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Early Cretaceous ammonites from the Butkov Quarry (Manín Unit, Central Western Carpathians, Slovakia)

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ABSTRACT:

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The taxonomic and stratigraphic study of rich ammonite material from the Lower Cretaceous deposits of the Butkov Quarry, near Ladce (Manín Unit, Slovak Central Carpathians) is presented. More than 55 ammonite species are recognised and twenty-one biostratigraphically significant ammonite species are described, with one species, *Sarasinella subdensicostata*, described as new. The recognised taxa document an interval from the Upper Valanginian through to the Lower Hauterivian. The ammonite assemblage represents the Mediterranean bioprovince, with only a single species, *Dichotomites evolutus*, from the Boreal bioprovince. A new ammonite zone, the *Teschenites flucticulus* Zone, is proposed for the basal Hauterivian in the Western Carpathians.

Key words: Western Carpathians; Manín Unit; Upper Valanginian; Lower Hauterivian; Ammonites.

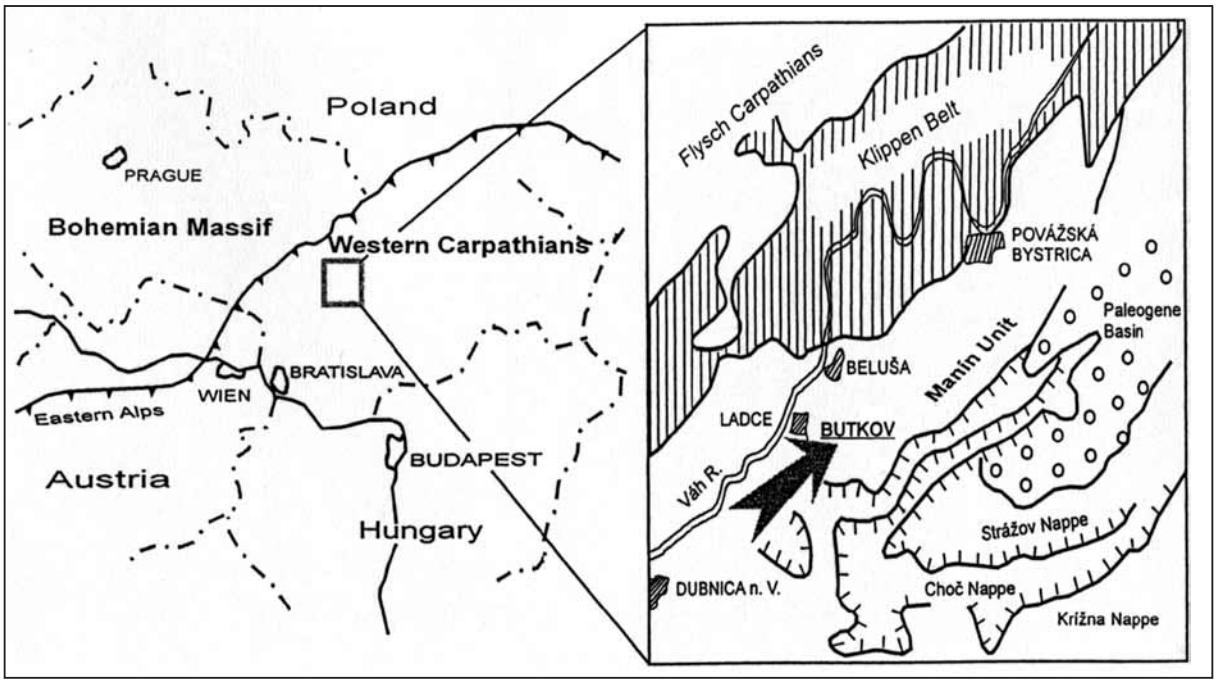
INTRODUCTION

