanniceras thurmanni* (Pictet & Campiche); Company, p. 114, pl. 7, figs. 1–6, pl. 18, fig. 19 (cum syn.)

Material. A single pyritized phragmocone with suture-lines, imperfectly preserved in in juvenile region, but with a relatively perfectly preserved last whorl (spec. 178), and a single reworked, incomplete calcareous mould (spec. 193).

Description. Shells semi-involute, with relatively high, slender whorls. Umbilical wall steep and low in postjuvenile region, flanks only weakly arched, sharply bounded against umbilical as well as ventral sides. Ventral side narrow and flat.

Constrictions (ca. 5 per whorl) visible on only partly preserved juvenile whorls, being weak on the last whorl. Ornamentation of the earlier part of the last whorl formed by arched prorsiradiate ribs starting from weak umbilical tubercles, usually in pairs. Simple ribs prevail on the later part of the last whorl. Ribs bifurcating at about mid-height of the whorl. All ribs discontinued on ventral side, terminated by weak ventrolateral tubercles orientated obliquely towards the mouth. Ventral area transected by a narrow smooth zone.

Suture-line. An almost completely preserved outer suture-line (Text-fig. 8) is preserved on the pyritized internal mould (178). Lobe E is narrow, lobe L deep and doubly trifid: as a whole and, in closer detail, also in its basal part.



■ **Text-fig. 8.** *Thurmanniceras thurmanni* (Pictet & Campiche). Outer suture-line at H = 13 mm. Spec. 178, site Š-45 (Plaňava Formation).

Measurements. The following parameters were measured on the best preserved specimen (178) reaching the maximum diameter of ca. 32 mm at D = 29.65 mm: H = 13.55 (0.46), U = 8.35 (0.28), B = 9.6 (0.32), B/H = 0.71.
Distribution. According to Company (1987), *Th. thurmanni* occurs in the Early Valanginian (*Thurmanniceras pertransiens* Zone) of the Mediterranean region.
Occurrence. Plaňava Formation, site Š-45; Gloriet Limestone, site Š-72.

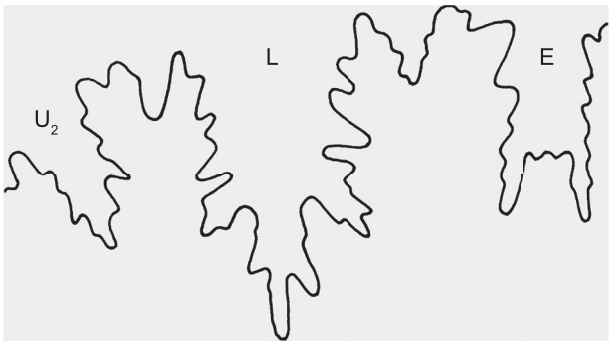
Thurmanniceras cf. *pertransiens* (Sayn, 1907)

Pl. 2, Figs. 12, 13
1987 *Thurmanniceras pertransiens* (Sayn); Company, p. 117, pl. 6, figs. 1–11, pl. 7, figs. 7, 8, pl. 18, figs. 16, 17 (cum syn.)
Material. A single fragment of a calcareous sculpture mould of a mostly corroded whorl, most probably belonging to the body chamber (spec. 352).
Description. Semi-involute shell with rather low whorls. Umbilical wall very low and steep. Flanks weakly arched, gently tapering to ventral side from lower fifth of whorl height; shell reaching maximum width at this point. Ventral side narrow and flat, separated from flanks by indicated edge. Ornamentation formed by weakly sigmoidally curved proverse ribs, starting at umbilicus with bullae and disappearing in central parts of flanks. Simple ribs bifurcating at about mid-height of whorl, or new ribs are inserted one at a time. All ribs along the circumference relatively thin, of equal thickness, dense, and terminated by obliquely orientated tubercles. Ventral area smooth.
Measurements. At H = 15.0 mm, B = 8.1 (B/H = 0.54).
Remarks. Weakened ornamentation in the central parts of the whorls is the characteristic feature of the described thurmanniceratid. Its fragmentary preservation does not allow a safe determination.

A mould of a large shell in the material of Uhlig (1902), coming from the Silesian Unit of the Outer Carpathians, determined by Vašíček (1975, pl. 5, fig. 1) as *T. pertransiens pertransiens*, does not belong to the above species as suggested by continued constrictions, a.o.
Distribution. *T. pertransiens* is a zone species of the Early Valanginian (*Thurmanniceras pertransiens* Zone) in the Mediterranean region.
Occurrence. The only find comes from the Kopřivnice Limestone (exact site unknown).

Thurmanniceras sp.

Pl. 2, Fig. 14, Text-fig. 9
Material. A single incomplete and partly deformed calcareous mould with filled umbilicus (spec. 196).
Description. Shell rather small, semi-involute, whorl heights exceeding whorl widths. Whorl flank flat, gradually tapering towards narrow, somewhat rounded ventral side. Ornamentation formed by weakly prorsiradiate, slightly sigmoidal, partly almost straight ribs interspersed with prominent constrictions. Ribs starting near umbilicus, at weak umbilical tubercles. Some ribs doubled, other ribs simple. Simple ribs and the front rib of the doubled ribs bifurcate at about mid-height of the whorl. All ribs on ventral side terminated by minute ventrolateral tubercles, obliquely inclined towards the mouth. Ventral area represented by a narrow ventral furrow. Constrictions weakly sigmoidally curved, with their number estimated at 4 to 5 per whorl.
Measurements. The measurements have merely an orientational character due to the deformation and imperfect preservation. Dmax reaches ~25.5 mm. At D ~23.5 mm, H ~10 mm (0.42) and Bmin = 7.8 (0.33). B/H ~0.78.
Suture-line. The suture-line is characterized by a rather shallow and especially narrow lobe E with rather low secondary saddle, by a deep and asymmetrically trifid lobe L and a similarly shaped but considerably shallower lobe U_2.



■ **Text-fig. 9.** *Thurmanniceras* sp. Outer suture-line at H = 8 mm. Spec. 196, site Š-59 (Kopřivnice Formation).

Remarks. The suture-line, the slender whorls and the constrictions indicate pertinence to the genus *Thurmanniceras* from the group of the type species. The shape of the ventral side, the juvenile stage and the poor preservation, however, do not provide features necessary for a more precise determination.
Occurrence. The shell comes from the Kopřivnice Limestone, site Š-59.

Genus *Kilianella* Uhlig, 1905
Type species: *Hoplites pexiptychus* Uhlig, 1882 (= *Ammonites Roubaudianus* d'Orbigny, 1850).

The concept of the genus *Kilianella* in this paper is in agreement with the diagnosis and the conclusions of Company (1987).

Kilianella roubaudiana (d'Orbigny, 1850)

Pl. 2, Figs. 15, 16
1987 *Kilianella roubaudiana* (d'Orbigny); Company, p. 121, pl. 8, figs. 3–8, pl. 18, figs. 11, 12 (cum syn.)
Material. Fifteen specimens preserved in the form of almost complete to incomplete juvenile pyritized and calcareous moulds (spec. 176, 177, 200, 202, 216–218 a.o.) and especially fragments of pyritized and calcareous juvenile or adult whorls (spec. 214–216, 222, 226, 228 a.o.).
Description. Mostly incomplete juvenile shells and smaller-sized shells, almost evolute, with circular to subrectangular cross sections of rather low whorls, whose widths approximately equal their heights. Umbilicus broad.

Juvenile whorls at shell diameter below 5 mm bearing sparse simple ribs and indistinct constrictions. Thin, occasionally bifur-

cated ribs starting to occur at the diameter of around 5 mm. Constrictions becoming prominent. Ribs between them sometimes bifurcating at upper third of whorl height. A rib running across posterior side of constrictions, sometimes more strongly developed than other ribs on the ventral side. Multiple bifurcation connected with this rib (unlike with ribs between constrictions) at several levels.

Minute lateral tubercles usually developed at sites of bifurcation of the first mentioned category of ribs. All ribs becoming somewhat stronger and sparser starting from shell diameter of ca. 8 mm. Ribs discontinued in ventral area. A narrow and smooth furrow corresponding to discontinuation in siphuncular zone. Five to six constrictions per whorl at shell diameter of ca. 12 mm.

Measurements. The following parameters were measured on the most complete juvenile shell (spec. 216): D = 12.0 mm, H = 4.8 (0.40), B = 4.6 (0.38), U = 3.8 (0.32), H/B = 1.04; Dmax = 12.8 mm. A fragment of an adult whorl of spec. 226 has H = 10.6 mm and B = 11.0 mm (H/B = 0.96).

Remarks. In accordance with the data of Company (1987), based on rich material from Spain, his concept of species is followed here. Hence, *Kilianella roubaudiana* (d'Orbigny, 1850) is a considerably variable species in its morphology, and *K. pexiptycha* (Uhlig, 1882) is its synonym, much like *K. ischnotera* Sayn and *K. bochianensis* Sayn, 1907 listed in the synonymy of Company. *Kilianella lucensis* Sayn, 1907 differs from *K. roubaudiana* in its sparser ribbing and strong tubercles at the sites of bifurcation of ribs. *K. clavicostata* Nikolov, 1960 differs in its stronger tubercles at the sites of bifurcation and especially in marked thickening of ribs in the ventrolateral region.

Distribution. According to Company (1987), this species has been reported from the Early Valanginian of the whole Mediterranean region. In Spain, it occurs in the *Thurmanniceras pertransiens* Zone and at the base of the *Vergoliceras salinarium* Zone. Reboulet (1996) reported this species from the Early Valanginian of France, ammonite *Thurmanniceras pertransiens* Zone and the older part of the *Busnardoites campylotoxus* Zone. In addition, it has been also reported from the Early Valanginian of Western Carpathians (from Outer and Central Carpathians).

Occurrence. Gloriet Limestone in sites Š-11a, Š-11cd, Š-34, Š-53, Š-72; Kopřivnice Limestone: Blücher Quarries, Š-72; Plaňava Formation (pyritized specimen) in sites Š-12, Š-45.

Kilianella cf. *clavicostata* Nikolov, 1960

Pl. 3, Figs. 1–3

1975 *Kilianella clavicostata* Nikolov; Vašíček, p. 88, pl. 3, figs. 2, 3, text-fig. 4 (cum syn.)

Material. Seven strongly corroded fragments not exceeding 1/4 of whorl, of medium to adult stage of growth, preserved in the form of calcareous sculpture moulds, with no remains of suturelines (spec. 201, 203, 209 to 213).

Description. Fragments of evolute shells with subrectangular cross sections of whorls. Whorls bearing relatively sparse sigmoidal ribs. Ribs simple or bifurcated at about mid-height of whorls. Particularly anterior branch markedly increasing in width on circumference of bifurcated ribs. Point of bifurcation accompanied by prominent lateral tubercle. Non-bifurcated ribs generally thinner, with no tubercles and no thickening of ventrolateral segment. All ribs terminated by a minute tubercle in the ventral area, being followed by a narrow, smooth ventral furrow. Constrictions developed.

Measurements. Only the height and width of whorls can be measured due to fragmentary preservation. In all cases the two values are equal or very close to each other, with the H/B ratio roughly equal to 1.

Remarks. The prominent broadening of some ribs in the ventrolateral region is a characteristic feature of *K. clavicostata.* The species of *K. lucensis*, which also bears lateral tubercles of similar strength at the site of bifurcation, lacks the above mentioned thickening of ribs.

Distribution. *K. clavicostata* has been reported from the Early Valanginian of Bulgaria and Outer Western Carpathians (Uhlig, 1902).

Occurrence. Kopřivnice Limestone – Blücher Quarries and a single, very incomplete fragment corresponding to the Gloriet Limestone (spec. 203), exact site unknown.

?Kilianella sp. ind.

Pl. 3, Figs. 4, 5

Material. Two corroded and very incomplete fragments of adult whorls preserved in the form of calcareous sculpture moulds (spec. 225, 227).

Description. Fragments of evolute shells with rounded whorls (H = 11.6, B = 11.8, H/B = 0.98 in spec. 225). Ornamentation formed by proverse, relatively sparse, branched or simple ribs. Branching ribs, starting as simple ribs near umbilicus, with weak (?corroded) tubercles. Ribs bifurcating or trifurcating at prominent lateral tubercles above mid-height of whorl. Simple ribs thinner, with no umbilical or lateral tubercles. All ribs terminated by minute ventrolateral tubercles near ventral area. A thin, smooth furrow running along siphuncular zone. A better preserved fragment (225) with no constrictions, more poorly preserved fragment bearing a distinct constriction.

Remarks. Attribution to a genus is unsafe due to the incompleteness of the fragments. Evolute coiling, the character of ribs and the circular cross sections of whorls suggest most probably the genus *Kilianella*, which is, however, not characterized by trifurcating ribs. Genus *Stoicoceras* Whitehouse, 1927 with trifurcating ribs typically shows different cross sections of whorls and particularly by higher heights of whorls. The unequivocally conceived genus *Sarasinella* Uhlig, 1905 is dominated by bifurcation of ribs at umbilical tubercles (not developed in the material described). It cannot be excluded that the described fragments belong to a new Valanginian species and maybe even a new genus.

Occurrence. Kopřivnice Limestone – Blücher Quarry.

Genus *Sarasinella* Uhlig, 1905

Type species: *Hoplites ambiguus* Uhlig, 1902.

Description of the genus is adopted from Company (1987, p. 140), with the species composition and stratigraphic range being extended by the data from Thieuloy and Bulot (1992, p. 88).

Sarasinella sp. ind.

Pl. 3, Figs. 8, 9, Text-fig. 11

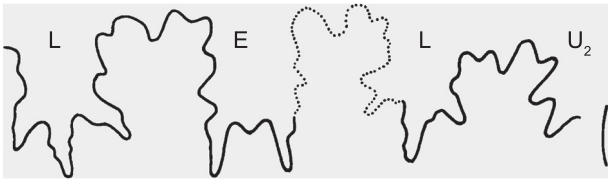
Material. A single small pyritized internal mould with partly preserved suture-lines (spec. 416). The terminal half-whorl represents the body chamber.

Description. Semi-involute juvenile shell, whorl width about equal to whorl height. Flanks of whorls strongly arched, gradually passing into undifferentiated umbilical wall and in the ventral side. Limitation of ventral side accentuated by ventrolateral tubercles. Ventral side characterized by a smooth, rather narrow concave zone.

Ornamentation consisting of two different parts. Juvenile whorls (max. ca. 10 mm at the observed shell diameter of ca. 5 mm) densely ribbed, with thin, sigmoidal ribs. Ribs simple, starting with no tubercles near umbilicus, some of them bifurcating from periodically developed lateral tubercles in upper third of whorl height. Whole segment accompanied by weak constrictions. Terminal half-whorl (body chamber) ribbed, with sparse and sharp, weakly sigmoidal, retroverse ribs. Some ribs bifurcating at a prominent lateral tubercle in upper third of flanks, or, especially at shell end, bifurcating in lower fourth of whorl height, however, with no tubercles present here. Nevertheless, indications of lateral tubercles present at the level of lateral tubercles on these ribs. The last bifurcated rib (near mouth) bearing a prominent lateral tubercle and a weakly developed umbilical tubercle. All ribs terminated by minute ventrolateral tubercles on ventral side. Terminal segments of ribs directed perpendicular to course of siphuncle with the exception of ribs accompanying constrictions, near which terminal segments run obliquely towards mouth. Ribs discontinued in ventral area, with a smooth concave zone running between them.

Measurements. The following parameters were measured on a rather incomplete specimen whose maximum diameter slightly exceeds 13 mm (estimation) at D = 10.7 mm: H = 4.8 (0.45), B = 5.4 (0.50) and U = 3.4 (0.32).

Suture-line. With respect to the juvenile character of the shell, differentiation of the suture-line is relatively complex. The suture-line is characterized by a narrow lobe E with a simple median saddle, and a somewhat less deep, trifid, weakly asymmetrical lobe L. The two preserved lateral saddles are bipartite.



■ **Text-fig. 11.** *Sarasinella* sp. ind. Outer suture-line at H = 2,8 mm. Spec. 416, site Š-55 (Plaňava Formation).

Remarks. Essential features of the described juvenile specimen include simple ribs, not bifurcated on the line of coiling. These ribs partly branch at prominent lateral tubercles. The ribs are terminated by minute ventrolateral tubercles, and most of their terminal segments are directed roughly perpendicular to the course of the siphuncle. A relatively broad, smooth zone stretches across the ventral area.

All the above stated features of the described juvenile specimen fit best with the diagnosis of the genus *Sarasinella* and the group of the species *S. eucyrta* (Sayn), in which juvenile suture-line has not been probably reported yet. Most of the representatives of the genus *Sarasinella* are characterized, unlike the material from Štramberk, by clearly visible umbilical tubercles.

Genus *Neohoploceras* Spath, whose juvenile shells are also close to the material from Štramberk, bears only a narrow, smooth furrow in the ventral area. Its juvenile suture-line is not only less complex, but also shows a different arrangement of lobe L. Genus *Karakaschiceras* Thieuloy is dominated by ribs bearing umbilical tubercles, at which the ribs often bifurcate or branch into three or even more branches. According to Kutek et al. (1989), lobe L of the suture-line is generally deeper than other lobes.

A corroded calcareous mould (spec. 417), ca. 25 mm in diameter, probably also belongs to the group of the above described specimen. This mould, however, lacks any visible juvenile whorls or a suture-line.

Distribution. According to Reboulet (1996), the genus *Sarasinella* is distributed throughout the Valanginian (*Thurmanniceras petransiens* Zone to *Teschenites callidiscus* Subzone).

Occurrence. Plaňava Formation, site Š-55. The calcareous mould (formed by grey limestone – spec. 417) of imperfectly known affiliation (?*Sarasinella* sp. ind.) comes from site Š-72.

?*Sarasinella* sp. juv.

Pl. 3, Figs. 10, 11, Text-fig. 12

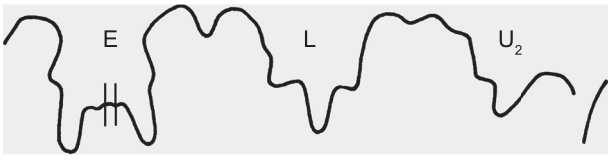
Material. A single miniature pyritized internal mould with suture-lines (spec. 233).

Description. Subevolute shell with strongly arched, low whorls. Ventral side flat. Last whorl width slightly exceeding its height.

Last whorl with numerous prominent ribs, starting one at a time near the line of coiling. Lateral tubercles, at which the ribs bifurcate, appear on all ribs at whorl mid-height, where maximum arching is achieved. All ribs terminated with minute ventrolateral tubercles on the circumference. Ventral area transected by a broad, smooth zone. Ornamentation waning towards embryonal end.

Measurements. The shell reaches maximum diameter of ca. 7.5 mm. At D = 7.2 mm, H = 3.5 (0.49), U = 2.1 (0.28), U = 4.0 (0.55).

Suture-line. With respect to the juvenile stage of growth, the outer suture-line shows rather simple incision. Lobe L is symmetrical, simply tripartite, lobe U_2 is asymmetrical.



■ **Text-fig. 12.** *?Sarasinella* sp. juv. Early outer suture-line at H = 2 mm. Spec. 233, site Š-12 (Plaňava Formation).

Remarks. Essential features including the suture-line resemble the above described pyritized internal mould designated as *Sara-*

sinella sp. ind., but clear distinctions can be seen in detail: ribbing is sparser than in the corresponding stage of the above specimen, lateral tubercles are present on all ribs while constrictions are absent. Therefore, the present specimen does not represent a more juvenile stage of the same species; it is to be solved whether the differences in ornamentation and in the early shell whorls lie at the species level or even the genus level. Our reservations are expressed by the question mark in front of the generic name.

A certain morphological similarity (ventral side morphology with a broad, smooth furrow and numerous lateral tubercles) is displayed by the smaller of the two specimens figured by Witkowski (1969) in pl. 20, figs. 3, 4, designated as *Leopoldia provincialis* Sayn [now attributed to *Neohoploceras provinciale* by Kutek et al. (1989, p. 722), a species considered a ?synonym of the species *N. arnoldi* Pictet & Campiche by Company (1987)]. The figure, however, shows that some ribs extend from the proximity of the line of coiling in bundles; thus, a definite identification with the find from Štramberk is impossible.

Occurrence. The only specimen comes from the Plaňava Formation, site Š-12.

Genus *Criosarasinella* Thieuloy, 1977

Type species: *Criosarasinella furcillata* Thieuloy, 1977.

Criosarasinella cf. *furcillata* Thieuloy, 1977

Pl. 5, Fig. 1

1994 *Criosarasinella furcillata* Thieuloy; Vašíček et al., p. 59, pl. 18, fig. 2

1996 *Criosarasinella furcillata* Thieuloy; Reboulet, p. 75, pl. 17, fig. 5, pl. 18, figs. 1–8, pl. 19, figs. 1–6, pl. 20, figs. 2–6 (cum syn.)

Material. A single sculpture mould, crushed into a bedding plane, with unfavourably preserved internal whorls and with ventral side covered with sediment (spec. 417).

Description. Evolute (to maybe slightly uncoiled) shell with flat, rather low whorls. Ornamentation of inner whorls indistinct, formed by dense, thin ribs. Former presence of lateral tubercles on some inner ribs cannot be excluded. Only terminal half of last whorl (probably corresponding to body chamber) with well preserved ornamentation. Ribs differentiated into main ribs and intercalatory ribs, slightly sigmoidally curved. Main ribs in the region of umbilical wall first convexly bent towards the mouth and then straightened, bearing weak bullate umbilical tubercles at transitions to whorl flank. Ribs sometimes bifurcating at these tubercles. Simple ribs, one at a time, inserted between main ribs at different levels. Shell reaching maximum diameter of over 60 mm.

Remarks. According to Thieuloy (1977 b, p. 109) the juvenile whorls of *Criosarasinella* are not in contact. The juvenile main ribs are trituberculated. These features are atypical of the true neocomitids. The taxonomic position of the genus *Criosarasinella* in the subfamily Neocomitinae is doubtful.

Distribution. According to Reboulet (1996), this species occurs in the Late Valanginian *Criosarasinella furcillata* Zone. A similar specimen has been also recorded in the Manín Unit in the Central Carpathians (Vašíček et al., 1994).

Occurrence. The single incomplete shell comes from the Plaňava Formation (site Š-64).

Genus *Neocomites* Uhlig, 1905

Type species: *Ammonites neocomiensis* d'Orbigny, 1841.

Genus *Neocomites* in this paper follows the concept of Company (1987), i.e., it is not subdivided into subgenera.

Neocomites neocomiensis (d'Orbigny, 1841)

Pl. 3, Figs. 6, 7, Text-fig. 10

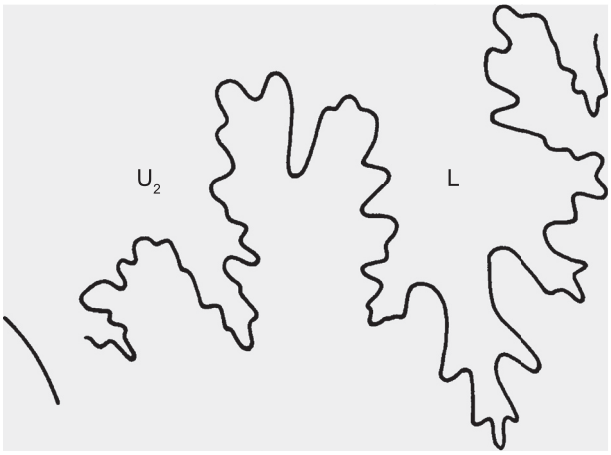
1987 *Neocomites neocomiensis* (d'Orbigny); Company, p. 129, pl. 9, figs. 5–11, pl. 10, figs. 1–5, pl. 19, figs. 2–4 (cum syn.)

1996 *Neocomites neocomiensis* (d'Orbigny); Reboulet, p. 86, pl. 4, figs. 1–12, pl. 5, figs. 4–12, pl. 6, figs. 7, 8, pl. 7, figs. 7, 8 (cum syn.)

Material. A single almost complete pyritized internal mould of a juvenile specimen (spec. 170) and corroded calcareous mould of similar size, with partly preserved suture-line (spec. 171).

Description. Semi-involute shells with high and narrow whorls. Lateral wall separated from narrow and steep umbilical wall by an edge. Flanks weakly arched, rather markedly tapering towards ventral side. Ventral side narrow and flat, separated from flanks by an indicated edge. Ornamentation formed by thin, acute ribs, starting at minute periumbilical tubercles located on edge between umbilicus and flanks. Ribs extending two to three at a time from umbilical tubercles; some simple ribs on terminal part of the last whorl extending one at a time. Inserted ribs, attaining to variable height of basal half of whorl height, sometimes present on terminal part of the last whorl. Ribs sigmoidally curved, prorsiradiate. All ribs bearing minute ventrolateral tubercles on the edge between flanks and ventral wall, and terminating shortly beyond these tubercles. Siphuncular zone narrow, smooth.

Measurements. Pyritized juvenile specimen (170), reaching max. diameter of 18.5 mm, shows the following parameters at D = 15 mm: H = 7.0 (0.47), U = 4.0 (0.27), B = 5.25 (0.35), B/H = 0.75. The calcareous specimen (171), reaching max. diameter of 26 mm,



■ **Text-fig. 10.** *Neocomites neocomiensis* (d'Orbigny). A part of outer suture-line at H = 8.3 mm. Spec. 171, (Col. Remeš, Kopřivnice Formation).

shows similar values of H/D a U/D ratios. Whorl width cannot be measured in the latter specimen.
Suture-line. An incomplete suture-line has been preserved in spec. 171. Lobe L is deep and trifid, lobe U_2 is strongly asymmetrical.
Remarks. Juvenile shells, showing no visible constrictions, with ribs branching at umbilical tubercles or in lower halves of the whorls, correspond to the species *N. neocomiensis* in all their attributes. The suture-line is identical with that figured by Company (1987, text-fig. 32 a).
Distribution. Reboulet (1996) reported *N. neocomiensis* from the Early/Late Valanginian boundary (latest part of the *Busnarodoides campylotoxus* Zone to the top of the *Neocomites peregrinus* Zone) of the whole Mediterranean region.
Occurrence. Plaňava Formation, sites Š-24b, Š-55 (cf.); Kopřivnice Limestone (spec. 171), lower Blücher Quarry.

Neocomites teschenensis (Uhlig, 1902)

Pl. 3, Fig. 14
1996 *Neocomites teschenensis* (Uhlig); Reboulet, p. 91, pl. 6, fig. 3 (cum syn.)
Material. A single incomplete sculpture mould crushed to a bedding plane (spec. 415).
Description. A fragment of the last whorl of a shell of medium size. Whorl flank high, probably flat, ventral side narrow. Ornamentation formed by numerous, relatively broad, sigmoidally curved ribs, starting at weak umbilical tubercles, extending from these tubercles one or two at a time, and increasing in width towards ventral side. One branched rib or inserted rib sometimes present at around whorl mid-height. A rib broader than other ribs occasionally present. All ribs terminated by weak ventrolateral tubercles on ventral side. Ventral side smooth. Maximum diameter of incomplete shell can be estimated at 50 mm.
Remarks. The concept of the species, with the exception of the systematic position of some specimens presented by Company (1987, pl. 10, figs. 10–14) is implied from the synonymy of the species.
Distribution. According to Reboulet (1996), *N. teschenensis* is distributed in the Mediterranean region around the Early/Late Valanginian boundary (topmost part of the *Busnardoites campylotoxus* Zone to the top of the *Neocomites peregrinus* Zone).
Occurrence. The only safe find comes from the Plaňava Formation, site Š-55; other unsafe find comes from site Š-12 (spec. 182, pyritized internal mould).

Subfamily Endemoceratinae Schindewolf, 1966
Genus *Karakaschiceras* Thieuloy, 1971
Type species: *Hoplites biassalensis* Karakasch, 1889.

Karakaschiceras ex gr. *quadristrangulatum* (Sayn, 1907)

Pl. 4, Figs. 1–4
1989 *Karakaschiceras quadristrangulatum* (Sayn); Kutek et al., p. 727, pl. 1, figs. 2, 4, 5, text-fig. 4A, 5B (cum syn.)
Material. A single fragment of about one-eighth of a weakly deformed whorl, somewhat corroded on the base and on one side, preserved in the form of a calcareous sculpture mould. It probably belongs to a body chamber (spec. 172).
Description. Shell semi-involute with a whorl having the shape of an isosceles triangle with cut-off apex in cross section. Flanks weakly arched, markedly tapering towards ventral side. Ventral side relatively narrow and flat. Umbilical wall obliquely inclined towards umbilicus. Maximum whorl width reached approximately at level of umbilical tubercles. Ribs sigmoidal. Some ribs starting in pairs from markedly elevated conical umbilical tubercles, other ribs starting near line of coiling and with no tubercles. Prominent depressions with ribs free of tubercles on their bottoms present between ribs with umbilical tubercles. Most ribs branching in lower half of whorl height, however, at different levels. Simple ribs present exceptionally. All ribs on shell circumference of equal thickness. Bluntly pointed, minute, partly alternating tubercles developed on the edge separating flanks and ventral side of whorl. Ribs beyond these tubercles shortly overlapping to ventral side, directed perpendicular to siphuncle. Ventral area smooth in a narrow zone.
Measurements. At H = 18.6 mm, B = 15.6 mm (measured in a depression between tubercles), B/H = 0.84.
Remarks. Characteristic features of the Štramberk specimen include primarily the triangular cross section of the whorl, prominent umbilical tubercles, branching of sigmoidal ribs and the termination of ribs on the ventral side, where they run perpendicular to the course of the siphuncle. The above features correspond to the genus *Karakaschiceras*. Cross section of the whorl, much like the B/H value fit best the parameters of the species *K. quadristrangulatum*. A cross section of the whorl similar to that of *K. quadristrangulatum* is also possessed by *K. pronecostatum* (Felix), but its somewhat more strongly arched whorls are higher at the same diameter, and its ribbing is of a somewhat different type. The incompleteness of the shell, however, does not allow an equivocal determination.
Distribution. According to the data of Kutek et al. (1989), typical representatives of *K. quadristrangulatum* have been particularly reported from the *Saynoceras verrucosum* Zone (around the Late Valanginian base); the Early Valanginian *Thurmanniceras pertransiens* Zone cannot be excluded either. The species was reported to be of subzone significance in the basal part of the *Busnardoites campylotoxus* Zone (Early Valanginian) in the Vocontian Trough (Reboulet, 1996).
Occurrence. Kopřivnice Limestone – marly site in the lower Blücher Quarry.

Genus *Neohoploceras* Spath, 1939
Type species: *Ammonites submartini* Mallada, 1887.

Neohoploceras sp. juv.

Pl. 3, Figs. 12, 13, Text-fig. 13
Material. Three juvenile specimens, of which two are pyritized, deformed and corroded moulds (spec. 320, 420) and a single relatively favourably preserved pyritized internal mould with a suture-line (spec. 421).
Description. Semi-evolute shells with relatively broad umbilicus and strongly arched whorls. Maximum arching of whorls in lower third of whorl height (at level of lateral tubercles). Flanks

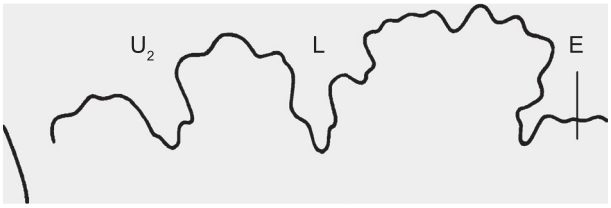
passing continuously as far as to line of coiling across a rounded zone, with umbilical wall thus being not clearly limited. Flanks on ventral side tapering into a narrow ventral side, indistinctly separated from flanks.

Ornamentation perfectly visible only on terminal half of the last whorl, composed of weakly proverse ribs, starting as simple ribs near umbilicus. Umbilical tubercles on these ribs not visible. Prominent lateral tubercles developed on lower third of whorl height. Ribs bifurcating at or around these tubercles, with occasional presence of a trifurcating rib. Simple ribs (with lateral tubercles) rare, simple inserted ribs sometimes starting at about level of these tubercles. All ribs, after reaching ventral side, directed perpendicular to siphuncle. All ribs bearing minute ventrolateral tubercles in a zone separating ventral side from whorl flank, being terminated shortly beyond these tubercles. Siphuncular zone represented by a narrow and smooth furrow.

Three constrictions developed on the last half-whorl, best developed on ventral side. Ribs on ventral side of unequal thickness: ribs lining the constrictions show a higher relief and those on posterior sides of the constrictions bear more marked ventrolateral tubercles.

Measurements. The following parameters were obtained for spec. 421 at D = 15.6 mm: H = 6.9 (0.44), U = 5.1 (0.33) and B (measured across the tubercles) = 8.5 (0.54).

Suture-line. The suture-line generally shows a weaker incision, which is also considerably accounted for by the juvenile stages of growth of the studied specimens. Lobe E is broad at the base, complicated by a very low and flat secondary saddle. First lateral saddle is large, divided only by a very shallow secondary lobe into two branches. Lobe L is weakly trifid and markedly asymmetrical. Umbilical lobe (U_2) is similar but much less articulated. The adjacent saddles are equally weakly incised.



■ **Text-fig. 13.** *Neohoploceras* sp. juv. Outer suture-line at H = 6.5 mm. Spec. 421, site Š-12 (Plaňava Formation).

Remarks. Specimens considered to be representatives of the genus *Neohoploceras*, figured in the literature, belong – with a single exception – to shells of considerably higher diameters. Such shells are mostly characterized by rib bundles consisting of high numbers of ribs. The only mentioned exception is the juvenile specimen figured by Wiedmann (1966, pl. 2, fig. 4 a–c), selected as a neotype of the species *Neohoploceras submartini* (Mallada). Its pertinence to *N. submartini*, hence also its suitability for the erection of a neotype, was disputed by Kemper (1976 – in caption to the figure in pl. 29, fig. 3 a, b). The ornamentation of the Wiedmann's neotype is very close to that of the Štramberk specimen which, however, lacks visible umbilical tubercles. In their size parameters, the two mentioned specimens somewhat differ in their whorl widths (B/D = 0.49 in the neotype). In contrast, their suture-lines can be considered identical; similar is also the juvenile suture-line of *N. submartini*, figured by Company (1987, text-fig. 34 b). Adult shells of *N. submartini* are different, of course, especially in their complex rib pattern, as also follows from recent literature data (e.g., Company, 1987, p. 155, Baraboshkin and Michailova, 1994, p. 44, a.o.), the authors of which, however, raised no objections against the neotype of Wiedmann.

Essential morphology of the Štramberk material, including the branched tuberculate ribs, constrictions, the narrow ventral furrow, etc., corresponds to the genus *Neohoploceras*. Nevertheless, with respect to the facts given in the Remarks, we leave our material in open nomenclature.

Distribution. Only the distribution of the genus can be referred to due to the open nomenclature: *Neohoploceras* was reported from the Late Valanginian by Wright et al. (1996). Reboulet assigned his material to the *Busnarodoides campylotoxus* Zone (Early Valanginian) to the older part of the *Neocomites peregrinus* Zone (Late Valanginian).

Occurrence. The rare finds come from the Plaňava Formation (sites Š-12, Š-46, Š-54).

Genus *Stoicoceras* Whitehouse, 1927

Type species: *Ammonites (Hoplites) teutoburgensis* Weerth, 1884.

Stoicoceras sp.

Pl. 4, Figs. 5, 6, Text-fig. 14

Material. A fragment of weakly weathered one-eighth of a whorl, with strongly corroded hence incomplete basal part. It is preserved as a mould, corresponding to a phragmocone (spec. 231).

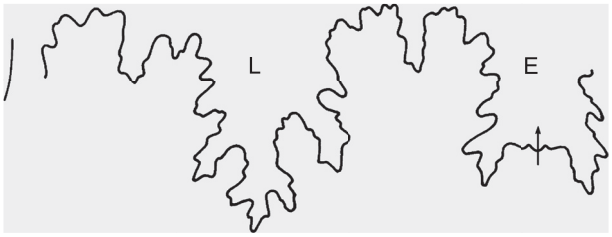
Description. Whorl triangular in cross section, its width about equal to, or slightly less, than its height. Its maximum width reached on incompletely preserved whorl base. Lateral walls flat, markedly tapering towards ventral side. Ventral side flat, relatively narrow.

Ribs on shell fairly thick, distinct, sigmoidally curved, generally prorsiradiate. Most ribs starting at bullate umbilical tubercles (the presence of which is, however, only indicated). Two ribs extending from these tubercles, with the posterior one further bifurcating. A tubercle indicated at site of lateral bifurcation. Other ribs simple, inserted, starting at about line of coiling. All ribs of approximately equal thickness. All ribs (inclined towards mouth) on an indicated edge separating whorl flank from ventral side bearing weak ventrolateral tubercles. Continuation of ribs beyond these tubercles on ventral side poorly visible, arched, running obliquely towards mouth. Ribs disappearing in centre of ventral area.

Measurements. Precise measurements are hindered by the incompleteness of the whorl. Whorl height H exceeds 13 mm, whorl width B is equal to, or slightly exceeds, 14 mm.

Suture-line. Lobes and saddles are neither deep nor high, with saddles being somewhat broader. Lobe E bears a low secondary saddle, lobe L is trifid, weakly asymmetrical. Both preserved saddles are bipartite, branched by a narrow and shallow secondary lobe. Inner branch is somewhat bigger than the outer branch.

Remarks. Even the attribution to a genus is confounded by the incompleteness of the whorl of the shell, which was semi-involute or semi-evolute. Among related species, the ends of ribs in *Neoho-*



■ **Text-fig. 14.** *Stoicoceras* sp. Outer suture-line at H = 12.8 mm. Spec. 231, Lower Blücher Quarry (Kopřivnice Formation).

ploceras and *Karakaschiceras* are directed perpendicular to the siphuncle; moreover, the ornamentation of the former is markedly tuberculate, even in the lateral region. Pertinence to these genera can be therefore excluded. The most closely related genus is *Stoicoceras*, whose ribs continue on the ventral side (beyond the ventrolateral tubercles), obliquely inclined towards the mouth, with a tendency to form an arch-like flexus. Nonetheless, ribs of the representatives of the genus are differentiated into stronger main ribs (often trituberculate) and weaker intercalatory ribs. Heterogeneity in the rib thickness should be best seen on the ventral side, much like that in the different thickness of ventrolateral tubercles. An exception is usually posed by fragments of the whorl of the medium growth stage in *S. germanicum* (Kemper, Rawson and Thieuloy, 1981, pl. 47, figs. 2, 3), which show an ornamentation close to that of our specimen. It, however, differs from our specimen in the detailed character of the rib pattern, and especially in the cross section of the whorl.

The figured suture-line of our specimen (as a possible diagnostic feature) differs markedly from that of the species *S. pitrei*, as figured by Busnardo et al. (1966, text-fig. 3), the type species of genus *Dicostella* Busnardo, 1966 which is a younger synonym for *Stoicoceras*. This suture-line, belonging to a considerably larger specimen (and probably posing the only suture-line of the genus *Stoicoceras* yet figured), moulds doubt on the pertinence of our fragment to this group.

It should be further noted that the fragment from Štramberk strongly resembles *"Hoplites" zitteli* Uhlig (1902, pl. 7, fig. 5 a), which also possesses a preserved lobe L of the suture-line (Uhlig, pl. 7, fig. 5 b). Unfortunately, the original specimen of Uhlig most probably does not exist any more, as it could not be found in the Vienna collections. While lobe L of the suture-line is practically identical in the two specimens, the original Uhlig's description of the ornamentation (1902, p. 61) suggests some differences: up to three ribs extend from the umbilical tubercles, of which one is more prominent than the other two; lateral bifurcation of ribs is accompanied by a distinct tubercle. These features are not present in our fragment.

With respect to the above given facts, the specimen from Štramberk could be paralleled with group of the species *S. germanicum* (the suture-line of which is unfortunately unknown) is possible.

Distribution. Genus *Stoicoceras* is distributed in the Late Valanginian of the Boreal realm, where the species, *S. tuberculatum*, is a zone species. In its position, it corresponds to the older part of the *Criosarasinella furcillata* Zone of the Mediterranean bioprovince.

Occurrence. The fragment comes from the eluvium of the lower Blücher Quarry (Kopřivnice Limestone).

Genus *Endemoceras* Thiermann, 1963
Type species: *Hoplites amblygonius* Neumayr & Uhlig, 1881.

?Endemoceras cf. *amblygonium* (Neumayr & Uhlig, 1881)

Pl. 5, Fig. 2
1963 *Endemoceras amblygonium* (Neumayr & Uhlig); Thiermann, p. 372, pl. 20, figs. 1–3, pl. 21, figs. 1–3 (cum syn.)
1967 *Lyticoceras ambligonium* (Neumayr & Uhlig); Dimitrova, p. 115, pl. 54, fig. 2 (cum syn.)

Material. Two fragments of about one quarter of a whorl, strongly compressed to the bedding plane, lacking whorl base (spec. 418, 419) and a single extremely strongly crushed sculpture mould (spec. 441).

Description. Shells semi-evolute, with rather low whorls. Flanks of weakly arched whorls separated from weakly arched ventral side. Simple ribs visible on whorl flank, weakly concave towards mouth on outer half of whorl. Ribs extending from indistinct umbilical tubercles near umbilicus, usually two at a time. All ribs bearing minute but distinct ventrolateral tubercles at transition to ventral side. Tubercles, or at least some of them, orientated not parallel but rather oblique to course of ribs. Ribs beyond ventrolateral tubercles weaker, crossing the ventral side in an arch-like to angular bend.

Remarks. Preservation of the whorl fragments as well as the deformed, incomplete shell is too poor to permit a safe species and generic determination. The absence of a keel, simple ribbing and the equal thickness of the ventrolateral tubercles on all ribs probably place these finds into the group of the species *E. amblygonium*. Wright et al. (1996), most probably erroneously, considered the genus *Endemoceras* a synonym of the genus *Lyticoceras* Hyatt, 1900, which gained a fully cumulative character in their concept.

Distribution. *E. amblygonium* is a zone species of an ammonite zone of the same name in the basal Hauterivian of the European Subboreal realm. This zone corresponds to the older part of the *Acanthodiscus radiatus* Zone in the Mediterranean (Rawson, 1995). Besides Germany, this species occurs also in Bulgaria and on Crimea (Dimitrova, 1967).

Occurrence. All specimens come from solid grey pelites, which form blocks in the slump bodies of the Plaňava Formation, site Š-55.

Genus *Breistrofferella* Thieuloy, 1971
Type species: *Ammonites castellanensis* d'Orbigny, 1840.

Breistrofferella sp.

Pl. 5, Fig. 3

Material. The last whorl of a single strongly deformed sculpture mould with incompletely preserved umbilical and ventral areas (spec. 422).

Description. Shell rather small, semi-involute, with whorls of medium height. Early half of preserved whorl with thin and

dense ribs of neocomitid type, sigmoidally curved. Indicated main ribs, extending from thin umbilical tubercles. Two to three inserted ribs lying between them, unequal in length, only slightly thinner than main ribs, some reaching as far as to umbilicus; additional ribs branching off in lower half of whorl. This ornament type abruptly replaced by strong sigmoidal ribs on edge of terminal half of whorl, extending from umbilical tubercles, usually two at a time. One of paired ribs (anterior one or posterior one) bifurcating in upper third of whorl height. Size parameters cannot be measured due to strong deformation and incompleteness of shell. Shell diameter around 38 mm in axis of elongation, with the ornamentation changing at the diameter of ca. 30 mm (also in axis of elongation).

Remarks. The visible morphological features, including particularly the sigmoidally curved adult ribs extending from the umbilicus in pairs, one of them bifurcating on the circumference, and the absence of inserted ribs are indicative of the genus *Breistrofferella*. The above features, on the other hand, prevent the correlation of the Štramberk specimen with the hitherto erected and described species of the genus, as listed by Thieuloy (1977 a) and Reboulet (1996). Relatively closest to that from Štramberk (especially in the strength of adult ribs) appears to be the specimen of *Breistrofferella varapensis* (Baumberger) figured by Thieuloy (1977 a, pl. 6, fig. 8).

Distribution. *Breistrofferella* is a genus of the basal Hauterivian. Its representatives have been reported especially from France and Switzerland. A single juvenile shell from the Central Carpathians of Slovakia was also figured by Eristavi (1961, pl. 4, fig. 2) under the name *Leopoldia* cf. *castellanensis* d'Orb. The regularly bifurcated ribs of the Slovak specimen do not, however, correspond either to any of the described species of the genus *Breistrofferella*, or to the Štramberk specimen. Unfortunately, neither the above mentioned specimen nor any other similar one could be found in the material to the cited paper of Eristavi, kept in Bratislava.

Occurrence. The only find comes from solid grey pelites, which form a block in the slump body of the Plaňava Formation, site Š-55.

Genus *Acanthodiscus* Uhlig, 1905
Type species: *Ammonites radiatus* Bruguière, 1789.

?Acanthodiscus sp.

Pl. 5, Fig. 4

Material. Two very imperfectly preserved, strongly deformed sculpture moulds: the smaller one partly as an imprint of the whole shell with a fragment of a compressed whorl (spec. 423), the larger one as a fragment of a whorl of the medium stage of growth (spec. 424).

Description. Semi-involute shells with high whorls. Smaller specimen, almost 30 mm in its deformed diameter, with main ribs bearing distinct umbilical and lateral tubercles. One or two shorter simple ribs inserted between main ribs. Ventral side not preserved.