For over 20 years researchers from the Geological Institute of the Slovak Academy of Sciences, of the Komenský University in Bratislava, and from the Technical University of Ostrava have carried out integrated sedimentological, palaeontological and biostratigraphical investigations of the Valanginian to Barremian (Lower Cretaceous) deposits of the Manín Unit, exposed in the Butkov Quarry, near the towns of Ilava and Dubnica (Vašíček and Michalík 1986; Borza *et al*. 1987; Michalík and Vašíček 1987; Michalík *et al*. 1990; Vašíček *et al*. 1994; Michalík *et al*. 1995; Vašíček 1997; Skupien and Vašíček 2002; Skupien *et al*. 2003 a, b; Michalík *et al*. 2005; Vašíček 2005, 2006). The biostratigraphy is based primarily on ammonites; however, micropalaeontological documentation based on calpionellids, calcareous and non-calcareous nannoplankton has also been undertaken.

The relative abundance of ammonites makes the Butkov succession of extreme importance for the recognition of their palaeontological record and stratigraphical potential. The taxonomy and discussion of the biostratigraphy of the ammonite material from the quarry is the aim of the present paper. The material described comes primarily from exploitation Level 10 of the quarry, which spans the Upper Valanginian and Lower Hauterivian, although finds from other levels are also included.

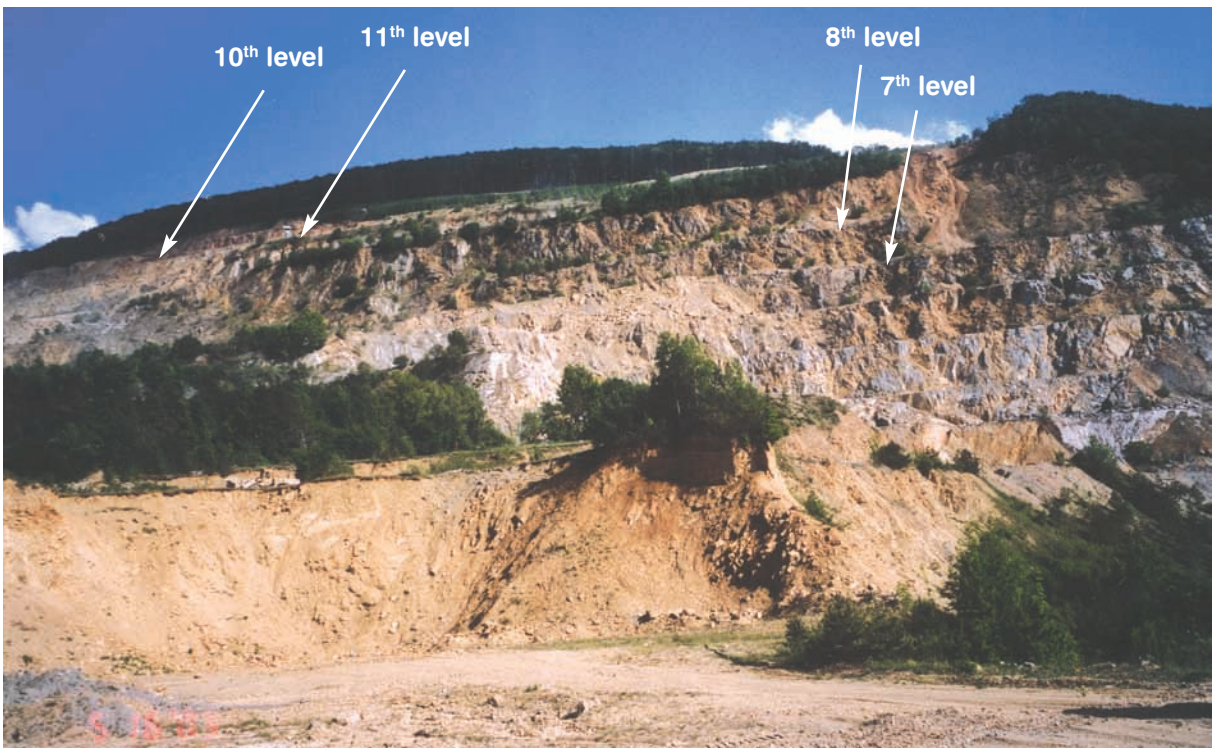
GEOLOGICAL SETTING

The Butkov Quarry (Text-fig. 1) is situated near the town of Ladce, c. 10 km NE of the town of Dubnica