Larger specimen (deformed whorl height of ca. 30 mm) with main ribs and intercalatory ribs developed across the whole whorl height. Main ribs and some intercalatory ribs with indistinct umbilical tubercles. Weak lateral tubercles can be neither excluded, nor unequivocally confirmed. Ventrolateral tubercles present on ribs on ventral side. These tubercles more prominent on main ribs than on inserted ribs. A broad, smooth siphuncular zone stretching between ventrolateral tubercles, with several indicated arched lines but otherwise smooth.

Remarks. The genus *Acanthodiscus* was given particular attention by Thieuloy (1977 a) in the last two decades. A number of shells were recently figured by Kemper (1992). The imperfectly preserved material from Štramberk indicates affinity with the species *A. radiatus* (smaller shell), while the other specimen is close – in its indistinct lateral tubercles – to *A. ottmeri* (Neumayr & Uhlig).

Distribution. Genus *Acanthodiscus* is generally considered Early Hauterivian in age, with its first appearance marking the base of the Hauterivian. Representatives of the genus *Acathodiscus* have been reported from the Mediterranean as well as from the Subboreal realm.

Occurrence. Both the unfavourably preserved finds come from solid grey pelites, which form blocks in the slump bodies of the Plaňava Formation, site Š-55.

Family Olcostephanidae Haug, 1910
Subfamily Olcostephaninae Haug, 1910
Genus *Olcostephanus* Neumayr, 1875
Subgenus *Olcostephanus* Neumayr, 1875
Type species: *Ammonites astierianus* d'Orbigny, 1840.

Olcostephanus (O.) ex gr. *stephanophorus* (Matheron, 1878)

Pl. 4, Figs. 10, 11

1989 *Olcostephanus stephanophorus* (Matheron); Bulot and Autran, p. 15, pl. 1, figs. 1–5, non 6, 7 (cum syn.)

Material. A single favourably preserved pyritized internal mould, the whole of which belongs to a phragmocone (spec. 158).

Description. Spherical convolute shell, whorl width exceeding whorl height. Whorl flanks continuously passing into a broad, flatly rounded ventral side. Umbilical wall obliquely inclined towards an umbilicus of medium width, being separated from flanks by a periumbilical edge.

Specimen with numerous dense ribs. Simple straight ribs starting on umbilical wall. Ribs indistinct near the line of coiling, but rapidly increasing in thickness towards umbilical edge, with conical umbilical tubercles on umbilical edge. Three to four thin ribs of equal thickness extending in bundles from these tubercles. A single inserted ribs sometimes present between bundles, disappearing at about level of the tubercles. Ribs proverse, arched, straight on ventral side. A single constriction visible, relatively wide and deep.

Measurements. At D = 26.6 mm, H = 10.5 (0.39), U = 7.4 (0.28), B = 18.8 (0.71), B/H = 1.80. Ten umbilical tubercles and ca. 40 peripheral ribs per half whorl.

Remarks. Judged by the measured parameters, the number of tubercles and ribs and the overall morphology, the Štramberk specimen is closest to *O. stephanophorus*. It somewhat differs from the French material in the smaller width of whorls. It is also similar to *Olcostephanus atherstoni* (Sharpe) which, howev-

er, lacks constrictions and has narrower whorls according to Autran (1993), and perhaps also to *A. perinflatus* (Matheron), which was lately revised by Bulot (1990). The latter author considers the last mentioned species a *nomen dubium*, the stratigraphic position of the type material of which is not clear enough. A certain similarity is also displayed by the specimen figured by Kemper et al. (1981, pl. 35, figs. 1, 2) under the name *Olcostephanus (O.)* sp. (*Proastieria* Stolley) from Germany.

Distribution. According to Bulot and Autran (1989), O. *stephanophorus* occurs especially in the Early Valanginian (topmost part of the *Thurmanniceras pertransiens* Zone and the *Busnardoites campylotoxus* Zone). Bulot and Thieuloy (1995) give the typical representatives of this species a zone-status, having the same extent as the *Busnardoites campylotoxus* Zone. Besides the Mediterranean region, the related types (see Kemper et al., 1981) also occur in the Subboreal realm in Germany.

Occurrence. The only found specimen comes from the Plaňava Formation, site Š-12.

Olcostephanus (Olcostephanus) sp. juv.

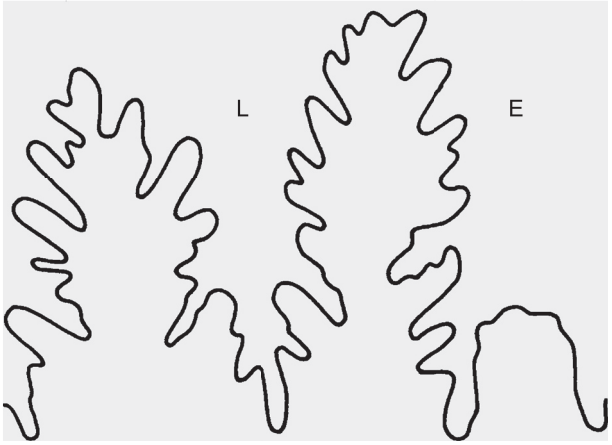
Pl. 4, Figs. 7 – 9. Text-fig. 15

Material. Juvenile incomplete (one-third missing) pyritized internal mould with partly preserved suture-line (borrowed from Geršl Š-12), the whole of which belongs to a phragmocone.

Description. Shell minute, spherical, involute, with a deep funnel-shaped umbilicus. Whorl flanks practically immediately passing into a very broad, rounded ventral side.

First two-thirds of last whorl almost smooth. Minute but distinct umbilical tubercles visible only on edge between umbilical wall and flanks. Poorly visible, dense and fine lines extending from these tubercles. An arched constriction developed at whorl diameter of ca. 10 mm, accompanied by a rib of similar course on anterior side. Yet another constriction developed on terminal third of shell, with lines around it (extending from periumbilical tubercles) increasing in thickness towards mouth thus having a character of thin ribs.

Measurements. Preserved Dmax reaches ca. 11 mm. At D = 10.5 mm, H = 4.4 (0.42), U = 2.6 (0.245) and B = 8.5 (0.81).



■ **Text-fig. 15.** *Olcostephanus (Olcostephanus)* sp. juv. Outer suture-line at H = 4 mm. Specimen borrowed from Geršl, site Š-12 (Plaňava Formation) .

Suture-line. The preserved outer suture-line is characterized by lobes of approximately equal depth, among which lobe L is almost symmetrically trifid. Saddles are high, slender, not branched.

Remarks. The developed umbilical tubercles and finally the thin ribs extending from them suggest the genus *Olcostephanus*, and not the genus *Valanginites* and its relatives. Our specimen is too young for the species determination. Based on more recent literature data (Bulot et al., 1990), our material may be related to some species of the group of *Olcostephanus drumensis* Kilian, 1910 (considered the oldest species in the evolutionary line leading to the separation of the genus *Valanginites*). This is suggested also by the equally simple-differentiated suture-line (Bulot et al., 1990, text-fig. 3).

Distribution. *O. drumensis* (if a close relation to the Štramberk material is considered) has been reported from the Early Valanginian according to Company (1987).

Occurrence. The find comes from the Plaňava Formation, site Š-12.

Genus *Valanginites* Sayn in Kilian, 1910
Type species: *Ammonites nucleus* Roemer, 1841.

The authorship of the type species and type genus was not conceived quite uniformly in the past. The controversy was solved only by the submission of the proposal to the Commission for Zoological Nomenclature by Rawson and Kemper (1989) and its acceptance. Our descriptions respect the accepted proposal.

Valanginites wilfridi (Karakasch, 1902)

Pl. 6, Fig. 1

1982 *Valanginites wilfridi* (Karakasch); Company, pl. 1, fig. 5
1985 *Valanginites wilfridi* (Karakasch); Company, pl. 1, fig. 12
1985 *Valanginites wilfridi* (Karakasch); Kvantaliani and Sakharov, p. 60, pl. 1, fig. 7 (cum syn.)
1987 *Valanginites wilfridi* (Karakasch); Kemper and Wiedenroth, pl. 6, figs. 8, 9, pl. 8, figs. 7, 8
1992 *Valanginites wilfridi* (Karakasch); Kemper, pl. 30, fig 5 a, b, pl. 31, figs. 3–5

Material. A single strongly crushed adult calcareous shell (spec. 425).

Description. Shell involute, of medium size, originally of more or less spherical shape. Thirteen prominent primary ribs terminated by pointed tubercles present on shell near a minute umbilicus. Four to five ribs extending from these tubercles, occasionally with a single similar inserted rib. Ribs passing onto ventral side with no interruption or thinning. Whole shell, in distorted and incomplete zone around mouth, terminated by a special, strong, cylindrical rib (reaching 3.5 mm in diameter), corresponding to a peristome stretching across the shell from one side of umbilicus as far as to opposite side. Deformed shell almost 40 mm in diameter.

Remarks. The prominent ornamentation in *V. wilfridi* and related types led Nikolov (1962) to the definition of the genus *Dobrogeites* (subsequently changed to *Dobrodgeiceras* Nikolov, 1963 because of homonymy), intended to separate ribbed forms from indistinctly ornamented valanginitids. Later studies (Kemper et al., 1981, Company, 1987 aj.), however, did not acknow-

ledge the independence of the genus of Nikolov due to the presence of continuous transitions between the extreme morphological types.

Distribution. The stratigraphic range reported from Bulgaria and the North Caucasus Mts. (Kvantaliani and Sakharov, 1985) is too generalized and too broad – Late Valanginian to Early Hauterivian. Kemper et al. (1981) and Company (1987) reported the Late Valanginian age, *Saynoceras verrucosum* Zone (i.e. *Prodichotomites hollwedensis* Zone in Germany), though they did not differentiate *V. wilfridi* from *V. nucleus*. Besides the Mediterranean region (Bulgaria and Spain), *V. wilfridi* was described also from transitional to Subboreal regions of the Crimea, North Caucasus Mts. and Germany.

Occurrence. The only find comes from solid grey pelites, which form a block in the slump body of the Plaňava Formation, site Š-55.

Valanginites cf. *bachelardi* (Sayn, 1889)

Pl. 5, Figs. 5, 6, Text-fig. 16

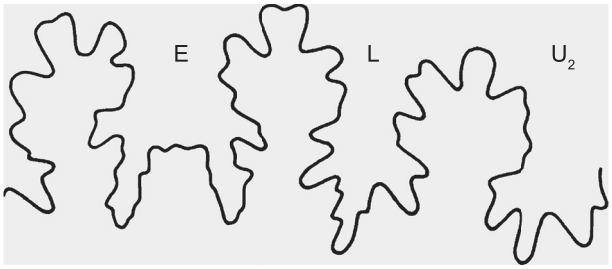
1987 *Valanginites bachelardi* (Sayn); Company, p. 177, pl. 17, figs. 9–11 (cum syn.)

Material. A single, very strongly weathered internal mould of a spherocone shell with partly preserved outer suture-lines (spec. 159). The terminal half-whorl belongs to a body chamber.

Description. Shell involute, originally spherical, whorl widths exceeding whorl heights. Umbilicus narrow, ventral side broad and rounded. Early part of shell smooth, with thin and dense ribbing appearing at a diameter of ca. 7 mm. Ribs visible especially on ventral side of whorl, with umbilical region being largely weathered. Ribs of similar thickness and density also preserved in a relic on ventral side near mouth. No tubercles visible in umbilical region. Imperfectly preserved constriction visible at shell diameter of ca. 18 mm (near mouth).

Measurements. Maximum shell diameter approx. 18.5 mm. At D = 8.8 mm (on the phragmocone), H = 4.0 (0.45), U = 1.3 (0.15), B = 6.1 (0.69), B/H = 1.525.

Suture-line. The incomplete outer suture-line is marked by its narrow and high saddles and by narrow lateral lobes. Contrastingly, lobe E is broader, with a median saddle extending to lower third of its height. All preserved lobes are of approximately the same depth. Lateral lobes are asymmetrically trifid. The phragmocone is terminated at the diameter of 9.5 mm. Suture-lines in the last segment are densely spaced in a manner characterizing the end of growth in adult shells.



■ **Text-fig. 16.** *Valanginites* cf. *bachelardi* (Sayn). Outer suture-line at H = 3.5 mm. Spec. 159, site Š-11b (Plaňava Formation).

Remarks. The absence of the umbilical tubercles is the chief argument for the placement of our specimen within the genus *Valanginites*. The closest species, considering the density of thin ribs, is *V. bachelardi*. Nevertheless, the well preserved material measured by Thieuloy (1977 b), shows somewhat broader and higher whorls compared to the present shell, which may be the result of weathering of the Štramberk specimen. Shells of another related species showing a considerable variability, *V. nucleus* (Roemer), with a possibly lower whorl width bear sparser and stronger ribs. With respect to the imperfect preservation and the problems mentioned above, we did not proceed to a definite determination of our specimen.

The suture-line of the Štramberk specimen is very similar to that of *V. bachelardi*, as figured by Company (1987) in text-fig. 38 (at H = 4.7 mm). It is equally similar to suture-lines figured by Thieuloy (1977 b) in pl. 4, figs. 7 and 9 on specimens designated as *V. psaephoides*, obtained on juvenile shell diameters (H = 4– 4.5 mm). With increasing diameters of the same shells (pl. 4, figs. 8, 10), the lobes remain similar but the saddles are much broader, rounded on the circumference. Company (1987) considered *V. psaephoides* a synonym of *V. bachelardi*.

It should be also noted that a considerably similar suture-line (at H = 4 mm), although with more complex and higher saddles, is also displayed by our juvenile specimen with umbilical tubercles, determined as *Olcostephanus* sp. juv. (suture-line in text-fig. 15). The figured juvenile suture-lines thus indicate a close phyletic relationship between the genera *Olcostephanus* and *Valanginites*.

Distribution. Company (1987) reported *V. bachelardi* from the Late Valanginian *Saynoceras verrucosum* Zone and from the base of the former *Teschenites pachydicranus* Zone (*Neocomites peregrinus* Zone).

Occurrence. The only specimen, composed of light grey-yellow claystone, comes from the Plaňava Formation, site Š-11b, which indicates that the shell has been redeposited.

Valanginites sp. juv.

Pl. 5, Figs. 7, 8, Text-fig. 17

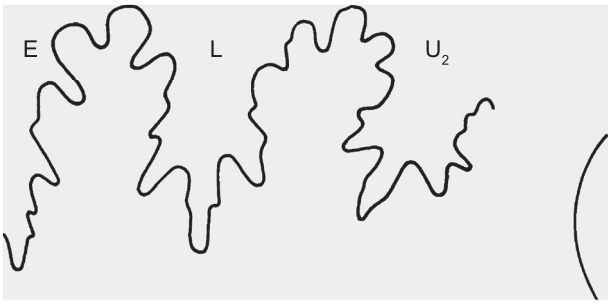
Material. A single fragment of pyritized, weakly deformed phragmocone of a semijuvenile shell (spec. 426) and two early juvenile pyritized internal moulds (spec. 427, 428), whose systematic appurtenance to the former shell is not absolutely sure.

Description. Shell semi-involute, with coronate whorls. Whorl flank low, continuously passing into a very broad, rounded ventral side. Umbilicus deep, with a steep umbilical wall. Shell mostly smooth, with simple, relatively sparse ribs indicated at end of phragmocone only. A weak constriction visible on penultimate whorl corresponding to shell diameter of ca. 3.5 mm.

Measurements. The diameter of the incomplete largest shell (426) can be estimated at slightly over 9 mm. At the end of the phragmocone, at H = 4.4 mm, B = 7.75 (B/H = 1.76).

Suture-line. Lobe E indistinct. Lateral lobes (L, U_2) are weakly asymmetrically trifid.

Remarks. The incompleteness of the shell and the weak deformation of the last whorl do not permit a definite determination. The suture-line undoubtedly belongs to the genus *Valanginites*.



■ **Text-fig. 17.** *Valanginites* sp. juv. Outer suture-line at H = 5 mm. Spec. 426, site Š-56 (Plaňava Formation).

The indication of sparse ribs at the end of the phragmocone suggests pertinence to the group of *V. nucleus*, which is, however, having narrower whorls (B/H = 1.45–1.52) according to Thieuloy (1977b). Both juvenile shells can be considered related to the specimen described exclusively on the basis of the overall shape of otherwise smooth shells.
Occurrence. Plaňava Formation, site Š-56; both juvenile shells come from site Š-55.

Genus *Saynoceras* Munier-Chalmas, 1894
Type species: *Ammonites verrucosus* d'Orbigny, 1841.

Saynoceras verrucosum (d'Orbigny, 1841)

Pl. 5, Figs. 9–11, Text-fig. 18
1987 *Saynoceras verrucosum* (d'Orb.); Kemper and Wiedenroth, pl. 5, fig. 9 a, b, pl. 6, fig. 1
1990 *Saynoceras verrucosum* (d'Orbigny); Bulot et al., p. 401, pl. 2, figs. 1–20 (cum syn.)
1992 *Saynoceras verrucosum* (d'Orbigny); Kemper, pl. 29, fig. 3 a, b, 6 a, b
Material. Six minute pyritized internal moulds, of which one can be designated as almost complete and weakly deformed (spec. 429; others are spec. 430–434). Some of them bear more or less preserved suture-lines.
Description. Shells small, involute, of spherical shape. Umbilicus relatively narrow, funnel-shaped, sharply separated from whorl flank. Flanks divided into two segments, separated by a series of lateral tubercles. Upper segments of flanks inclined towards ventral side. Ventral side relatively broad and weakly arched.

Ornamentation formed especially by two series of prominent tubercles: lateral tubercles and ventrolateral tubercles. Simple weaker ribs extending from lateral tubercles towards umbilicus, waning near umbilical edge. Lateral and ventrolateral tubercles interconnected by similar ribs inclined towards mouth. Ventrolateral tubercles not lying in counterpart positions but shifted against each other. Ribs interconnecting ventrolateral tubercles on ventral sides weak, of zig-zag course.
Measurements. The largest specimen reaches diameter of ca. 12 mm. The best preserved (although weakly deformed) spec. 429 shows the following parameters at D = 8.3 mm (measured across the ventrolateral tubercles): H = 3.9 (0.47), U = 1.5 (0.18), B = 5.8 (0.70), B/H = 1.49. Nine tubercles are developed on half whorl at Dmax ~10 mm.
Suture-line. Suture-line from the central part of the phragmocone shows a relatively weak incision: saddles are not divided into separate branches and lobes are not deep. Lobe E is broad, with a low secondary saddle. Lobe L is asymmetrical, trifid, much like the shallow lobes U. Another suture-line (spec. 429) from the end of the phragmocone is characterized by rather low, broad, indistinct lobes and saddles.

■ **Text-fig. 18.** *Saynoceras verrucosum* (d'Orbigny). High up – outer suture-line at H = 5 mm. Spec. 430, site Š-55 (Plaňava Formation). Down - outer suture-line at H = 3 mm. Spec. 429, same site.

Remarks. Dimorphic pairs can be distinguished in *S. verrucosum* according to Bulot et al. (1990). Based on the above data, our measurable specimen belongs to the category of smaller-sized shells with broader cross sections of whorls (average B/H ~1.4).
Distribution. Late Valanginian, base of the *Saynoceras verrucosum* Zone according to Bulot et al. (1990). It is widely distributed in the Mediterranean region as well as in the Subboreal Realm of Germany, Poland and North Caucasus Mts. *S. verrucosum* has not been found yet in other depositional areas of Western Carpathians, where Valanginian sediments are developed in pelagic facies.
Occurrence. Plaňava Formation, sites Š-55 and Š-56.

Family Polyptychitidae Wedekind, 1918
Subfamily Polyptychitinae Spath, 1924
Genus *Prodichotomites* Kemper, 1971
Type species: *Polyptychites polytomus* Koenen, 1902.

Prodichotomites ex gr. *complanatus* (Koenen, 1902)

Pl. 6, Figs. 2–5, Text-fig. 19
1988 *Prodichotomites complanatus* (Koenen); Jeletzky and Kemper, p. 104, pl. 15, fig. 2, pl. 16, fig. 4, pl. 20, figs. 4, ?3, text-fig. 41 a (cum syn.)
1992 *Prodichotomites complanatus* (Koenen); Kemper, pl. 24, fig. 5
Material. Five juvenile, partly deformed and fragmented pyritized internal moulds, sometimes with partly preserved suture-lines (spec. 323–325, 354, 355), a single reworked pyritized fragment of a whorl of medium stage of growth (spec. 356) and

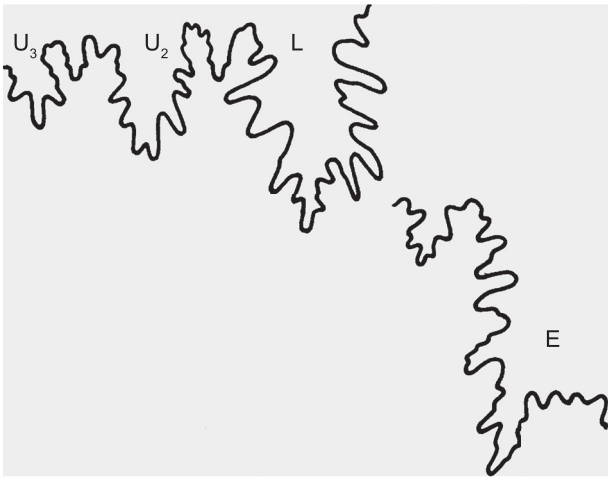
two sculpture moulds of fragments of adult whorls crushed onto bedding plane (spec. 435, 436).

Description. Juvenile and medium whorls characterized by semi-involute shells with rather low, weakly arched whorls, gradually tapering towards rather narrow, strongly rounded ventral side. Whorl flanks distinctly separated from a low, inclined umbilical wall. Umbilicus relatively narrow, step-like. Whorl height slightly exceeding whorl width; whorl height more distinct than width in the fragment of more adult whorl.

Ornamentation of early whorls formed by relatively sparse ribs, concave towards mouth at whorl base, or even emphasized by weak bullae in most whorls. Ribs in their further course proverse, weakly sigmoidal. Thin inserted ribs (usually around 4–5) added to (or branching off) these ribs at different levels at whorl mid-height. Ribs crossing ventral side arched, dense and of equal thickness. Ribs on deformed adult whorl similar, but ribbing somewhat weaker on flanks.

Measurements. Juvenile shells reach the maximum diameter of ca. 12–13 mm. The following parameters were measured on the best preserved juvenile shell (spec. 325) at D = 11.3 mm: H = 5.2 (0.46), U = 2.9 (0.26), B = 4.8 (0.42). Nine main ribs are developed per half whorl.

Suture-line. Outer suture-line, although not fully complete and locally corroded, can be traced in spec. 356. Its lobes are relatively narrow and asymmetrical.



■ **Text-fig. 19.** *Prodichotomites* ex gr. *complanatus* (Koenen). Outer suture-line at H = 12 mm. Spec. 356, site Š-55 (Plaňava Formation).

Remarks. The juvenile material from Štramberk best resembles the shells described and figured under the name *Prodichotomites collignoni* (Thieuloy, 1977 b, pl. 6, figs. 12–16), or *Craspedites complanatus* (Koenen) in Witkowski (1969, pl. 19, fig. 5), which were included within the synonymy of the species *P. complanatus* by Kemper (in Jeletzky and Kemper, 1988). It may be also close to *P.* cf. *collignoni* (in Thieuloy, 1977 b, pl. 6, figs. 17–21, placed within *P. flexicosta* Koenen in the above cited paper by Kemper); this specimen, however, shows a denser ribbing and its inserted ribs reach deeper, as far as to the lower half of the whorl. An unequivocal species determination of the herein described juvenile material, i.e., also the material of the above cited authors, is impossible because the material from Germany is dominated by large adult shells characterized *inter alia* by a narrower umbilicus (U/D = 0.15–0.18). Suture-lines of adult shells figured by Thieuloy (1977 b, pl. 3, fig. 2) and Jeletzky and Kemper (1988, text-fig. 41a) are of no definite help either. Nevertheless, a certain common feature could be the indicated ornamentation weakening observed on the flanks of the fragment of an adult whorl (spec. 436), which is considered characteristic for adult shells of *P. complanatus*.

Distribution. Thieuloy (1977 b) reported *P. collignoni* from the topmost part of the *Busnardoites campylotoxus* Zone, while early Late Valanginian age is more probable according to Kemper (in Jeletzky and Kemper, 1988). Besides Germany, shells ranked within *P. complanatus* have been reported from France and Poland.

Occurrence. Shells of different growth stages occur in the Plaňava Formation, site Š-55. A single find comes from site Š-44.

Subfamily Platylenticeratinae Casey, 1973
Genus *Platylenticeras* Hyatt, 1900
Type species: *Oxynoticeras heteropleurum* Neumayr & Uhlig, 1881.

We did not make an attempt for a subdivision into subgenera with respect to the incompleteness and paucity of our material as well as to the discussion in Kemper et al. (1981, p. 278).

Platylenticeras ex gr. *marcousianum* (d'Orbigny, 1850)

Pl. 6, Fig. 6, Text-fig. 20

1961 *Platylenticeras (Tolypeceras) marcousianum* (d'Orbigny); Kemper, p. 145, pl. 7, figs. 2 a,b, 3, pl. 8, figs. 1–3, pl. 9, fig. 1, text-figs. 50–60 (cum syn.)

Material. A single pyritized internal mould of approximately one-fourth of the whorl belonging to the phragmocone (spec. 160).

Description. Fragment of a large, high whorl with fastigate cross section. Whorl flank passing, through an arched segment at the base, into a rather low, steep umbilical wall. Lateral walls high, broadest at the base, weakly arched and markedly tapering towards ventral side. Ventrolateral edge indicated on flanks in the proximity of ventral side; whorl walls behind this edge inclined to shell periphery at a different (blunter) angle than before. Acute keel present on ventral side.

Four prominent bullate tubercles (outer ones incomplete) preserved in lower part of whorl, starting at the base and strongly concave towards mouth. Their splitting into two ribs indicated in their continuation; these ribs disappearing at about whorl mid-height. Upper half of whorl smooth.

Measurements. At whorl height H1 = 34 mm (measured between tubercles), B1 = 18.6 mm (B/H = 0.55); at H2 = 32.5 mm (measured on tubercles), B2 = 24 mm (B/H = 0.74).

Suture-line. The quality of incompletely preserved outer suture-line with rather low saddles and rather shallow lobes is affected by unfavourable grain size of the fossilizing pyrite. Lobe E has not been preserved. First lateral saddle is broad, asymmetrically divided into two parts. Lateral lobe semicircular in general shape, asymmetrically articulated by accessory elements. The (?) next lobe also broad, asymmetrically bifid. Lobe U2 and the continuation of other parts of the suture-line are already indistinct.

Remarks. In the cross section of its whorl and in the presence of periumbilical bullae, the fragment clearly belongs to the group

■ **Text-fig. 20.** *Platylenticeras* ex gr. *marcousianum* (d'Orbigny). Adult outer suture-line at H = 34 mm. Spec. 160, site Š-12 (Plaňava Formation).

of species *P. marcousianum*, which is also documented by the forms recently figured by Kemper (1992, pl. 7, figs. 1–3, 6) under the name *P. marcousianum*. In the cross section of its whorl, the present specimen is also close to *P. fragile* (Koenen), which, however, has no well-preserved inner whorls with tubercles and a somewhat different suture-line. Incompleteness of our material does not allow a perfectly definite determination.
Distribution. Typical representatives of the species have been reported from the Early Valanginian (*Thurmanniceras pertransiens* Zone) of Germany (Subboreal Realm), southern France and Switzerland (Mediterranean Realm).
Occurrence. The fragment comes from the Plaňava Formation, site Š-12.

Platylenticeras sp.

Pl. 6, Figs. 7, 8
Material. A fragment of a whorl of a calcareous mould with imperfectly preserved base, which belongs to the body chamber (spec. 161).
Description. A fragment of adult whorl, width and height about equal. Lateral walls strongly arched, especially in lower half, where they gradually pass to unlimited umbilical region. Whorl flanks in upper part tapering towards bluntly pointed ventral side. The mould is free of any ornamentation.
Measurements. At H = 22.8 mm, B = 23 mm (B/H = 1.01).
Remarks. The body chamber suggests a specimen of a relatively small diameter. The cross section of the whorl is closest to that of the group of the species *P. coronatum* (Koenen), but a closer determination is impossible due to the considerable incompleteness of our fragment.
Occurrence. The fragment formed by Gloriet limestone type comes from the eluvium of the Kopřivnice Limestone from the lower Blücher Quarry.

Family Bochianitidae Spath, 1922
Subfamily Protancyloceratinae Breistroffer, 1947
Genus *Protancyloceras* Spath, 1924
Type species: *Ancyloceras Guembeli* Oppel in Zittel, 1870.

Protancyloceras cf. *punicum* Arnould-Saget, 1951

Pl. 6, Figs. 9, 10
1987 *Protancyloceras punicum* Arnould-Saget; Company, p. 89, pl. 1, figs. 1–6 (cum syn.)
2003 *Protancyloceras punicum* Arnould-Saget; Vašíček and Hoedemaeker, p. 13, pl. 1, figs. 1, 2
Material. A single minute fragment of a small whorl preserved in the form of a sculpture mould (spec. 223).
Description. Shell juvenile, loosely coiled, as indicated by weakly arched inner side lacking a impressed area for preceding whorl. Whorl rather low, of narrow, oval cross section, with subparallel flanks. Flanks flat, continuously passing to both umbilical side and ventral side. Ventral side tapering towards an indicated keel. Ornamentation formed by simple, relatively sparse ribs: straight at first but distinctly inclined forward towards mouth at the end of ventrolateral region. Ribs V-shaped (chevron) on ventral side; their median line forming a narrow, smooth ridge.
Measurements. At H = 3.15 mm, B = 2.45 (B/H = 0.78).
Remarks. Judged by the maximum whorl height of 3.2 mm, the fragment probably belongs to a loosely crioceraticone-coiled shell rather than to a juvenile (spiral) part of whorl of an ancyloceraticone-type shell. As for its generic position, our fragment should belong to the genera *Leptoceras* Uhlig or *Protancyloceras* Spath. On the other hand, pertinence to the genus of Uhlig is contradicted by the presence of chevrons on the ventral side.

According to the character of ribbing and the presumed crioceraticone coiling, the fragment probably belongs to the group of *P. punicum* rather than to the group of Tithonian species recently studied by Wierzbowski (1990).
Distribution. The distribution of typical representatives of *P. punicum* is restricted to Tunisia, Spain and France, stratigraphically ranging from the later part of the Late Berriasian (top part of the *Subthutmannia boissierri* Zone) to the Early Valanginian (*Thurmanniceras pertransiens* Zone) according to Company (1987). In the section at Río Argos (Spain), the typical representatives occur in the Middle to Late Berriasian (Vašíček and Hoedemaeker 2003).
Occurrence. The only fragment comes from the Gloriet Limestone (spec. 223), site Š-20.

Subfamily Bochianitinae Spath, 1922
Genus *Bochianites* Lory, 1898
Type species: *Baculites neocomiensis* d'Orbigny, 1842.

Bochianites neocomiensis (d'Orbigny, 1842)

Pl. 6, Figs. 14, 15, Text-fig. 21
1971 *Bochianites neocomiensis neocomiensis* (d'Orbigny); Mandov, p. 93, pl. 1, figs. 1–11 (cum syn.)
1987 *Bochianites neocomiensis* (d'Orbigny); Immel, p. 114, pl. 11, fig. 3
1992 *Bochianites neocomiensis* (d'Orbigny); Vašíček et al., p. 51, pl. 9, fig. 3
1992 *Bochianites neocomiensis* (d'Orbigny); Kemper, pl. 29, figs. 5, 9, 10
1996 *Bochianites neocomiensis* (d'Orbigny); Reboulet, p. 179, pl. 26, figs. 3–19, ?1–2 (cum syn.)
1999 *Bochianites neocomiensis* (d'Orbigny); Vašíček, pl. 1, fig. 1, text-fig. 1/1
Material. Two minute fragments (only ca. 1 cm long) preserved in the form of partly corroded pyritized internal moulds with suture-lines (spec. 322, 437).
Description. Arms straight, oval in cross section, arm height somewhat exceeding arm width. Ornamentation formed by oblique

simple ribs, strongest in ventral area and thinning in the opposite direction.
Measurements. In spec. 437 at H = 3.6 mm, B = 3.2 mm (B/H = 0.89).
Suture-line. Complete suture-lines are visible in both specimens. Although they are of the same type, some insignificant differences are yet present, possibly also resulting from the different quality of preservation. Lobe E bears a low secondary saddle, which is smooth or weakly articulated. Lateral saddle is broad and bipartite. Lobe L is asymmetrical. Lobe U between two umbilical saddles is shallow; it resembles the secondary lobe dividing the lateral saddle into two branches. Lobe I is somewhat asymmetrical, complex, with finger-like projections.

■ **Text-fig. 21.** *Bochianites neocomiensis* (d'Orbigny). Complete suture-line at H = 3.5 mm. Spec. 322, site Š-45 (Plaňava Formation).

Remarks. Mandov (1971) subdivides *B. neocomiensis* into a number of subspecies, which are not respected, probably correctly, by either Company (1987) or Reboulet (1996). Nevertheless, Company (1987) also included *B. oosteri* Sarasin & Schöndelmayer, 1902 (lacking ornamentation) into the synonymy of *B. neocomiensis*, which is incorrect in our opinion.
Distribution. According to Company (1987) and Reboulet (1996), *B. neocomiensis* ranges from the late Early Valanginian (*Busnardoites campylotoxus* Zone) to the early Late Valanginian (*Neocomites peregrinus* Zone) in the Mediterranean region and also in the Subboreal realm. Maximum distribution and diversity are reached in the *Saynoceras verrucosum* Zone.
Occurrence. Plaňava Formation, sites Š-65 and Š-45.

Bochianites oosteri Sarasin & Schöndelmayer, 1902

Pl. 6, Figs. 11, 12, Text-fig. 22
1971 *Bochianites oosteri* Sarasin et Schöndelmayer; Mandov, p. 98, pl. 3, fig. 10, pl. 4, figs. 3–5, ?1, ?2 (cum syn.)
1999 *Bochianites oosteri* Sarasin & Schöndelmayer; Vašíček, pl. 1, fig. 2, text-fig. 1/2
Material. Four fragments of pyritized internal moulds, two of which display visible suture-lines (spec. 320, 321, 438, 439).
Description. Specimens straight, smooth, oval in cross section. A linear furrow present on side opposite to ventral side, i.e., on dorsal side, in spec. 320.
Measurements. Spec. 320, which is best preserved, is a fragment 14.5 mm long. At H = 4.2 mm, B = 3.85 (B/H = 0.92).
Suture-line. The complete suture-line is characterized by relatively narrow saddles and lobes. Lobe E bears an asymmetrical secondary saddle, reaching to about mid-height. Lobe U is shallow, with almost no differentiation. Lobe I, about as deep as lobe L, is evenly serrated.
Remarks. Smooth shell, but especially the different suture-line than in *B. neocomiensis* confirm the independent position of the

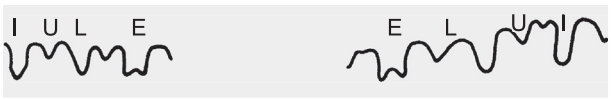
■ **Text-fig. 22.** *Bochianites oosteri* Sarasin & Schöndelmayer. Both branches of a complete suture-line at H = 4 mm. Spec. 320, site Š-45 (Plaňava Formation).

species *B. oosteri*. Of the material figured in the literature, this species most probably does not include the large shells of Mandov (1971) of Hauterivian age, with arm height of over 15 mm (marked by a question-mark in the synonymy); these shells probably belong to isolated arms of the species *Ptychoceras meyrati* Ooster.
Distribution. According to Mandov (1971), *B. oosteri* is distributed in the Tithonian to Valanginian of the Mediterranean region. Besides Late Valanginian, this species is common also in the Early Hauterivian of the Central Carpathains (Vašíček et al., 1994).
Occurrence. The fragments come from the Plaňava Formation, sites Š-45, Š-46, under Š-56 and Š-65.

Genus *Baculina* d'Orbigny, 1850
Type species: *Baculina rouyana* d'Orbigny, 1850.

Baculina rouyana (d'Orbigny, 1850)

Pl. 6, Fig. 13, Text-fig. 23
1996 *Baculina rouyana* d'Orbigny; Wright et al., p. 210, fig. 162/1 a,b
1999 *Baculina rouyana* d'Orbigny; Vašíček, pl. 1, fig. 3, text-fig. 1/3
Material. A single miniature pyritized internal mould with preserved phragmocone and a part of the body chamber (spec. 440).
Description. Shell weakly flexed, smooth. Periodically repeated oblique constrictions, with the last constriction lying already on body chamber.
Measurements. The total length of the preserved arm is 14 mm. At H = 1.45 mm in the posterior part of the body chamber, B = 1.4 mm (B/H = 0.96).
Suture-line. The phragmocone displays increasing frequency of suture-lines towards the body chamber (see Vašíček, 1999, text-fig. 1/3). The suture-lines show relatively simple incision. Lobe E bears a low, simply bent secondary saddle, other suture-lines – with the exception of lobe I – are simple and smooth. Lobe U is relatively shallow on the last suture-lines, thus giving the impression of a secondary lobe, dividing the saddle in the ventral area into two parts. Lobe I, which is slightly trifid, becomes gradually smooth. Lateral saddle is bipartite and smooth, umbilical saddle is simple, ventral saddle is weakly bipartite.



■ **Text-fig. 23.** *Baculina rouyana* d'Orbigny. Left: complete earliest preserved suture-line at H = 1 mm; right: last adult suture-line at H = 1.4 mm. Spec. 440, site Š-45 (Plaňava Formation).

Remarks. The high frequency of suture-lines at the end of the phragmocone clearly shows that the specimen is a miniature adult shell, characterized by numerous oblique constrictions and a weak flexion.
Distribution. In their stratigraphic column, Bulot and Thieuloy (1995) place the occurrences of *B. rouyana* to the Early Valanginian *Thurmanniceras pertransiens* Zone.
Occurrence. The find comes from the Plaňava Formation, site Š-45.

Stratigraphic assessment

As the Štramberk locality does not allow bed-by-bed sampling of the Lower Cretaceous deposits, precise superposition of the collected ammonite species in the stratal succession is unknown. It can be reconstructed and inferred from our systematic determination, although not absolutely, only on the basis of literature data (however, considering the above mentioned problems and insufficiencies in unequivocal determination). Among the safely determined material, especially non-persistent species having the character of index and zone species can be used for this purpose. As implied from the taxonomic part, ammonites mostly pertaining to the Mediterranean bioprovince combine with Subboreal taxa in the Štramberk material. Mutual time correlation between these two categories has not been safely established yet. Some authors are of the opinion that such correlation is perhaps even impossible (Hoedemaeker, 2002).

Solution of the stratigraphic position of the Štramberk ammonites was guided by the Lower Cretaceous ammonite zonation of the Mediterranean region recommended at the Lyon session in 2002 (Hoedemaeker, Reboulet et al., 2003). Also the zonation used by Company (1987) in Spain proved useful, much like the classic Mediterranean zonation (Hoedemaeker, Company et al., 1993) correlated with Boreal ammonite zones (Rawson, 1995, Rawson, Hoedemaeker et al., 1999).

The following quantitative composition of the whole studied collection of ammonites from Štramberk was found, by pertinence to ammonite suborders: of the total of 312 specimens determined at least to generic level, 23.4 % (73 specimens) belong to the suborder PHYLLOCERATINA, 25 % (78 specimens) to the suborder LYTOCERATINA, 51.6 % (161 specimens) to the suborder AMMONITINA. Within the AMMONITINA, 95 % of specimens are represented by spirally coiled shells while the remaining 5 % (8 specimens) are straight heteromorphic shells, placed within the ANCYLOCERATINA in previous taxonomy before the proposal of Cecca (1997).

The quantitative composition of the AMMONITINA at Štramberk is by far most conspicuously contributed by haploceratids (approx. 45 %) and also by kilianellas (almost 20 %). The remaining part (only slightly above 35 %) is represented by other genera (19 genera determined in total).

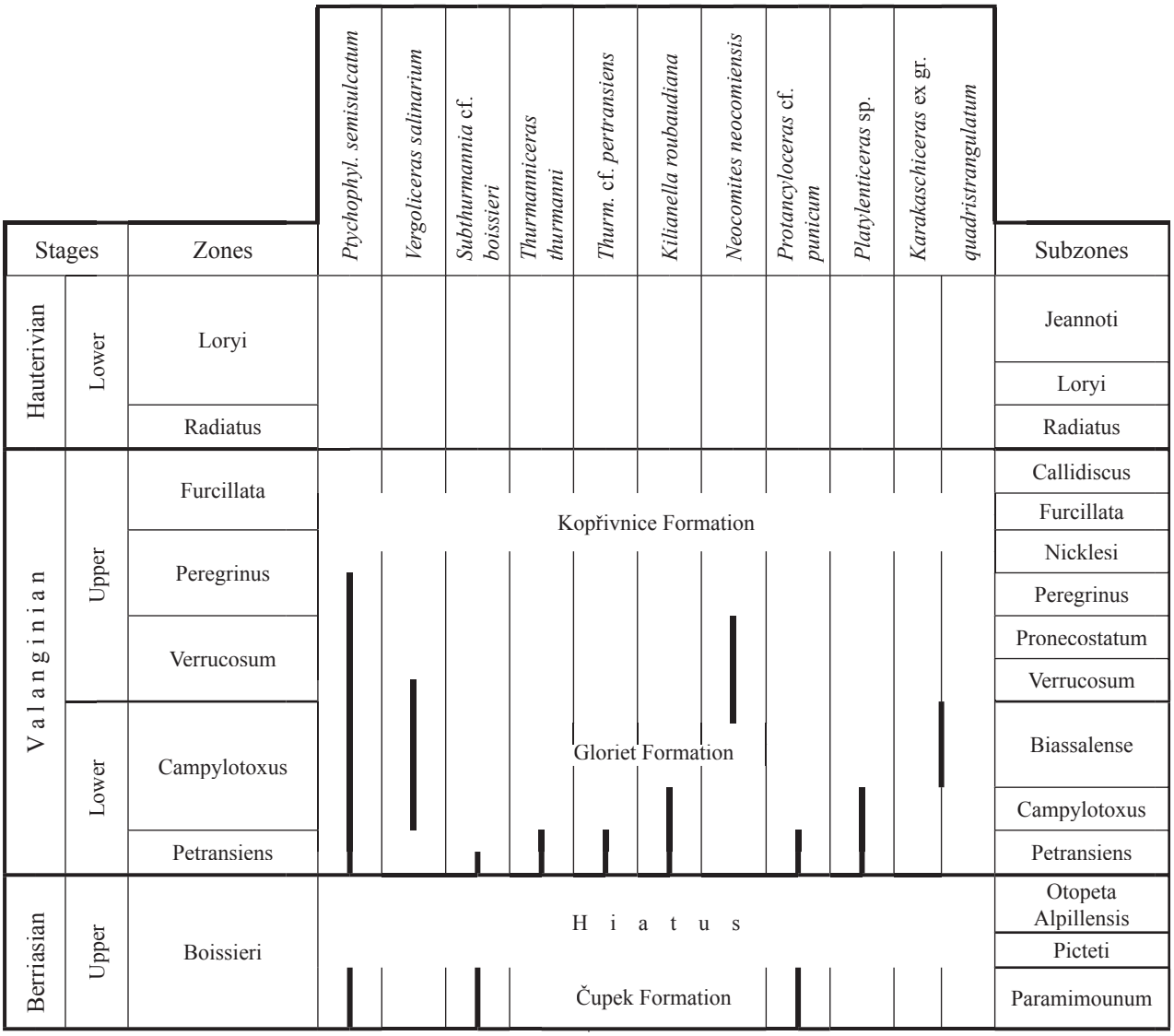
Whereas phylloceratids (almost exclusively represented by shells with slender, not broadly inflated whorls) and lytoceratids are of low importance for the detailed stratigraphy, specimens of the AMMONITINA include many stratigraphically significant, partly zone-species.

As for the overall time range, the assembled heterogeneous collection of Lower Cretaceous ammonites from Štramberk suggests the latest Berriasian to earliest Hauterivian ages. Ammonites preserved in limestones in the form of calcareous internal moulds suggest the latest Berriasian to early Late Valanginian ages (*Saynoceras verrucosum* Zone). The latest Berriasian age cannot be, however, considered perfectly documented as the two not very safely determined species of the set – i.e., *Subthurmannia* cf. *boissieri* and *Protancyloceras* cf. *punicum* – extend to the Early Valanginian according to the literature data (Company 1987) – see Table l. Ammonites preserved especially in the dark pelites show the range between the Early Valanginian and earliest Hauterivian (*Thurmanniceras pertransiens* to *Acanthodiscus radiatus* zones, see Table 2). Although the Early Valanginian (*Petranensis* Zone) can be considered proven, basal Hauterivian has not been documented with such certainty.