Text-fig. 1. Geographic and geological location of the Butkov Quarry

upon Váh. The exposed Lower Cretaceous marly-calcareous succession belongs to the Manín Unit of the western margin of the Central Western Carpathians. The unit is here in tectonic contact with the Pieniny Klippen Belt. The structural problems in the interpretation of the Manín Nappe in the Carpathian System were discussed by Michalík and Vašíček (1987), and are not repeated herein. Palaeogeographically, Vašíček and



Text-fig. 2. General view of the Butkov Quarry (as in the year 2003). Arrows indicate the position of exploitation Levels 7, 8, 10 and 11

Text-fig. 3. The succession of exploitation Level 10 (photo J. Michalík, 2007)

Michalík (1999) interpret the Manín Unit as a part of the Fatric Superunit, extending along its western margin.

Borza *et al*. (1987) subdivided the Lower Cretaceous succession exposed in the Butkov Quarry (Text-fig. 2) into several lithostratigraphic units. The Cretaceous, which overlies the Late Jurassic limestone (Tithonian; see Michalík *et al*. 1999) with a small hiatus, starts with a 1–5 m thick basal breccia (Michalík *et al*. 2005). The breccia is followed by flesh-coloured marly pelagic limestones of the Ladce Formation (Borza *et al*. 1987), covered, in turn, by grey-coloured marly-calcareous, usually spotted deposits of the Mráznica Formation (Borza *et al*. 1987). The Mráznica Formation is followed by a layer of sandy-calcareous turbidite overlain by pale grey limestones with so-called contour cherts passing up into brown-grey limestones with cherts, all belonging to the Kališčo Formation (Borza *et al*. 1987).

The continuous succession exposed on exploitation Level 10 begins in the upper part of the Ladce Formation and continues up to the Kališčo Formation (Text-figs 3, 4). The latter is incomplete, with its upper part cut out tectonically. The succession exposed on Level 10 is 175 m thick. The GPS coordinates of the southern end of the Level are: 49°01'38'' N, 018°19'47'' E (582 m above sea level); and of the northern end: 49°01'30''N, 018°19'46''E (592 m above sea level). Its lower part, up to 140 m thick, is fossiliferous (see Text-fig. 4).