The composition of Early Valanginian ammonites corresponding to the *Thurmanniceras pertransiens* and *Busnardoides campylotoxus* zones is almost identical regardless of their preservation in limestones or in the form of pyrite moulds in dark claystones (with the exception of the two genera mentioned in the paragraph above): *Kilianella roubaudiana, Thurmanniceras thurmanni*, *Vergoliceras salinarium*, a.o. The common Mediterranean representatives are occasionally complemented by representatives of the genus *Platylenticeras.* The genus *Platylenticeras* is usually taken as Boreal element. However, a considerable areal of distribution of this genus is connected with more probable immigration of its representatives from the Meriterranean to the Boreal area (e.g. Kemper et al. 1981). Whereas in the Mediterranean area platylenticeratids occurred usually rarely, especially in Germany (Lower Saxony Basin) the platylenticeratids (Platylenticeras-Schichten) were abundant in a short time. In the whole assemblage described, only the following three specimens of *Platylenticeras* occur: *Pl.* ex gr. *marcousianum, Pl. cardioceroides* Sayn (described by Vašíček 1979) and *Pl.* sp. This assemblage did not specifically yield the zone species of the *Campylotoxus* Zone – *Busnardoites campylotoxus* (Uhlig); on the other hand, the Boreal genus *Polyptychites* Pavlow is absent. The *Busnardoides campylotoxus* Zone is represented by *Vergoliceras salinarium* and by some of the above listed species (also olcostephanids). To get a complete picture, it has to be noted that a similar composition of Early Valanginian ammonites was given by Uhlig (1902) for the neighbouring basinal (Godula) development of the Silesian Unit (including representatives of the genus *Platylenticeras*, but also the index species *Busnardoites campylotoxus*).

Ammonites fossilized by calcareous material or preserved in limestone indicative of the Late Valanginian occur only sporadically at Štramberk. In fact, only *Neocomites neocomiensis* and *Valanginites* cf. *bachelardi* can be mentioned, although the latter species was found as a redeposited specimen in the dark pelites of the Plaňava Formation. Their finds probably correspond to the *Saynoceras verrucosum* ammonite Zone only.

A special position in the collection of probable Late Valanginian representatives from Štramberk is occupied by a single whorl fragment preserved in the red limestone of the Kopřivnice Formation, herein determined as *Stoicoceras* sp. One of the species of this genus, *Stoicoceras tuberculatum* (Roman), is con-

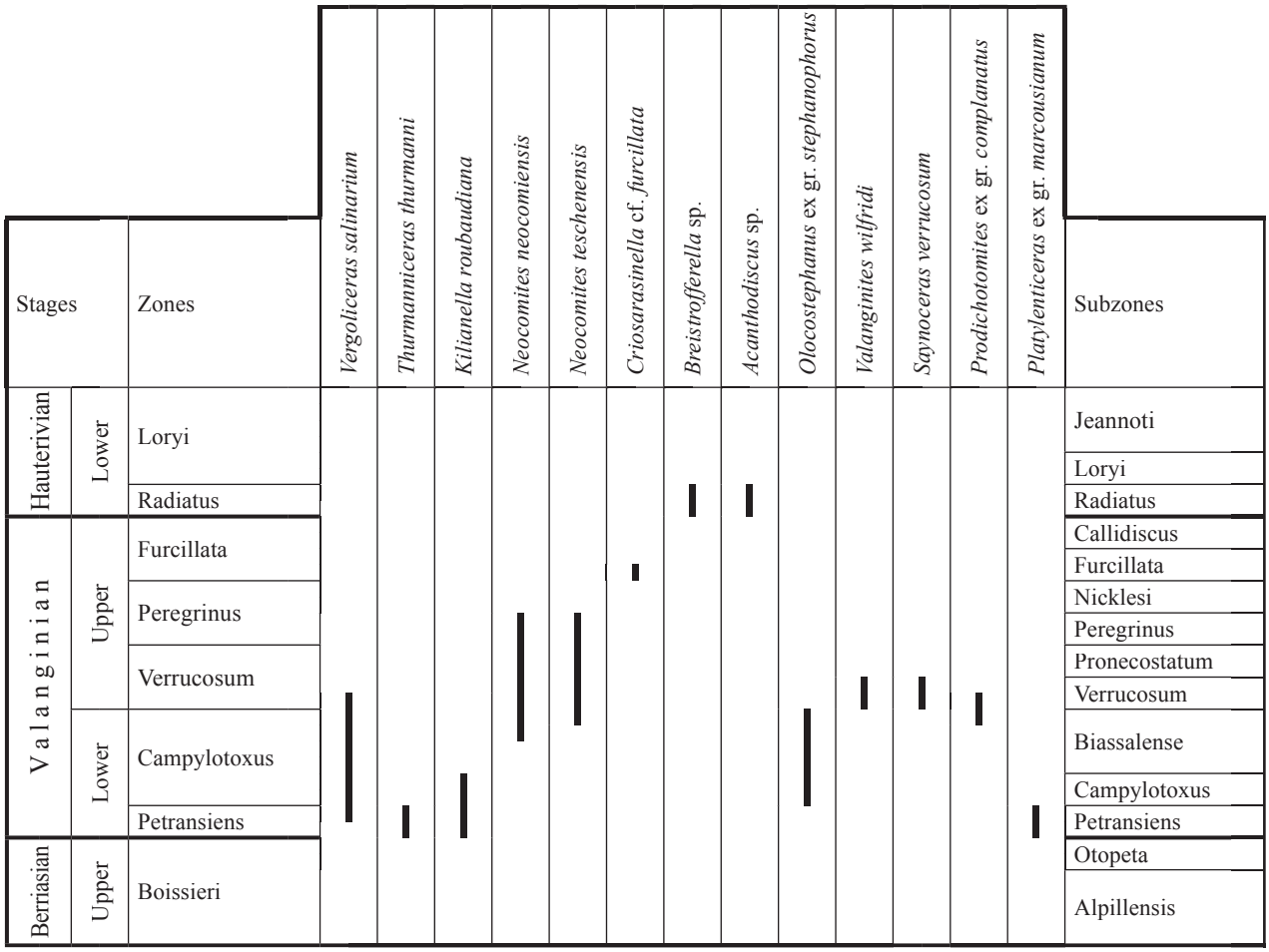


■ **Tab. 1.** Known stratigraphic distribution of some important species of ammonites found in the Kopřivnice and Plaňava Formations in the form of redeposited limestone relics derived from the carbonate deposits of the upper Čupek and Gloriet Formations at Štramberk.

sidered a zone species in the Subboreal Realm, roughly equivalent to the lower part of the *Criosarasinella furcillata* Zone in the Mediterranean Realm. If the determination was unambiguous, this find would refer to the youngest ammonite found in the Kopřivnice Limestone.

In contrast, Late Valanginian ammonites, either juvenile pyritized moulds in disintegrated pelites forming slumps of the Plaňava formation or adult shells deformed onto bedding planes in the solid grey to dark grey pelites forming blocks in the slump bodies of the Plaňava Formation are relatively abundant at Štramberk. The most common are, however, the ammonites representing the Late Valanginian *Saynoceras verrucosum* Zone. This zone is documented particularly by the occurrence of the zone species *Saynoceras verrucosum*. Other significant species are *Valanginites wilfridi*, *Valanginites* sp. juv., *Prodichotomites* ex gr. *complanatus* and probably also *Neocomites neocomiensis*, *N. teschenensis* and *Bochianites neocomiensis*, or other bochianitids. Remarkable from paleogeographic point of view is the occurrence of valanginitids and especially the presence of Subboreal representatives of the genus *Prodichotomites*. A substantial part of this ammonite assemblage consists of elements known by their penetration from the Mediterranean region to the Saxonian Subboreal Realm in the earliest Late Valanginian. On the other hand, the genus *Prodichotomites* belongs to the category of ammonites penetrating from the Subboreal Realm to the Mediterranean.

Stratigraphically younger Lower Cretaceous deposits of the Plaňava development are already lacking pyritized ammonites. The Late Valanginian *Criosarasinella furcillata* Zone is suggested by only a single specimen of *Criosarasinella* cf. *furcillata*, preserved in dark grey solid pelites forming blocks in the slump bodies of the Plaňava Formation. The latest Valanginian – *Teschenites callidiscus* Subzone – has not been evidenced on



■ **Tab. 2.** Known stratigraphic distribution of some important species of ammonites found in the form of free pyritized remains in the dark leaf-like disintegrated pelites of the Plaňava Formation (submarine slumps) or pelitic moulds or impressions in grey solid pelites forming blocks floating in the same Formation in the Kotouč Quarry at Štramberk.

the basis of ammonites yet. Surprising is especially the absence of neocomitids ranked within the genus *Teschenites* Thieuloy (1971, 1977, a. o.). This is in contrast with the Late Valanginian sediments from the neighbouring depositional area of the Silesian Unit of the Outer Flysch Carpathians, which do contain the above mentioned teschenitids (Uhlig 1902).

The blocks of solid dark-coloured shale deposits in the Plaňava Formation also contain poorly preserved thus not absolutely safely determinable representatives of the basal Hauterivian (*Acantodiscus radiatus* Zone). These belong to genera which include zone-species, such as ?*Acanthodiscus* sp., *Breistrofferella* sp. and ?*Endemoceras* cf. *amblygonium*. The last mentioned taxon is considered a Subboreal element; contrastingly, representatives of the genus *Acanthodiscus* are known to have penetrated from the Mediterranean region to the Subboreal Realm between Germany and England. No corresponding ammonite equivalents have been reported from the basinal Godula development of the Silesian Unit.

Stratigraphically younger ammonites of the Lower Hauterivian (*Crioceratites loryi* Zone and higher), or the Late Hauterivian, have not been documented yet from the Lower Cretaceous deposits of Štramberk.

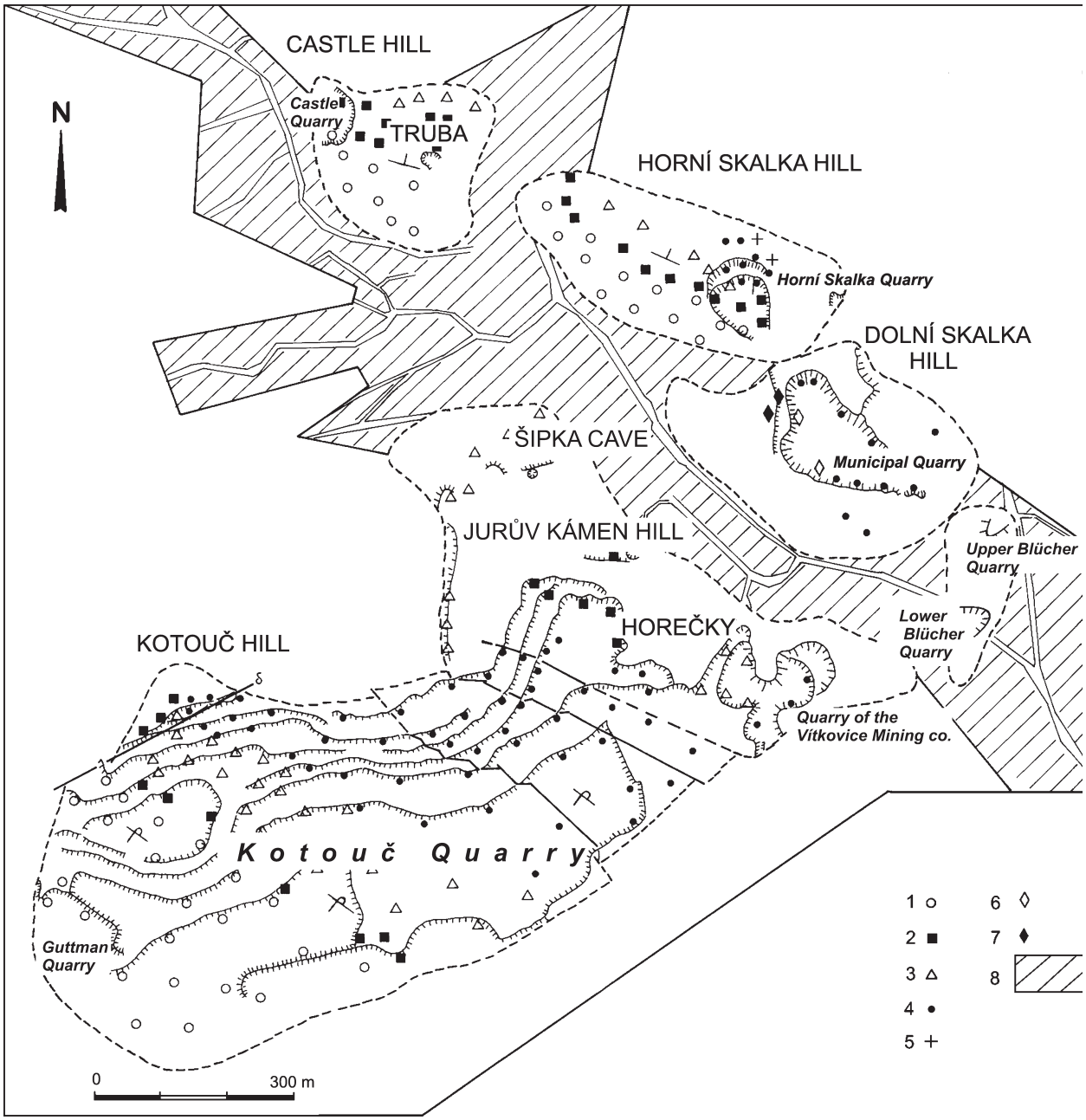
Notes on the geological history of the Štramberk segment of the Baška elevation in light of finds of early cretaceous ammonites

A brief review of previous studies

The history of deposition above the limestone bodies at Štramberk during Early Cretaceous times remained long completely unnoticed. This was not due to the absence of exposures of Lower Cretaceous rocks in the Štramberk quarries but due to the fact that all limestones lithologically deviating from, but spatially associated with, the typical Štramberk Limestone were considered as its facies or "varieties" by previous authors (e.g., Remeš) and mostly attributed the same, i.e., Tithonian, age. This postulate, favoured by most previous authors, resisted all objections raised by Coquand (e.g., 1869), Hébert (1869) or Jaekel (1891) and others based on the finds of younger, Early Cretaceous species in the Štramberk fauna. The last mentioned author was sharply criticized for his objections by Remeš (1904, p. 280–282), who uncompromisingly defended the original idea of Zittel on the

"uniform character" of the Tithonian fauna at Štramberk. Remeš attempted to subdivide the Štramberk Limestone by the principle of facies diversity (Remeš, 1899, 1904). One of the facies distinguished by him, the "echinoderm" facies, was represented by the Kopřivnice Limestone. The presence in the Kopřivnice (Nesselsdorf) Limestone of some species known from the Earliest Cretaceous elsewhere was explained by Remeš by the extension of their stratigraphic range to the Tithonian. In this respect, Remeš was following Zittel who was refuting Coquand's objections against the uniformity of Tithonian fauna using the same arguments. Remeš founded his statement on the Tithonian age of the Kopřivnice Limestone upon the finds of several species of typical Tithonian ammonites in the Blücher Quarry (i.e. Lower Blücher Quarry – see Text-fig. 24), where only the Kopřivnice Limestone is exposed. It is obvious now that these Tithonian species were derived from redeposited fragments of the Štramberk Limestone, commonly enclosed in the Kopřivnice Limestone.

The idea of the "uniform character" of the Štramberk Limestone was adopted also by some scientists working at Štramberk after Remeš. For example, Eliáš (1962) considered the Kopřiv-



■ **Text-fig. 24.** A map of the main limestone bodies in the vicinity of Štramberk, with the positions of principal quarries and calpionellid zonation. From Houša (1990), revised. 1 – limestone without calpionellids; 2 – *Chitinoidella* Zone; 3 – *Crassicollaria* Zone; 4 – *Calpionella alpina* Subzone; 5 – *Remaniella ferasini* Subzone; 6 – *Calpionella elliptica* Subzone; 7 – *Calpionellopsis simplex* Subzone; 8 – town of Štramberk.

nice "facies" an "analogue of the earlier part of the Štramberk limestone body" (Eliáš 1962, p. 35). Later finds of clearly Early Cretaceous species in the Kopřivnice Limestone and also in bodies of lithologically different rocks within the limestone bodies at Štramberk led Eliáš (1970) to the conclusion that the Štramberk Limestone stratigraphically extends much higher with its facies than believed by Remeš: not only to the lowermost Cretaceous but even to the Middle Cretaceous. This misinterpretation later became the basis for Eliáš's views on the geological development of the region in the Early Cretaceous, which unfortunately proved also erroneous as for the origin and structure of the Štramberk Limestone bodies at Štramberk.

Detailed studies of the occurrences of Early Cretaceous faunas in the Štramberk quarries (Houša 1961, 1965 a, 1965 b, 1976, a.o.) led to the conclusion that rocks lithologically different from the Štramberk Limestones contain only younger faunas. These younger rocks mostly rest on the original upper surface of the Štramberk Limestone bodies but also frequently form isolated bodies in the Štramberk Limestone. These bodies most commonly proved to represent fillings of deep fissures in the limestone bodies at Štramberk (Houša 1965 a) or fills of cavities formed by fossil, Early Cretaceous karstification of the Štramberk Limestone (Houša 1965 b), but sometimes also represent later fillings of primary cavities in the limestone (Houša 1964). In some cases, however, these bodies were formed by rocks originally deposited on top of the limestones, lying *in situ* in the depressions of this surface, and occasionally tectonically overthrust by neighbouring limestone blocks thereby actually becoming incorporated within the limestone body. Exposures of rocks overlying the original upper surface of limestone bodies are generally known only from such exposures, as the mining practice generally avoided the border of limestone bodies as much as possible, due to possible contamination of the mined limestone with enveloping rocks. These younger rocks, if sufficiently rigid, sometimes even form separate tectonic bodies.

Štramberk limestone

The **Štramberk Limestone** is a clearly integral unit from the lithological, paleontological and stratigraphic points of view. It is formed by light grey to whitish grey biodetrital limestones with a characteristic fauna, on the basis of which the upper part of the Tithonian stage was defined as the uppermost stage of the Jurassic in the Tethyan Realm by Oppel and Zittel. Both these classics founded their work on the materials from the Hohenegger collection which was coming, as for the Štramberk area, almost exclusively from the Castle (Zámecký) Quarry (Schlossberg Steinbruch)(see Text-fig. 24), where the mining was started in 1780. This quarry was therefore selected as the type section of the Štramberk Limestone (Houša 1968). The body of the Štramberk Limestone forming Castle Hill (Zámecký kopec, Schlossberg) is opened by the Castle Quarry at the stratigraphic level corresponding to the late part of the Early Tithonian (in division of Tithonian in two parts), i.e. *Chitinoidella* Zone and nearest levels below it (Houša 1975, 1990). Ammonite fauna coming from this quarry has an absolutely uniform character, documenting this stratigraphic interval. Material of the Hohenegger collection came, however, from other sites, too. Its minor portion was derived from the Municipal Quarry (Obecní lom, Gemeinde Steinbruch) at Štramberk, then still rather small in size (opened in 1820). Part of Hohenegger's material was obtained from the sites of the so-called "exotic boulders" of the Štramberk Limestone, then extracted at different places of the Podbeskydská pahorkatina Highland. And it was these sites of "exotic boulders" and the Municipal Quarry at Štramberk that yielded species arousing doubts on the uniformity of the Štramberk Limestone ammonite fauna among later authors. "Exotic boulders" are accumulations of clasts of limestones mainly of the Štramberk Formation of different sizes in younger Cretaceous and Tertiary rocks of the Silesian and Subsilesian units, but also in other tectonic units of the Beskydy Mts. flysch. They were formed during erosive destruction of the original limestone accumulations of the Štramberk Formation, which started in the Hauterivian and lasted for the whole of the Barremian and Aptian (Houša, 1976). The detrital material thus formed (minute fragments to boulders and huge blocks) was transported by different means (mostly by submarine slumps, but also in the form of olistoliths), often quite far from the site of its original occurrence (especially in the Chlebovice Formation; this material became commonly redeposited again later). It is obvious that such accumulations include limestones of the Štramberk Formation from different stratigraphic levels spanning across practically the whole of its original range, i.e. practically from the latest Kimmeridgian to the early Berriasian, according to the present knowledge. These limestone clasts are accompanied by clasts belonging to the formations which were immediately overlying the Štramberk Limestone and were deposited on top of its accumulations in the Berriasian, Valanginian and possibly even in the Early Hauterivian: limestones of the Čupek Formation, Gloriet Formation and the Kopřivnice Formation (see below).

The younger Remeš collection of fossils from the Štramberk Limestone shows a somewhat different spectrum of fauna than the older collections. This is explained by the fact that it was constituted later, between 1870 (when it was started by Remeš's father) and ca. 1930, by sampling in the quarries then open and by purchase from quarry workers. The Castle Quarry was practically abandoned at that time, and the main sources were the quarry on Kotouč Hill and the Municipal Quarry (Remeš, 1899, 1904). The sites of exotic boulders are also represented in the Remeš collection, but restricted to those still existing at that time (e.g., Rychaltice, Skalička). The newly opened quarry on Kotouč Hill was, however, the main source of fossils. Here, Štramberk Formation limestones of the Kotouč Hill body were extensively exposed and extracted during the 1910s, practically in its whole stratigraphic range between the Early Tithonian and the Early Berriasian (in the present chronostratigraphic concept). The Municipal Quarry, as we know now, exposed the Štramberk Formation limestones especially in their youngest part now placed to the Early Berriasian, but also opened large portions of limestones of the Berriasian Čupek Formation. This is why some of the Berriasian ammonites in the Remeš collection come from rocks lithologically different from the limestones of the Štramberk Formation.

Nevertheless, the principal source of Early Cretaceous ammonites in the Remeš collection was the Kopřivnice Limestone. Remeš intensively studied (Remeš, 1897, 1904, a.o.) the occurrences of the Kopřivnice Limestone in the lower Blücher Quarry and in outcrops above this quarry (the so-called upper Blücher Quarry, which is the

type section of the Kopřivnice Limestone – Suess 1858), especially for their rich fauna, mainly echinoderms and brachiopods. The numerous finds of species identical with those of the Štramberk Limestone (corals, ammonites, bivalves a.o., but restricted to mere clasts of Štramberk limestones in the Kopřivnice Formation, as revealed later) made him to refer to the Kopřivnice Limestone as the "echinoderm facies" of the Štramberk Limestone.

The Jurassic/Cretaceous boundary in the Tethyan Realm was previously placed stratigraphically higher than today. Zittel and other authors were placing it between the Tithonian (the whole of which was included in the Jurassic) and the Berriasian (considered Cretaceous already). As we know, the uppermost Tithonian in the concept of Zittel (uppermost Štramberk limestone) was overlapping with the lowermost Berriasian in the concept of Coquand, which was the main reason for controversy between these two classics. This problem was to be solved much later (1939) by Mazenot, by the ammonite-based definition of the J/K boundary (between the *Berriasella jacobi* and *Pseudosubplanites grandis s.s.* Subzones). In this conception this boundary was placed practically on the upper lithological boundary of the Štramberk Limestone. Nevertheless, the J/K boundary was tentatively placed "lower" by judgment of the Lyon colloquium of 1973: to the base of the ammonite *Berriasella jacobi* Zone, i.e., to the base of the calpionellid *Calpionella alpina* Subzone, which is practically identical with the base of the *Berriasella jacobi* Zone. The J/K boundary thus actually appeared inside the Štramberk Limestone. It can be well defined here on the basis of calpionellids (Houša 1983), but is accompanied by no lithological change whatsoever.

As suggested by the hitherto obtained results, the oldest parts of the Štramberk Limestone in bodies exposed in the Štramberk area are of earliest Tithonian age. Microfossils indicating the latest Kimmeridgian have been recorded in some portions. These come most probably from large clasts to olistoliths of the lowermost parts of the Štramberk Limestone redeposited during the sedimentation of the higher parts of the Štramberk Limestone. Destruction of the older parts of the complex of coral–*Diceras* reefs occurred probably at each eustatic sea-level fall when apical parts of these reefs became emerged; this happened several times during the Štramberk Limestone deposition. A Early Tithonian age is documented by an ammonite fauna (e.g., Blaschke 1911) coming from the former Guttman Quarry, opened in the oldest, southwestern part of the Homole limestone body of the Kotouč Hill complex in 1881. The latest Early Tithonian rocks contain the first calpionellids (*Chitinoidella*). The well-known calpionellid stratigraphy permitted a relatively detailed stratigraphic subdivision of those parts of the limestone bodies that are attributed to the latest Early Tithonian, the whole Late Tithonian and the earliest Berriasian. In the whole of its stratigraphic range, the Štramberk Limestone is composed of pure carbonate material (mostly biodetrital limestones of variable grain size), with practically no admixtures of different lithological character. Limestone in some intervals is very coarse to gravelly, formed by whole rudist shells (*Diceras*) and minute coral colonies. In contrast, the limestone is very fine, micritic in some other intervals. The most common type, however, is finely biodetrital limestone. The youngest calpionellid zone documented in the Štramberk Limestone is the *Remaniella ferasini* Subzone. *Calpionella elliptica,* the index species characteristic for the subsequent subzone, has not been recorded in the Štramberk Limestone.

Ammonites of the Štramberk Limestone are not the subject of this paper; however, the knowledge of the geological history of the area during the deposition of the Štramberk Limestone and the development of the opinions on the Tithonian and lowermost Berriasian stratigraphy in this area are significant for the understanding of the geological history of younger formations overlying the Štramberk Limestone. The present paper is aimed at the ammonite fauna of only these younger formations.

Čupek Formation

All limestones younger than those of the Štramberk Formation differ lithologically from the latter especially in the presence of a strong or weak clay admixture; therefore, they were separated, one after another, from the Štramberk Limestone and earned the status of separate lithostratigraphic units. The **Čupek Limestone** of Berriasian age contains rich benthic fauna but only rare ammonites, mostly represented by stratigraphically insignificant forms of lytoceratids and phylloceratids. Benthic fauna is dominated by brachiopods and echinoderms. Of the calpionellid zones, *Calpionella elliptica* Subzone has been documented from several sites but is represented by the development with frequent large individuals of *Tintinnopsella carpathica*, much like in the Vocontian Trough (Remane 1964). The *Calpionellopsis simplex* subzone has been also documented from this formation.

No reliable gradual transition between the Štramberk Limestone and Čupek Limestone has been documented yet. Therefore, it cannot be excluded that a short period of shallowing or even non-deposition took place between their deposition (in the time interval immediately following the *Remaniella ferasini* Subzone, after which no reefal sedimentation was restored). Conglomerate beds are present in the Municipal Quarry at the level where the boundary between the two formations would be expected. The Čupek Formation contains calpionellids indicative of the *Calpionella elliptica* and *Calpionellopsis simplex* Subzones (Houša 1990). The youngest Berriasian calpionellid subzones, *Calpionellopsis oblonga* Subzone and *Lorenziella hungarica* Subzone, are completely missing on the stratotype of the Čupek Limestone in the Municipal quarry. It can be therefore concluded that the latest Berriasian sediments are primarily absent, and a hiatus developed in this period, corresponding to the eustatic sea-level fall known from the Late Berriasian.

Gloriet and Plaňava Formations

Evidence of the reactivation of deposition in the area of the Štramberk elevation is available from the earliest Valanginian already. The Early Valanginian rocks have not been preserved in their original position overlying the Štramberk Limestone and the Čupek Limestone. Their remains, but mostly the fossils from these rocks, are found redeposited in younger lithostratigraphic units (see below). Exceptionally, the Early Valanginian limestones have been preserved inside the limestone bodies at Štramberk either in the form of fissure fillings or as the last generation of the fills of primary cavities in the Štramberk Formation limestones (Houša 1964, Uchman et al. 2003).

Based on the identified remains and redeposited occurrences, the Early Valanginian rocks presently known from the area of lime-

stone bodies at Štramberk can be divided into two groups. The first group was represented by rather light carbonate deposition (light clayey limestones), and the second group by the deposition of dark pelites. These pelites now form slump bodies resting in situ on surface of the limestone bodies at Štramberk. Only light Valanginian carbonate rocks can be found inside the limestone bodies (mostly in fissures), while the dark pelites are completely absent in fissure fillings. This suggests that the area providing material for fissure fillings, i.e., the sea bottom on the top surface of accumulations of the Tithonian and Berriasian limestones on the Baška elevation in the Valanginian, was governed exclusively by light clayey limestones. Dark Valanginian pelites must have been therefore deposited outside the limestone accumulations, in their neighbourhood, and must have been emplaced on their surface only later, in the form of submarine slumps (see below). Where the original surface of the limestone accumulations was preserved beneath these slumps of dark Valanginian pelites, it often bears only water-abraded remnants of light Early Valanginian limestones.

The limestone sedimentation of Valanginian age (**Gloriet Formation**) was dominated by light greenish to yellowish clayey micritic limestones. Its fossils can be mostly found redeposited in younger formations (particularly in the Kopřivnice Limestone). The oldest clearly documented ammonite species are the forms characteristic for the *Thurmanniceras pertransiens* Zone. Two of these species are known to occur as early as in the latest Berriasian (*Subthurmannia* cf. *boissieri* and *Protancyloceras punicum*) but also reach to the *Thurmanniceras pertransiens* Zone, which is their youngest occurrence. Nevertheless, the species of *Thurmanniceras thurmanni*, *T. pertransiens*, *Kilianella roubaudiana*, *K. clavicostata* and the genus *Sarasinella* have been reported only from this ammonite zone. This is also the case of the species *Platylenticeras* sp., a fragment of a calcareous inner mould of which has been found as a redeposited clast in the Kopřivnice Limestone. In the Subboreal Realm, the genus *Platylenticeras* is considered an analogue of the *Thurmanniceras pertransiens* Zone in the Mediterranean. The subsequent ammonite *Busnardoites campylotoxus* Zone is characterized by the presence of *Vergoliceras salinarium*, although this species has been elsewhere reported also from the latest part of the *T. pertransiens* Zone and from the earliest part of the *Saynoceras verrucosum* Zone (already Late Valanginian), following the *B. campylotoxus* Zone. The *S. verrucosum* Zone is evidenced by the presence of species *Karakaschiceras* ex gr. *quadristrangulatum* and *Neocomites neocomiensis*. The latter species has already appeared in the preceding *B. campylotoxus* Zone and reaches to the next Late Valanginian zone – the *Neocomites peregrinus* Zone – but reached its maximum distribution in the *Saynoceras verrucosum* Zone. No clearcut evidence was found for the presence of the youngest Valanginian zones – *Neocomites peregrinus* and *Criosarasinella furcillata* Zones – in the limestone development of the Valanginian (Gloriet Limestone).

Valanginian ammonites, mostly represented by pyritized remains, are also contained in the dark, greyish-black pelites with fine leaf-like disintegration. These dark pelites (**Plaňava Formation**) are never present in situ, being known only from secondary sites in the form of slumps lying on the surface of the Štramberk Limestone. They contain pyritized ammonites and numerous other organic remains, which are either pyritized (e.g., bivalve moulds) or calcareous (e.g., echinoderm remains). The oldest pyritized ammonites found in these dark pelites belong to species characteristic for the *Thurmanniceras pertransiens* Zone (much like in the calcareous facies): *Thurmanniceras thurmanni*, *Platylenticeras* ex gr. *marcousianum* and *Kilianella* ex gr. *roubaudiana*. Another two species of pyritized ammonites reported from here – *Vergoliceras salinarium* and *Olcostephanus* ex gr. *stephanophorus* – have been also reported from the late part of the *T. pertransiens* Zone but their presence in the subsequent ammonite *Busnardoites campylotoxus* Zone is more common. The *Busnardoites campylotoxus* Zone is evidenced by the presence of *Platylenticeras cardioceratoides* (see Vašíček 1979), *Neocomites teschenensis* and *Prodichotomites* ex gr. *complanatus*. Whereas the first mentioned species is considered characteristic for the early part of the *B. campylotoxus* Zone (Bullot and Thieuloy 1993), the latter two species may overlap to the subsequent ammonite *Saynoceras verrucosum* Zone, the presence of which in the dark pelites of the Plaňava Formation is documented by the occurrence of the index species of *Saynoceras verrucosum*. The presence of the subsequent ammonite *Neocomites peregrinus* Zone is documented by no line of evidence. The last Valanginian ammonite zone in the Plaňava Formation is represented by its index species *Criosarasinella* cf. *furcillata* recorded, however, in only one specimen.

These pyritized ammonites, generally restricted to the dark pelites with fine leaf-like disintegration, strongly convoluted, deposited in submarine slump bodies, naturally evidence the age of the original destructed rock, the *in situ* position of which is unfortunately unknown. They cannot be obviously taken as evidence of the age of the slump bodies in which these claystones are preserved. The above mentioned ammonites, derived from four different Valanginian ammonite zones, are found mixed in the claystones. The slumps must be younger, also because they lie on the upper surafce of the Štramberk Limestone and the Čupek Limestone, where eroded remains of the original cover can be found, formed by the limestones of the Gloriet Formation. These slump pelites often enclose "floating" boulders of limestone of the Štramberk Formation, on the surfaces of which the situation is identical. They, however, also contain floating blocks of harder grey calcareous claystone with Early Hauterivian ammonites (see below). No fossils demonstrably coeval with the slumping have been found in these pelite slump bodies yet.

Kopřivnice Formation

In the apical part of the Baška elevation, i.e., in the area of the limestone development, a break in sedimentation probably occurred as early as in the latest Valanginian. No ammonite remains from the time interval corresponding to the *Neocomites peregrinus* and *Criosarasinella furcillata* zones were evidenced in the limestone development. It is probable that the break in sedimentation began in the latest Valanginian as a progressive shallowing only on top of the elevation. This was soon followed by erosion of the Gloriet Limestone on the top of the elevation and by the redeposition of eroded material in deeper slope parts of the Baška elevation. Sediments consisting of the material of the destroyed Gloriet Limestone, of the underlying Čupek Limestone and finally even the Štramberk Limestone, if this was also exposed, were

accumulated in the adjacent sea. This is exactly the character of the limestones of the **Kopřivnice Formation**, namely its oldest Blücher Member. This member is composed of clasts (rock fragments of different roundness, often angular; giving rise to the term "Kopřivnice Breccia") of all three above mentioned formations. Most of the clasts are, however, derived from the Gloriet Limestone, the lithological character of which is largely shared by the Kopřivnice Limestone. A parallel situation is seen in the fauna of the Kopřivnice Limestone, which combines elements of all three formations: the oldest fossils are of Tithonian age and come from clasts of the Štramberk Limestone, Berriasian fossils are represented by numerous brachiopods and crinoid remains from the Čupek Limestone, and Valanginian fossils by a number of ammonites (see above) from the Gloriet Limestone. Most macrofaunal remains (especially crinoid and echinoid elements, but also belemnites, brachiopodes, aptychi and others) come from the biodetrital beds of the Čupek Limestone, although the final deposition of some of them could have proceeded through a temporary deposition in the Gloriet Limestone.

A practically identical fauna to that of the Blücher Member was yielded by the claystones of the Šipka Member, which have been reported only from fissures in the Štramberk Limestone as the youngest generation of fillings. Claystones of the Šipka Member probably represent a fissures-bound facies coeval to the Blücher Member.

No signs of the presence of destroyed rocks of an extrabasinal embayment were found in the Kopřivnice Formation. It is therefore probable that only the apical part of the Štramberk elevation was eroded in the latest Valanginian. Sediments of the extrabasinal embayment probably got also to the proximity of the sea level but were protected from destruction by the ridge of the carbonate Baška elevation, still separating the area of the extrabasinal embayment from the open sea. Sedimentation in the extrabasinal embayment during the latest Valanginian is documented by *Criosarasinella* cf. *furcillata* in the Plaňava Formation and by grey claystones containing aptychi from the Valanginian/Hauterivian boundary, which were found in the Překop area on level 2 of the Kotouč Quarry in the envelope of the Štramberk Limestone. They typically lack signs of anoxia, characteristic for older dark claystones of the Plaňava Formation.

No sediments from the times of the earliest Hauterivian were preserved *in situ* on the top parts of the Baška elevation. This can be assumed by the fact that this area was probably subjected to continued erosion even at that time. Nevertheless, the area of the extrabasinal embayment was not emergent, and still functioned as the site of deposition. This is documented by the youngest ammonites present in the studied collection from the Early Cretaceous limestone accumulations at Štramberk, which are the species found in blocks of harder grey calcareous claystones in slump bodies of the Plaňava Formation. These ammonites are ?*Endemoceras* cf. *amblygonium*, *Breistrofferella* sp. and ?*Acanthodiscus* sp. All these taxa are characteristic for the oldest Hauterivian ammonite zone – *Acanthodiscus radiatus* Zone. These grey calcareous claystones are the youngest known sediments of the fill of the extrabasinal embayment. They are known merely as solid blocks (usually 1 m to several metres in size), now "floating" in dark, leaf-like disintegrated pelites of the Plaňava Formation slump bodies (Houša 1976). Ammonites preserved in these blocks of solid claystones are not pyritized. These sediments were not so fine as the Valanginian black claystones and completely lack any signs of anoxia (much like the above mentioned claystones found in the Překop area). This indicates that the communication of the extrabasinal embayment with the sea was more open in the earliest Hauterivian than in the Valanginian. This area was, however, still protected from the destructive action of open-sea waves by the Baška elevation.

Origin of the Plaňava Formation

The earliest Hauterivian (i.e., the top of the *Acanthodiscus radiatus* Zone) in the Štramberk segment of the Baška elevation was a period which marked a break in the persisting trends. Opening of fissures in the Štramberk Limestone stopped, with the last generation of the fill being represented by the claystones of the Šipka Member. Also in the extrabasinal embayment were deposited the last known sediments (claystones of the *A. radiatus* Zone). These processes were followed by the destruction of sediments of the extrabasinal embayment and the transport of the loose material thus obtained by submarine slumping (Plaňava Formation) into the basin across the Baška elevation where the material partly accumulated. This implies a reconfiguration of the existing physiographic setting characterized by the sedimentary fill of the extrabasinal embayment being protected by the ridge of the Baška elevation. This means that the apical part of the Štramberk elevation must have subsided below the level of the accumulations of the extrabasinal embayment. The possible mechanisms may include either tectonic uplift of the extrabasinal embayment (this possibility is less probable especially because its fill would emerge above sea level) or a subsidence of the block of the Baška elevation below the level of the fill of the extrabasinal embayment. Continued subsidence of the apical part of the elevation exposed the area of the former extrabasinal embayment to the destructive action of sea waves. Soft sedimentary material was rapidly eroded, and the products of this erosion were transported across the surface of the subsided elevation into the basin as slumps of the Plaňava Formation. The destruction of sediments of the extrabasinal embayment took place well after the lithification of the grey ammonite-bearing claystones of the earliest Hauterivian *Acanthodiscus radiatus* Zone, i.e. not sooner than in the Early Hauterivian.

Paleogeography

Issues related to the fact that two different faunal bioprovinces (Mediterranean and Boreal) existed in the northern hemisphere in Early Cretaceous times became topical again during the course of the five-year project IGCP No. 362 "Tethyan and Boreal Cretaceous" started in 1993. The submitted project studied the configuration of European Early Cretaceous Mediterranean and Boreal depositional realms, especially the problems of their mutual communication in both time and geographic dimensions. The starting points of the project also included the problem of the composition of the Mediterranean (also Tethyan) and Boreal (sometimes also Subboreal or West European) faunal assemblages, ammonite assemblages included. Solution of the project

was initiated by the early session in Coimbra (October 1993) where the opening papers on Early Cretaceous biostratigraphy and paleogeography summarized scientific knowledge obtained in the last decades (Bulot and Thieuloy 1993, Rawson 1993 a). The previous evidence of the presence of Boreal ammonites in the Mediterranean bioprovince was coming especially from Lower Cretaceous deposits of SE France. Ammonites considered to be of Boreal provenance are, however, rare in this area, usually not exceeding 1 % of the whole ammonite population (Bulot and Thieuloy 1993). The problem of the Boreal and Mediterranean ammonites was then extensively studied by Rawson (1993 b, 1994, 1995), a.o.

The early results of the solution of IGCP 362 further include the establishment of a correlation scheme in which standard Mediterranean ammonite zones (Hoedemaeker and Company et al. 1993) are paralleled with Boreal zones (Rawson 1995). Of equally high importance are the paleogeographic maps of European format, suggesting the basic distribution of dry land and depositional areas in the early Early Cretaceous, and the possible communication paths between them on the northern hemisphere (Rawson 1994, 1995).

Additional partial results aimed at the correlation between the Mediterranean and Boreal ammonite zonations were published in the further course of the IGCP 362 and after it had finished (Rawson, Hoedemaeker et al. 1999). Most importantly, the Final Volume was published, summarizing the results of IGCP 362 achieved by the individual active participants (Michalík 2002).

As suggested by literature data, the first mixing of Mediterranean and Boreal elements in the European Early Cretaceous took place not earlier than in the Early Valanginian in the ammonite *Thurmanniceras pertransiens* Zone. This mixing is connected particularly with the migration of the genus *Platylenticeras*. It is associated with the Early Valanginian sea-level rise, often accompanied by transgression designated as the Early Valanginian event by Rawson (1994).

A second event, designated as the Middle Valanginian event by Rawson (1994), roughly corresponds to the base of the *Saynoceras verrucosum* Zone. It is connected primarily with the penetration of the genus *Prodichotomites* to the Mediterranean Realm and, on the other hand, with the important penetration of Mediterranean elements (such as *Saynoceras verrucosum*, *Valanginites* of the *nucleus* group, *Neohoploceras*, *Bochianites* and *Karakaschiceras*) to the Subboreal Realm.

The third event in the basal Hauterivian is associated with the occurrence of the genus *Endemoceras* in the Mediterranean regions and with the penetration of the genus *Acanthodiscus* to the Subboreal Realm. Another similar event has been reported from the Middle Hauterivian. All the above mentioned events are linked with a global sea-level rise, accompanied by transgressions and sea floodings, as also implies from the many published sea-level curves for the Early Cretaceous (Kemper et al. 1981, Rawson 1994, a.o.). An important role in fauna migrations was also played by climatic effects (Kemper and Wiedenroth 1987, a.o.).

The first three listed Early Cretaceous events (see above) are documented by ammonite fauna in the Štramberk area. The dominant Mediterranean elements (represented mainly by common phylloceratids, lytoceratids, haploceratids and kilianellids) occasionally – periodically, in three time-separated time intervals – combine with elements of Boreal or Subboreal character.

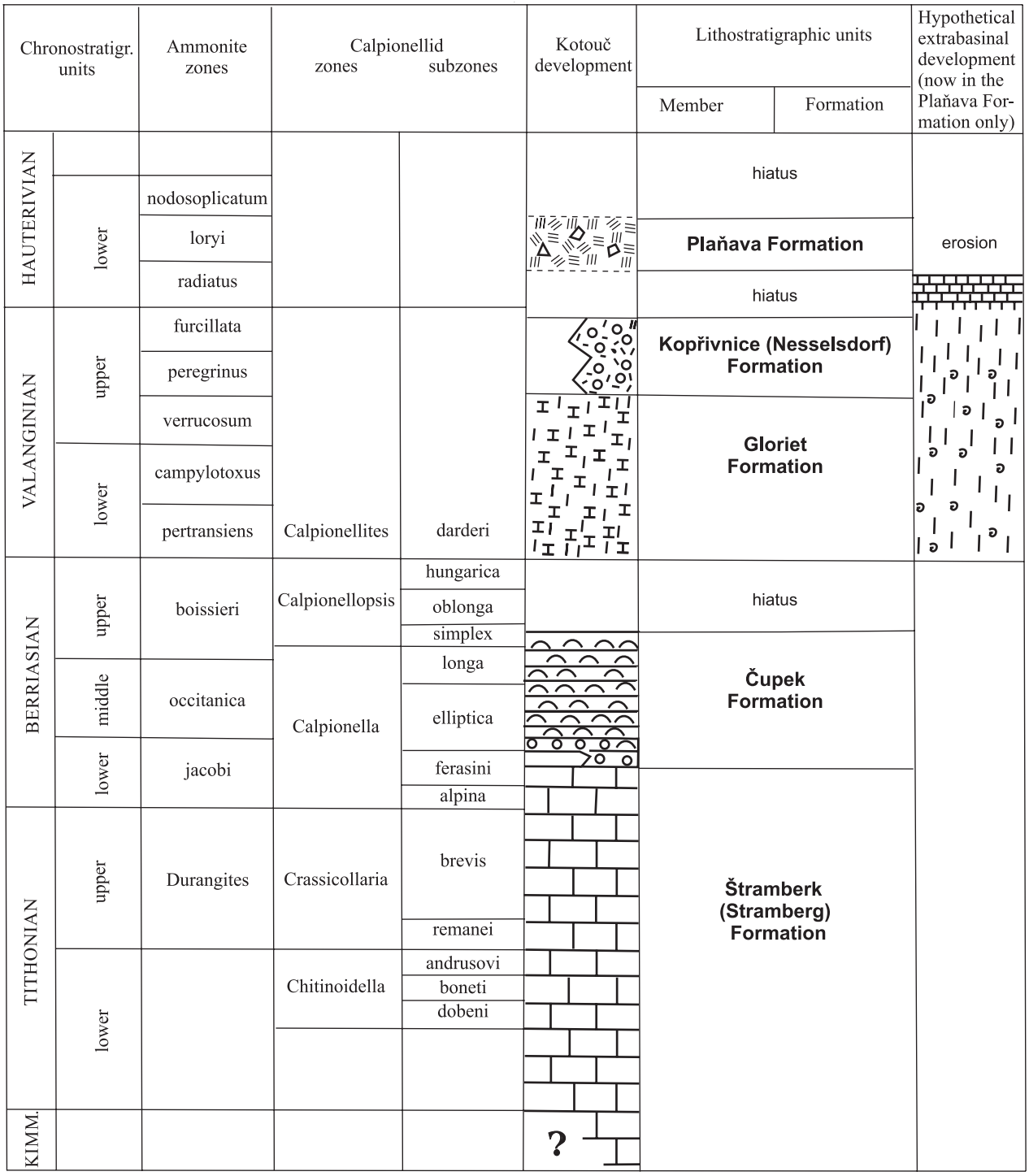
In the *Thurmanniceras pertransiens* Zone (Early Valanginian) at Štramberk, the mixing elements are represented by the find of a single fragment of the species *Platylenticeras* ex gr. *marcousianum* in the Plaňava Formation, or by the find of a single whorl fragment in the Kopřivnice Limestone determined as *Platylenticeras* sp. It has to be pointed out that platylenticerates from the neighbouring Godula Development of the Silesian Unit (from the Czech territory) were also reported by Uhlig (1902) – *Platylenticeras pseudograsianum* (Uhlig), including additional remains of two morphologically different types not determinable to the species level. Besides the above mentioned representatives of the genus *Platylenticeras*, also a single pyrite specimen of the species *Platylenticeras cardioceratoides* (Sayn) was found in similar deposits at Štramberk (Vašíček 1979). Ammonites of the last mentioned species characterize the lower part of the *Busnardoides campylotoxus* Zone according to Bulot and Thieuloy (1993, 1995).