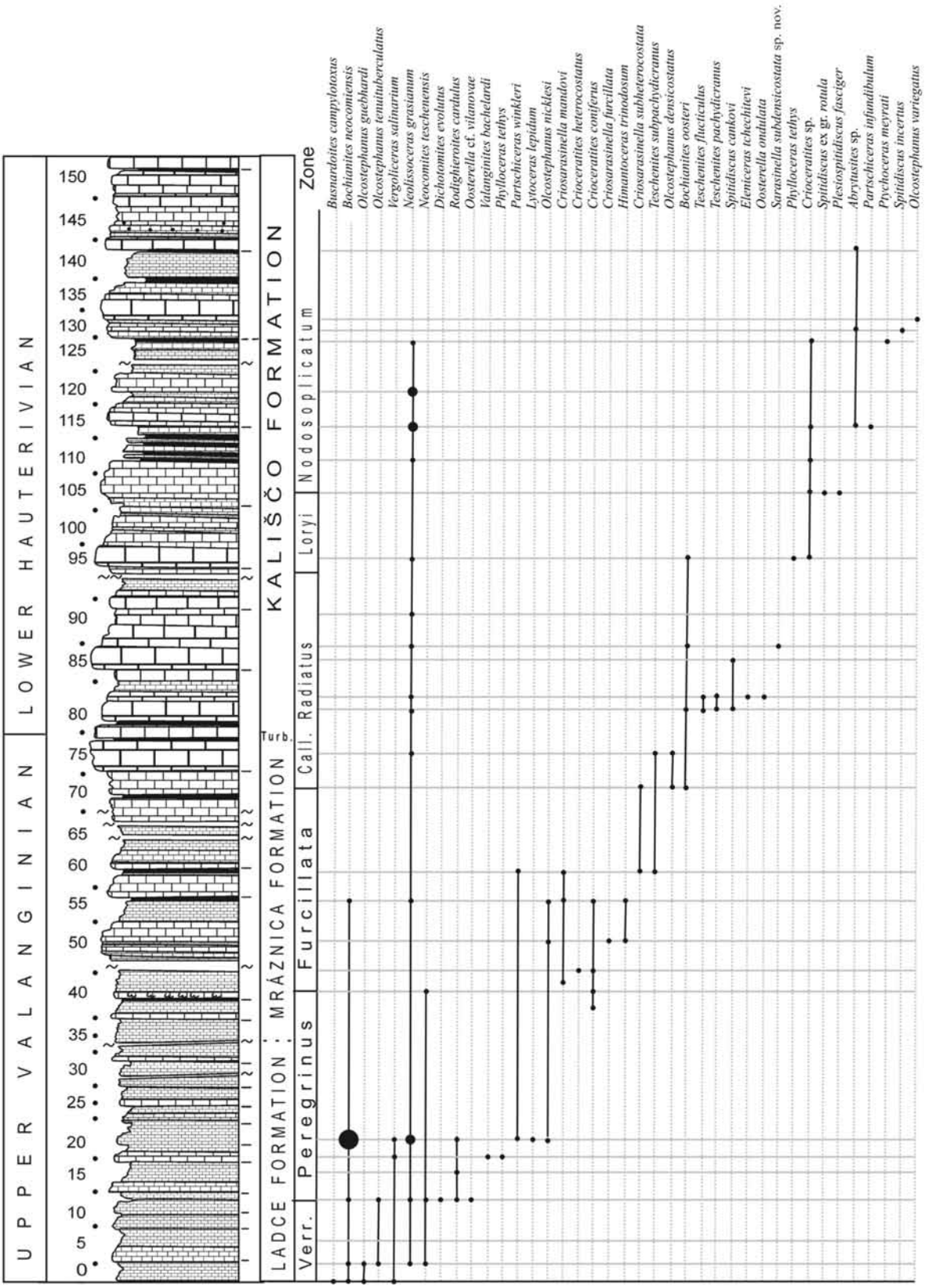
TAXONOMIC SECTION

The ammonite classification used herein follows Wright *et al*. (1996), with modifications after *Fossilium Catalogus of Lower Cretaceous ammonites* (Klein 2005; Klein and Vermeulen 2006 and Klein *et al*. 2007). Following Vermeulen (2007), the family Holcodiscidae, classified earlier in the superfamily Perisphinctoidea, is regarded as belonging to the superfamily Silesitoidea.

The synonymies given with the species descriptions include only papers with the original description or first revision, plus selected most important references. Full synonymy lists are to be found in the *Catalogus*.

The dimensions measured and simple ratios are as follows: D – shell diameter, H – whorl height, U – umbilicus width; H/D and U/D.

Order Ammonitida Agassiz, 1847
Suborder Ammonitina Hyatt, 1889



Text-fig. 4. The succession of exploitation Level 10; geological log, bio- and lithostratigraphy, and ammonite ranges; largest circles – mass-occurrence, medium-sized circles – abundant; turb. – turbidite

Superfamily Perisphinctoidea Steinmann, 1890
Family Olcostephanidae Haug, 1910
Subfamily Spiticeratinae Spath, 1924

Genus *Spiticeras* Uhlig, 1903
Subgenus *Spiticeras* Uhlig, 1903

TYPE SPECIES: *Ammonites spitiensis* Blanford, 1864.

Spiticeras simplicostatum Nikolov, 1960
(Pl. 1, Fig. 1)

1960. *Spiticeras simplicostatum* n. sp.; T. G. Nikolov, pp. 191–192, pl. 26, fig. 1.
1967. *Spiticeras* (*Spiticeras*) *simplicostatum* Nikolov; N. Dimitrova, pp. 88–89, pl. 43, fig. 2.