Significant is the relatively common occurrence of mostly juvenile pyritized ammonites such as *Prodichotomites* ex gr. *complanatus*, *Saynoceras verrucosum*, *Valanginites wilfridi*, *Bochianites neocomiensis*, *Neohoploceras* sp. juv. and others around the Early/Late Valanginian boundary (near the base of the *Saynoceras verrucosum* Zone) in the non-carbonate Plaňava Formation. The first mentioned species is an important Boreal element, other species are known by their penetration to the Subboreal regions. Not a single one of the above listed species has been, however, found in the coeval calcareous sediments at Štramberk. Neither are they (with the exception of *B. neocomiensis*) known from deposits equivalent to the Hradiště Formation of the Godula Development of the Silesian Unit.

Younger Late Valanginian zones (*Neocomites peregrinus* and *Criosarasinella furcillata*) in the Štramberk area have been only vaguely documented by ammonite fauna. Finds from the shale sediments are exemplified only by the Mediterranean *Criosarasinella* cf. *furcillata*.

The youngest ammonite finds, reported exclusively from the shale sediments of the Plaňava Formation, correspond to the basal Hauterivian (*Acanthodiscus radiatus* Zone). They are characterized by very poor and fragmentary preservation. Here, fragments of shells ranked within the genus *Acanthodiscus* are accompanied by shells from the group of *Endemoceras amblygonium*, equally poorly preserved and deformed. Both taxa have been reported from the Mediterranean as well as Boreal Realms.

The leading problem, not yet discussed, is the communication of the Silesian depositional area with the Subboreal Realm. The possible interconnection of this area with the surrounding basins was suggested by Vašíček and Michalík (2002). Communication is indicated by paleogeographic maps (figs. 6.2 and 6.3 therein) drawn by J. Michalík; these maps show geographic distribution of selected ammonite species. Fig. 6.2 (in Vašíček and Michalík 2002) illustrates the Early Valanginian event connected with the occurrence of the genus *Platylenticeras*. Remarkable is especially the distribution of the species *Pl. marcousianum* along the southern margins of the North European Platform from France: first towards the east and then further north across the Danish–Polish



■ **Tab. 3.** Stratigraphic units in the region of Štramberk segment of the Baška elevation in the Tithonian and older part of the Early Cretaceous.

Furow in Poland (Witkowski 1969, Kutek and Marcinowski 1996, Marcinowski and Gasinski 2002, a.o.) as far as to Germany.

The event around the Early/Late Valanginian boundary (Middle Valanginian event of Rawson) is documented by fig. 6.3 in the above paper. It shows the distribution of the species *Prodichotomites complanatus* and its equivalents (see also Marcinowski and Gasinski 2002), particularly the wide distribution of *Valanginites wilfridi* from the Caucasus region across Bulgaria farther northwest to Germany and also along the southern margins of the North European Platform as far as to Spain. Surprising about the above described geographic distribution is the fact that equivalent Valanginian Boreal ammonites from, e.g., France and Poland have not

	Š-1	Š-3	Š-6	Š-11	Š-11a	Š-11b	Š-11cd	Š-12	Š-20	Š-21	Š-24	Š-24b	Š-25	Š-34	Š-44	Š-45	Š-46	Š-53	Š-54	Š-55	Š-56	Š-58	Š-58b	Š-59	Š-61	Š-64	Š-65	Š-72	Š-74	Kopř. F.
Phylloceras (Ph.) serum Oppel								x				x			x				x								x			
Phylloceras (Hypophylloceras) ex gr. *thetys* (d'Orb.)								x								x	x			x							x			
Phylloceras (Hypophylloceras) sp. juv.								x													x									
Phylloceras (Hypophylloceras) sp. indet.				x				x	x							x	x		x		x				x		x			
Phylloceras subgen. et sp. indet.								x								x	x		x	x							x			c
?*Partschiceras* sp.								x																						
Ptychophylloceras semisulcatum (d'Orb.)				c				x								x	x				x	c					c			
Sowerbyceras (Gyrophyllites) calypso (d'Orb.)																x														
Lytoceras cf. *subfimbriatum* (d'Orb.)								x																						
Lytoceras sp. indet.	c	c			c			x	c		x	xc	c			x					x						x			c
Protetragonites quadrisulcatus (d'Orb.)								x					x		x	x	x					c								c
Protetragonites cf. *quadrisulcatus* (d'Orb.)								x		c						x	x				x									
Neolissoceras grasianum (d'Orb.)	c							x								x														c
Vergoliceras salinarium (Uhlig)					c			x								x	x		x	x							x			c
Haploceras sp. indet.			c	x	c			xc							xc	x	x			x			c				x	c		c
Subthurmannia cf. *boissieri* (Pictet)																		c												
Thurmanniceras thurmanni (Pictet & Campiche)																x												c		
Thurmanniceras cf. *pertransiens* (Sayn)																														c
Thurmanniceras sp.																								c						
Kilianella roubaudiana (d'Orb.)					c		c	x						c		x		c										c		c
Kilianella cf. *clavicostata* Nikolov																														c
?*Kilianella* sp. ind.	c							c										c												c
Sarasinella sp. ind.																				x								c		
?*Sarasinella* sp. juv.								x																						
Criosarasinella cf. *furcillata* Thieuloy																										x				
Neocomites neocomiensis (d'Orb.)												x								x										c
Neocomites teschenensis (Uhlig)								x												x										
Karakaschiceras ex gr. *quadristrangulatum* (Sayn)																														c
Neohoploceras sp. juv.								x									x		x											
Stoicoceras sp.																														c
?*Endemoceras* cf. *amblygonium* (Neum. & Uhlig)																				m										
Breistrofferella sp.																				m										
?*Acanthodiscus* sp.																				m										
Olcostephanus (O.) ex gr. *stephanophorus* (Matheron)								x																						
Olcostephanus (O.) sp. juv.								x																						
Olcostephanidae gen. indet.								x									x													
Valanginites wilfridi (Karakasch)																				n										
Valanginites cf. *bachelardi* (Sayn)						c																								
Valaginites sp. juv.																				x	x									
Saynoceras verrucosum (d'Orb.)																				x	x									
Prodichotomites ex gr. *complanatus* (Koenen)															x					x										
Platylenticeras ex gr. *marcousianum* (d'Orb.)								x																						
Platylenticeras sp.																														c
Protancyloceras cf. *punicum* Arnould-Saget									c																					
Bochianites neocomiensis (d'Orb.)																x											x			
Bochianites oosteri Sarasin & Schöndelmayer																x	x				x						x			
Baculina rouyana (d'Orb.)																x														

■ **Tab. 4.** Occurrence of taxa of Early Cretaceous ammonites at individual sites in the Kotouč Quarry and its vicinity at Štramberk. x = pyritized internal moulds; c = calcareous moulds; m = sculpture moulds with shell rests or impressions in solid grey pelites forming blocks in the Plaňava Formation; n = as above, individual block „n".

been found in the well investigated Rumanian deposits lying approximately between the finds in Bulgaria and the Danish–Polish Furrow. Some indices from this period were, however, reported by Avram (1988), Melinte (2002) and others.

The above given information on the distribution of the two groups of Valanginian ammonites implies that the Silesian depositional area communicated with the Lower Saxony Basin across the Danish–Polish Depression (also designated as the Carpathian seaway) in the Valanginian, as was suggested earlier. Besides the herein treated Štramberk ammonites, this fact is evidenced also by other recent studies: by the data on the distribution of index ammonites in, e.g., Witkowski (1969), Kutek et al. (1989), Kutek and Marcinowski (1996), Cecca (1998), Marcinowski and Gasinski (2002). Highly relevant are also regional lithostratigraphic studies on the distribution of Lower Cretaceous deposits in the Danish–Polish Depression in Poland, carried out by Marek and his colleagues for many years. The obtained data were lately summarized by Marek (1997). The absence of Boreal polyptychitids (in the Early Valanginian) and dichotomitids (in the Late Valanginian) in the Silesian Unit can be appropriately explained by the Marek's conclusions on periodical shoaling of the Danish–Polish Furrow in Poland, which was connected with the interrupted or restricted marine communication between the two areas.

Besides the communication of the Outer Carpathian Silesian depositional area with the Lower Saxony Basin in Germany (across the Danish–Polish Furrow), a communication across a hypothetical depression lying roughly between the Bohemian Massif and the Rhenish Massif has been suggested by some authors (e.g., Rawson, 1994, 1995, Michalík, 1995). While the existence of the Danish–Polish Furrow in Poland has been documented by the respective sediments and ammonites, the other depression – considered as an alternative possibility – has not been documented by equivalent sediments and direct faunal evidence yet (e.g., from the Helveticum or Eastern Alps).

Boreal event in the basal Hauterivian, documented at Štramberk merely by the presence of poorly preserved ammonites from the groups of genera *Endemoceras* and *Acanthodiscus*, is rather specific as the genus *Endemoceras*, considered a Boreal element, is not known from France in comparison with the Valanginain Boreal events from the Vocontian Trough or other areas of the French Early Cretaceous. Nevertheless, *E. amblygonium* has been reported from the easterly lying Lower Cretaceous deposits of Bulgaria and Crimea. According to Marcinowski and Gasinski (2002), communication across the Danish–Polish Furrow was closed starting from the Late Valanginian. Contrastingly, Mutterlose and Bornemann (2002) presumed that the communication of the Lower Saxony Basin with the Tethyan realm across the Danish–Polish Furrow was restored for a short period at the Valanginian/Hauterivian boundary.

Sediments younger than the Early Hauterivian with ammonites, which would possibly document the so-called Middle Hauterivian event of Rawson (1994), has not been recorded in the Štramberk area yet.

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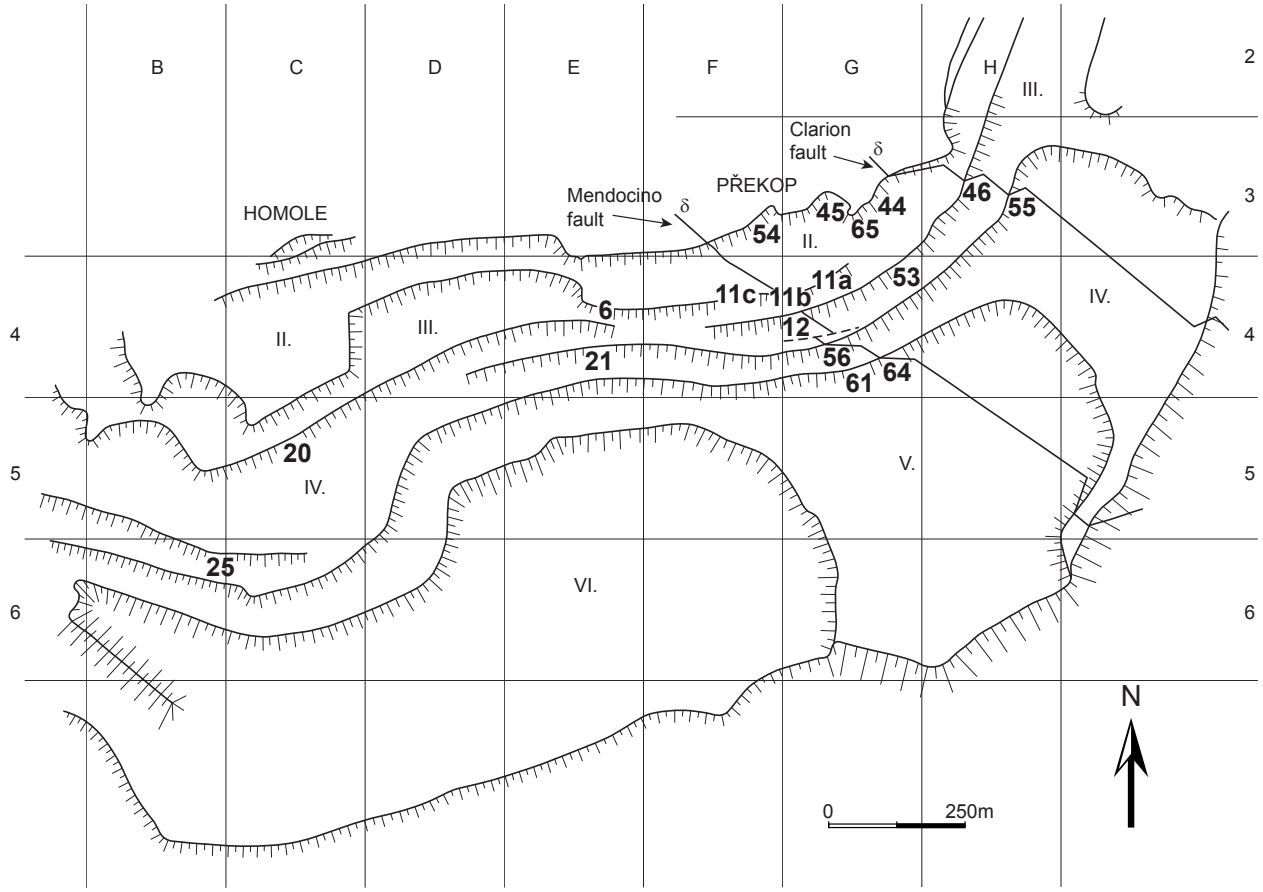
Appendix

Sites of Lower Cretaceous ammonites in the limestone bodies of the Štramberk area

During the field studies and sample collection, the individual sites were designated by letter Š (for Štramberk) and a serial number. Only permanent and larger sites outside the mining area were designated by local names (e.g., Blücher Quarry). Most of the sites of group "Š" lie in the area of the only presently active quarry at Štramberk – the Kotouč Quarry. A map of the principal sites is shown in Text-fig. 25. They have been sampled continuously since 1956. Most of these sites do not exist any more as they were exposed in quarry walls and destroyed during progressive exploitation. The species recorded at the individual sites are indicated in Table 4. The mode of preservation of the individual specimens is mentioned as a part of the description of taxa.

Š-1 (První) – Kotouč Quarry, level 2, N wall, quadrangle G3 – destroyed by mining in 1963; areally exposed fissure "Dlouho otevřená", its fill formed by rocks of the Čupek Formation, Gloriet Formation and Kopřivnice Formation – destroyed by mining.
Š-3 (Izméniová) – Dolní Skalka, Kozí skála Cliff, walls facing south near the top in the eastern neighbourhood of the Obecní Quarry; fissure partly areally exposed, filled with rocks of the Čupek Formation, Gloriet Formation and Kopřivnice Formation.
Š-6 (Eliáš) – Kotouč Quarry, level 3, N wall, quadrangle E4 – uncertain genesis (?matrix among blocks of the Štramberk Limestone), formed by rocks of the Gloriet Formation and Kopřivnice Formation – destroyed by mining.
Š-11 (Sjezd) – Kotouč Quarry, a complex of sites in the area of a road connection between levels 2 and 3 in central part of the quarry, quadrangle F4, G4, destroyed by mining.
Š-11a – northern wall of "Sjezd", upper part; areally exposed fissure "Dlouho otevřená"; it was lying at the place of the destroyed site Š-1, its fill was formed by rocks of the Čupek Formation, Gloriet Formation and Kopřivnice Formation – destroyed by mining.
Š-11b – northern wall of "Sjezd", middle part; Plaňava Formation on the primary surface of the Štramberk Limestone of the Homole Block – destroyed by mining.
Š-11cd – northern wall of "Sjezd", lower part; Plaňava Formation on the primary surface of the Štramberk Limestone of the Homole Block – destroyed by mining.
Š-12 (Kulisa) – Kotouč Quarry, level 3, N wall, below the central part of "Sjezd", quadrangle G4; black claystones of the Plaňava Formation overlying the surface of the Štramberk Limestone of the Homole Block near the Mendocino Fault – destroyed by mining.
Š-20 (Ferdinand) – Kotouč Quarry, level 4, N wall, quadrangle C5, near the opening of the test gallery; fissure filled with rocks of the Gloriet Formation and Kopřivnice Formation – destroyed by mining.
Š-21 (Okrajová) – Kotouč Quarry, level 4, N wall, quadrangle E4, below the connection road from level 3; fissure RO-IV, Gloriet Formation and Kopřivnice Formation – destroyed by mining.



■ **Text-fig. 25.** A map of some important sites of early Cretaceous ammonites in the Kotouč Quarry at Štramberk.

Š-24 (Pod Kulisou) – Kotouč Quarry, level 4, N wall, quadrangle G4; Plaňava Formation, black claystones showing leaf-like disintegration together with boulder conglomerate (slump) – destroyed by mining.
Š-24b – greyish-black claystones
Š-25 (Nepovšimnutá) – Kotouč Quarry, N wall of the connection road from level 4 to the crusher, quadrangle B6; fill of fissure R6, Gloriet Formation and Kopřivnice Formation – destroyed by mining.
Š-34 (Překvapivá) – Kotouč Quarry, level 2, N wall, quadrangle B5; fill of fissure; Kopřivnice Formation – destroyed by mining.
Š-44 (Májová) – Kotouč Quarry, level 2, N wall, quadrangle G3; black claystones of the Plaňava Formation showing leaf-like disintegration (slump) – destroyed by mining.
Š-45 (Servác) – Kotouč Quarry, level 2, NE wall of "Překop", quadrangle G3; black claystones of the Plaňava Formation showing leaf-like disintegration, underlying boulder conglomerate (slump) – destroyed by mining.
Š-46 (Bonifác) – Kotouč Quarry, level 3, N wall, quadrangle H3; black claystones of the Plaňava Formation showing leaf-like disintegration (slump), overlying the primary surface of the Štramberk Limestone of the Překop Block near the Clarion Fault.
Š-53 (Třetí) – Kotouč Quarry, level 3, N wall, quadrangles G3/H3; areally exposed fissure "Dlouho otevřená" (also exposed at sites Š-1, Š-11a); Čupek, Gloriet and Kopřivnice Formations – destroyed by mining.
Š-54 (Černá) – Kotouč Quarry, level 2, N wall, Překop, quadrangle F3; dark claystones of the Plaňava Formation (slump), overlying the primary surface of the Štramberk Limestone of the Homole Block near the Mendocino Fault zone.
Š-55 (Očekávaná) – Kotouč Quarry, level 4, N wall, quadrangle H3; black claystones of the Plaňava Formation showing leaf-like disintegration (slump) with floating blocks of grey solid claystones (slump) near the Clarion Fault – destroyed by mining.
Š-56 (Převis) – Kotouč Quarry, level 4, N wall, quadrangle G4; black claystones of the Plaňava Formation showing leaf-like disintegration (slump), overlying the primary surface of the Štramberk Limestone near the Mendocino Fault – destroyed by mining.
Š-58 (Blok) – Kotouč Quarry, level 3, a boulder of the Gloriet Formation limestone near site Š-46, quadrangle H3; dark Gloriet Limestone – destroyed by mining.
Š-58b (Blok b) – as above, other boulder – destroyed by mining.
Š-59 (Velká Červená) – Kotouč Quarry, level 5, N wall, quadrangle G4; brownish-red claystones with numerous pebbles of the limestones of the Čupek and Gloriet Formations, Kopřivnice Formation – destroyed by mining.
Š-61 (Mezikra) – Kotouč Quarry, level 5, N wall, quadrangle G4; boulder conglomerate with blocks of the Plaňava Formation (slump) with varicoloured claystone matrix near the Mendocino Fault zone – destroyed by mining.

Š-64 (Neporušená) – Kotouč Quarry, level 5, N wall, quadrangle G4; greyish-black thickly bedded claystones with an intercalation of slump origin, Plaňava Formation – destroyed by mining.
Š-65 (Konečná) – Kotouč Quarry, level 2, N wall, quadrangle G3; black claystones of the Plaňava Formation showing leaf-like disintegration (slump) – destroyed by mining.
Š-72 (Roh) – Kotouč Quarry, level 6, N wall, quadrangle H5; brownish-red claystones with numerous pebbles of the limestones of the Čupek and Gloriet Formations, Kopřivnice Formation – destroyed by mining.
Š-74 (Zasypaná) – Kotouč Quarry, level 5, N wall, quadrangle J3; black claystones of the Plaňava Formation showing leaf-like disintegration (slump), overlying the primary surface of the Štramberk Limestone near the Clarion Fault – destroyed by mining.

Plate 1

- **Figs. 1, 2.** *Phylloceras (Phylloceras) serum* Oppel
  1 – lateral view, 2 – a view of ventral side, ×2. Spec. 276, site Š-54, Plaňava Formation.
- **Fig. 3.** *Phylloceras (Phylloceras)* cf. *serum* Oppel
  Lateral view of a juvenile shell, ×4. Spec. 442, site Š-55, Plaňava Formation.
- **Fig. 4.** *Phylloceras (Hypophylloceras)* ex gr. *thetys* (d'Orbigny)
  Juvenile, evolute shell, ×4. Spec. 402, site Š-65, Plaňava Formation.
- **Figs. 5, 6.** *Phylloceras (Hypophylloceras)* ex gr. *thetys* (d'Orbigny)
  5 – lateral view, 6 – a view of ventral side, ×2. Medium stage of growth. Spec. 403, site Š-46, Plaňava Formation.
- **Figs. 7, 8.** *Phylloceras (Hypophylloceras)* sp. juv.
  7 – lateral view, 8 – a view of ventral side, ×3. Spec. 281, site Š-12, Plaňava Formation.
- **Figs. 9, 10.** *Ptychophylloceras semisulcatum* (d'Orbigny)
  9 – lateral view, 10 – a view of ventral side, ×2. Spec. 109, site Š-45, Plaňava Formation.
- **Fig. 11.** *?Partschiceras* sp.
  Lateral view; ×2. Spec. 119, site Š-12, Plaňava Formation.
- **Fig. 12.** *Protetragonites quadrisulcatus* (d'Orbigny)
  Lateral view, ×1. Spec. 76, site Š-12, Plaňava Formation.
- **Figs. 13, 14.** *Sowerbyceras (Gyrophyllites) calypso* (d'Orbigny)
  13 – lateral view, 14 – a view of ventral side, ×2. Spec. 286, site Š-45, Plaňava Formation.
- **Fig. 15.** *Lytoceras* cf. *subfimbriatum* (d'Orbigny)
  Lateral view of whorls of medium growth stage, ×2. Spec. 78, site Š-12, Plaňava Formation.

Photos by K. Mezihoráková, Ostrava University. Specimens were bleached by ammonium chloride before photographing. All material, except for the specimens borrowed, is kept in the collections of the Institute of Geology, Academy of Sciences of the Czech Republic in Prague.

■ **Plate 1**

Fig. 1

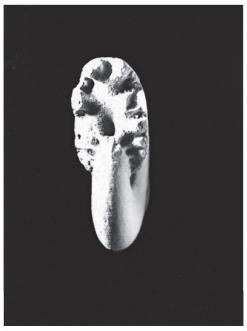


Fig. 2

Fig. 3

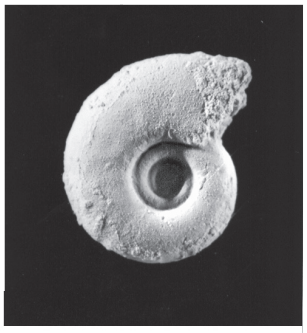


Fig. 4

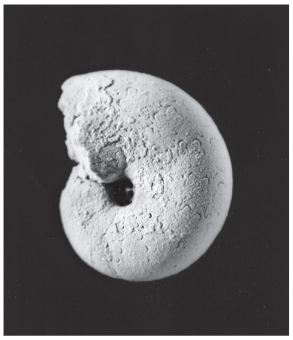


Fig. 5

Fig. 6

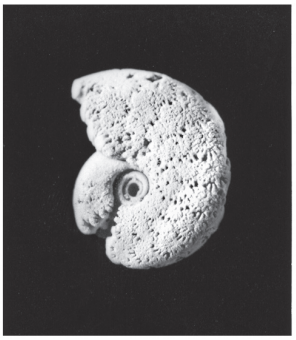


Fig. 7

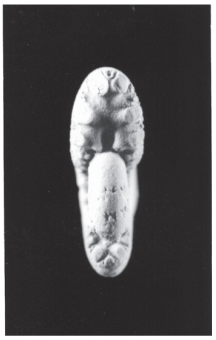


Fig. 8

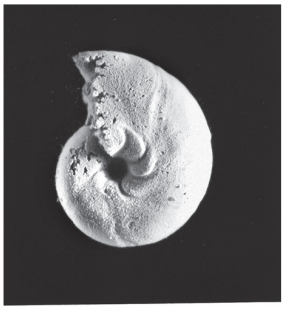


Fig. 9

Fig. 10

Fig. 11

Fig. 12

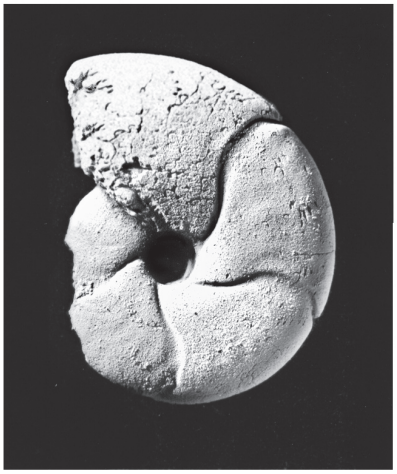


Fig. 13

Fig. 14

Fig. 15

Plate 2

- **Figs. 1, 2.** *Neolissoceras grasianum* (d'Orbigny)
  1 – lateral view, 2 – a view of ventral side, ×2. Spec. 410, site Š-12, Plaňava Formation.
- **Figs. 3–8.** *Vergoliceras salinarium* (Uhlig)
  3 – lateral view, 4 – a view of ventral side, ×2. Spec. 412, site Š-54, Plaňava Formation; 5 – lateral view, 6 – a view of ventral side, ×2. Spec. 296, site Š-12, Plaňava Formation; 7 – lateral view, 8 – a view of ventral side, ×2. Spec. 148, Col. Remeš, Kopřivnice Formation.
- **Fig. 9.** *Subthurmannia* cf. *boissieri* (Pictet)
  Lateral view of a whorl fragment, ×1. Spec. 199, site Š-53, Čupek Limestone.
- **Figs. 10, 11.** *Thurmanniceras thurmanni* (Pictet & Campiche)
  10 – a view of ventral side, 11 – lateral view, ×1. Spec. 178, site Š-45, Plaňava Formation.
- **Figs. 12, 13.** *Thurmanniceras* cf. *pertransiens* (Sayn)
  12 – lateral view of a corroded fragment, 13 – a view of ventral side, ×1. Spec. 352, Col. Silesian Museum in Opava, Kopřivnice Formation.
- **Fig. 14.** *Thurmanniceras* sp.
  Lateral view of an incomplete shell, ×1. Spec. 196, site Š-59, Kopřivnice Formation.
- **Figs. 15, 16.** *Kilianella roubaudiana* (d'Orbigny)
  15 – lateral view, 16 – a view of ventral side, ×2. Spec. 216, site Š-12, Plaňava Formation.

Photos by K. Mezihoráková, Ostrava University. Specimens were bleached by ammonium chloride before photographing. All material, except for the specimens borrowed, is kept in the collections of the Institute of Geology, Academy of Sciences of the Czech Republic in Prague.

■ **Plate 2**

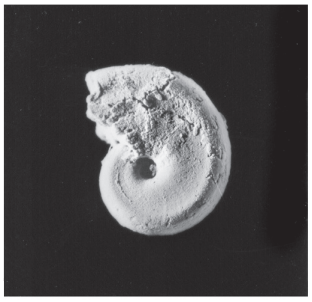


Fig. 1

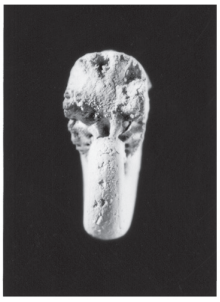


Fig. 2

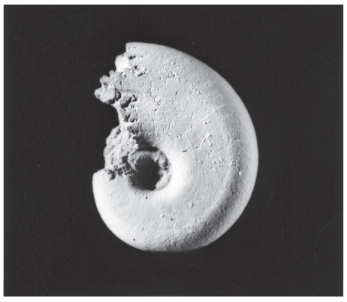


Fig. 3

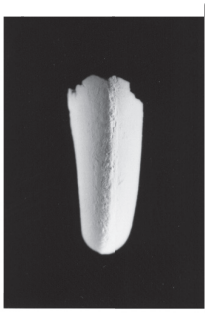


Fig. 4

Fig. 5

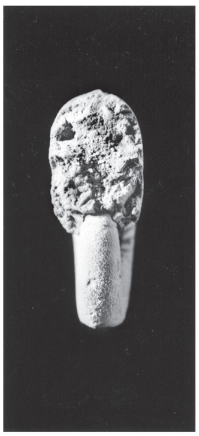


Fig. 6

Fig. 7

Fig. 8

Fig. 9

Fig. 12

Fig. 13

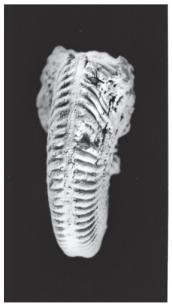


Fig. 10

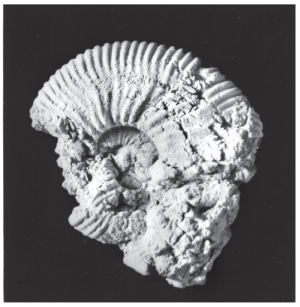


Fig. 11

Fig. 14

Fig. 15

Fig. 16

Plate 3

- **Fig. 1.** *Kilianella* cf. *clavicostata* Nikolov
  Lateral view of a corroded fragment; ×2. Spec. 210, Lower Blücher Quarry, Kopřivnice Formation.
- **Figs. 2, 3.** *Kilianella* cf. *clavicostata* Nikolov
  2 – lateral view, 3 – a view of ventral side of a corroded fragment; ×2. Spec. 209, Col. Andrusov, Kopřivnice Formation.
- **Figs. 4, 5.** *?Kilianella* sp. ind.
  4 – lateral view, 5 – a view of ventral side, ×2. Spec. 225, Kopřivnice Formation.
- **Figs. 6, 7.** *Neocomites neocomiensis* (d'Orbigny)
  6 – a view of ventral side, 7 – lateral view, ×2. Spec. 170, site Š-24b, Plaňava Formation.
- **Figs. 8, 9.** *Sarasinella* sp. ind.
  8 – lateral view, 9 – a view of ventral side, ×3. Spec. 416, site Š-55, Plaňava Formation.
- **Figs. 10, 11.** *?Sarasinella* sp. juv.
  10 – lateral view of a juvenile shell, 11 – a view of ventral side, ×4. Spec. 233, site Š-12, Plaňava Formation.
- **Figs. 12, 13.** *Neohoploceras* sp. juv.
  12 – lateral view, 13 – a view of ventral side, ×2. Spec. 421, site Š-12, Plaňava Formation.
- **Fig. 14.** *Neocomites teschenensis* (Uhlig)
  Lateral view of a crushed shell, ×1. Spec. 415, site Š-55, Plaňava Formation.

Photos by K. Mezihoráková, Ostrava University. Specimens were bleached by ammonium chloride before photographing. All material, except for the specimens borrowed, is kept in the collections of the Institute of Geology, Academy of Sciences of the Czech Republic in Prague.

■ **Plate 3**

Fig. 1

Fig. 2

Fig. 3

Fig. 6

Fig. 4

Fig. 5

Fig. 7

Fig. 8

Fig. 9

Fig. 10

Fig. 11

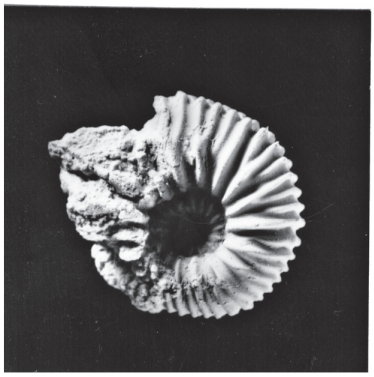


Fig. 12

Fig. 13

Fig. 14

Plate 4

- **Figs. 1–4.** *Karakaschiceras* ex gr. *quadristrangulatum* (Sayn)
  1 – lateral view of the left side of a whorl fragment, 2 – a view of ventral side, 3 – lateral view of the right side, ×1; 4 – cross section of the whorl, ×2. Spec. 172, Lower Blücher Quarry, Kopřivnice Formation.
- **Figs. 5, 6.** *Stoicoceras* sp.
  5 – a view of ventral side, 6 – lateral view, ×2. Spec. 231, Lower Blücher Quarry, Kopřivnice Formation.
- **Figs. 7–9.** *Olcostephanus (Olcostephanus)* sp. juv.
  7 – a view of the ventral side with incipient ribbing, 8 – lateral view of the right side of the whorl with a constriction and of umbilical tubercles around inner half of the whorl, ×3; 9 – lateral view of the left side with umbilical tubercles on the terminal part of the whorl, ×2. Specimen borrowed from Geršl, site Š-12, Plaňava Formation.
- **Figs. 10, 11.** *Olcostephanus (Olcostephanus)* ex gr. *stephanophorus* (Matheron)
  10 – lateral view, 11 – a view of ventral side, ×3.5. Spec. 158, site Š-12, Plaňava Formation.

Photos by K. Mezihoráková, Ostrava University, and J. Brožek (Plate 4, Figs. 10, 11). Specimens were bleached by ammonium chloride before photographing. All material, except for the specimens borrowed, is kept in the collections of the Institute of Geology, Academy of Sciences of the Czech Republic in Prague.

■ **Plate 4**

Fig. 1

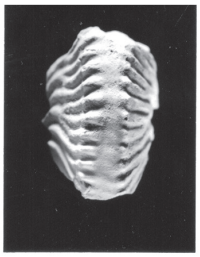


Fig. 2

Fig. 3

Fig. 4

Fig. 5

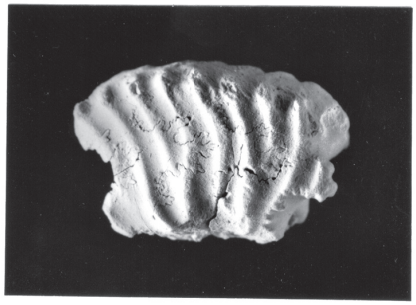


Fig. 6

Fig. 7

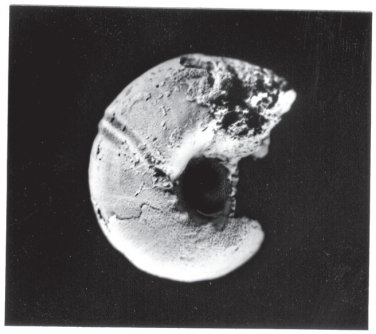


Fig. 8

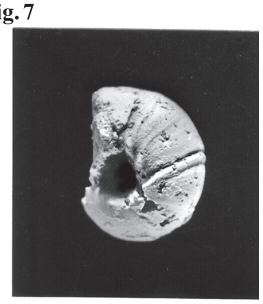


Fig. 9

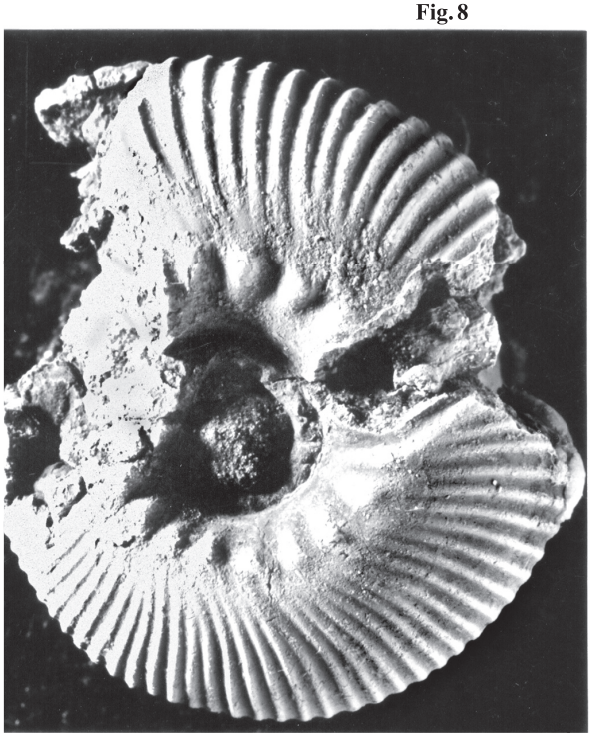


Fig. 10

Fig. 11

Plate 5

- **Fig. 1.** *Criosarasinella* cf. *furcillata* Thieuloy
  Lateral view of a deformed shell, ×1. Spec. 417, site Š-64, Plaňava Formation.
- **Fig. 2.** *?Endemoceras* cf. *amblygonium* (Neumayr & Uhlig)
  A view of a series of ventrolateral tubercles, ×1. Spec. 418, site Š-55, Plaňava Formation.
- **Fig. 3.** *Breistrofferella* sp.
  Lateral view of a strongly deformed shell, ×1. Spec. 422, site Š-55, Plaňava Formation.
- **Fig. 4.** *?Acanthodiscus* sp.
  Lateral view of a strongly deformed shell, ×1. Spec. 424, site Š-55, Plaňava Formation.
- **Figs. 5, 6.** *Valanginites* cf. *bachelardi* (Sayn)
  5 – lateral view of a separated inner whorl, ×4; 6 – a view of the ventral side of the last whorl, ×6. Spec. 159, site Š-11 b, Plaňava Formation.
- **Figs. 7, 8.** *Valanginites* sp. juv.
  7 – lateral view of an incomplete shell, 8 – a view of ventral side, ×3. Spec. 426, site Š-56, Plaňava Formation.
- **Figs. 9, 10.** *Saynoceras verrucosum* (d'Orbigny)
  9 – lateral view, 10 – a view of ventral side; ×3. Spec. 429, site Š-55, Plaňava Formation.
- **Fig. 11.** *Saynoceras verrucosum* (d'Orbigny)
  Lateral view, ×3. Spec. 430, site Š-55, Plaňava Formation.

Photos by K. Mezihoráková, Ostrava University, and J. Brožek (Plate 5, Fig. 6). Specimens were bleached by ammonium chloride before photographing. All material, except for the specimens borrowed, is kept in the collections of the Institute of Geology, Academy of Sciences of the Czech Republic in Prague.

■ **Plate 5**

Fig. 1

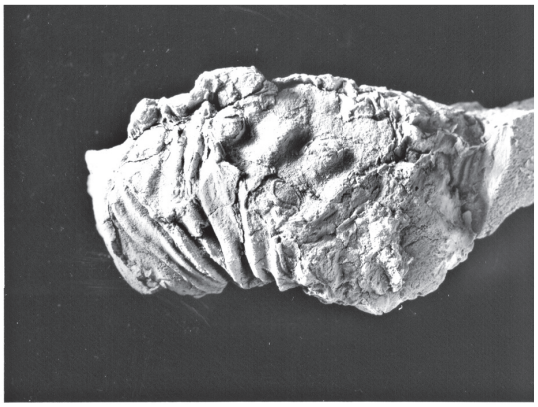


Fig. 4

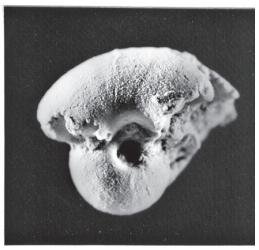


Fig. 7

Fig. 2

Fig. 3

Fig. 8

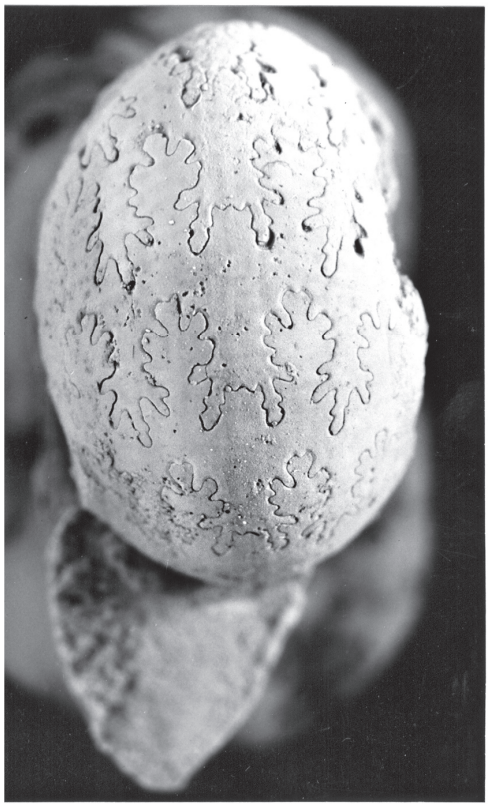


Fig. 6

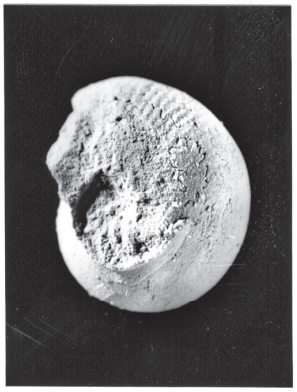


Fig. 5

Fig. 10

Fig. 9

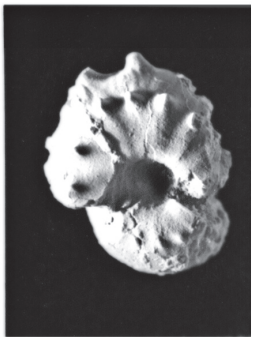


Fig. 11

Plate 6

- **Fig. 1.** *Valanginites wilfridi* (Karakasch)
  Lateral view of a strongly deformed shell with isolated peristome; ×1. Spec. 425, site Š-55, Plaňava Formation.
- **Fig. 2.** *Prodichotomites* ex gr. *complanatus* (Koenen)
  Fragment of an adult whorl crushed onto bedding plane; ×1. Spec. 436, site Š-55, Plaňava Formation.
- **Fig. 3.** *Prodichotomites* ex gr. *complanatus* (Koenen)
  Deformed, partly pyritized shell, ×4. Spec. 324, site Š-55, Plaňava Formation.
- **Figs. 4, 5.** *Prodichotomites* ex gr. *complanatus* (Koenen)
  4 – lateral view, 5 – a view of ventral side, ×3. Spec. 323, site Š-44, Plaňava Formation.
- **Fig. 6.** *Platylenticeras* ex gr. *marcousianum* (d'Orbigny)
  Fragment of an adult whorl, ×1. Spec. 160, site Š-12, Plaňava Formation.
- **Figs. 7, 8.** *Platylenticeras* sp.
  7 – lateral view, 8 – a view of ventral side, ×1. Spec. 161, Lower Blücher Quarry, Kopřivnice Formation.
- **Figs. 9, 10.** *Protancyloceras* cf. *punicum* Arnould-Saget
  9 – lateral view, 10 – a view of ventral side, ×3. Spec. 223, site Š-20, Gloriet Formation.
- **Figs. 11, 12.** *Bochianites oosteri* Sarasin & Schöndelmayer
  11 – a view of ventral side, 12 – a view of dorsal side, ×3. Spec. 320, site Š-45, Plaňava Formation.
- **Fig. 13.** *Baculina rouyana* (d'Orbigny)
  Lateral view, ×3. Spec. 440, site Š-45, Plaňava Formation.
- **Figs. 14, 15.** *Bochianites neocomiensis* (d'Orbigny)
  14 – a view of ventral side, 15 – lateral view, ×3. Spec. 437, site Š-65, Plaňava Formation.

Photos by K. Mezihoráková, Ostrava University, and J. Brožek (Plate 6, Fig. 3). Specimens were bleached by ammonium chloride before photographing. All material, except for the specimens borrowed, is kept in the collections of the Institute of Geology, Academy of Sciences of the Czech Republic in Prague.

■ **Plate 6**

Fig. 1

Fig. 2

Fig. 3

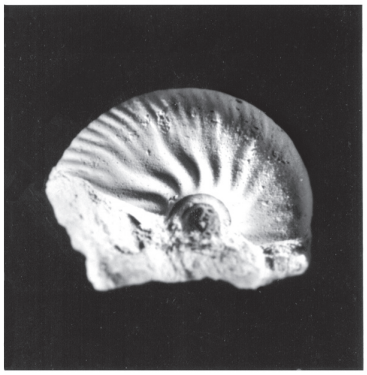


Fig. 4

Fig. 5

Fig. 6

Fig. 7

Fig. 8

Fig. 9

Fig. 10

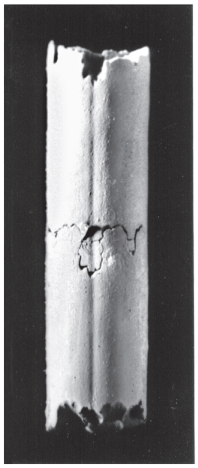


Fig. 11

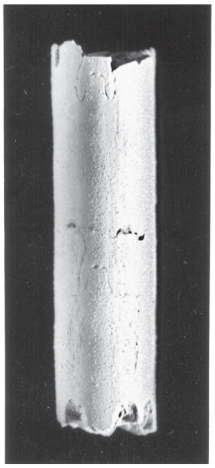


Fig. 12

Fig. 13

Fig. 14

Fig. 15