MATERIAL: A single, strongly deformed shell with a filled umbilicus, compressed flat (BK7Z-44/1 = SNM Z 24706).

DESCRIPTION: The shell is large, semi-involute, with a wide umbilicus, ending in the area of the peristome as indicated by the final constriction. The ribs are rather strong. The primary ribs are retroverse and have the character of bullate tubercles in the periumbilical region. Three ribs usually arise from the tubercles. The anterior rib is usually simple; the two posterior ribs arise together from a single point. There is usually one inserted rib between bundles of ribs. On the whorl flanks the ribs do not bifurcate and no inserted ribs occur.

MEASUREMENTS: The maximum diameter of the shell is 110 mm. At D = 108.5 mm, H = 36.0 (0.33), U = 44.0 (0.405). There are 26 umbilical tubercles on the last whorl and 65 ribs on the ventral side of the last half-whorl.

REMARKS: The characteristic features of the species are: shell size, rather evolute coiling and simple ribbing. Unfortunately, the specimen does not preserve the umbilical and lateral tubercles of the early whorls, which are one of the main diagnostic features of *Spiticeras*.

S. simplicostatum resembles some of the specimens of *S. multiforme*, as illustrated by Djanélidzé (1922). The latter differ, however, in a narrower umbilicus (with U/D approximately 0.35) and fewer primary ribs (18 per whorl).

OCCURRENCE: The Butkov specimen comes from the Upper Berriasian of the Ladce Formation; westernmost part of exploitation Level 7 (44 metre level of the succession). Besides Butkov, *S. simplicicostatum* is known from the *Subthurmannia boissieri* Zone of the Upper Berriasian of Bulgaria.

Subfamily Olcostephaninae Haug, 1910

Genus *Olcostephanus* Neumayr, 1875

TYPE SPECIES: *Ammonites astierianus* d'Orbigny, 1840.

Olcostephanus tenuituberculatus Bulot, 1990
(Pl. 1, Figs 5, 6)

1987. *Olcostephanus astierianus* d'Orbigny; M. Company, pp. 166–168, pl. 16, figs 1–11.
2005. *Olcostephanus tenuituberculatus* Bulot; J. Klein, p. 100 (cum syn.).

MATERIAL: Three microconchs, represented by flat deformed sculptured moulds (BK11-29/14; BK11-29/28 = SNM Z 24707; BK10/11p-04/3 = SNM Z 24708) and one macroconch, compressed laterally (BK10/11n-04/20 = SNM Z 24709).

DESCRIPTION: The microconchs are small in size, with a medium-wide umbilicus. The primary ribs are prominent and short, slightly concave, bent towards the mouth. They end in very narrow periumbilical tubercles from which arise three, but most often four, secondary ribs. Some of them bifurcate in the immediate vicinity of the tubercles, some of them higher. Bundles of ribs are usually intercalated with one inserted rib. On the body chamber the ribs are proverse and arcuated near the mouth. The shell of the largest specimen ends with a wide constriction, after which the peristome probably followed.

The diameter of the macroconch is about 60 mm. The primary ribs are indistinct particularly on the last half-whorl. They end in tiny conical tubercles. Three to four ribs bifurcating at various heights on the whorl flanks arise from the tubercles. There are one to two inserted ribs between the bundles of ribs. There are two constrictions on the last whorl.

MEASUREMENTS: The microconch Z 24707 has its maximum diameter slightly exceeding 36 mm. At D = 36 mm its H is about 15 mm (0.42) and U = 10.4 (0.29). There are 20 primary ribs on the last whorl and 46 ribs on the circumference of the last half-whorl. The macroconch has at D = 58.0 mm (measured between

the main axes of deformation), H = 19.0 mm (0.33) and U = 20.5 mm (0.35). There are 26 primary ribs on the last whorl and 72 peripheral ribs on the last half-whorl.

REMARKS: *O. balestrai* (Rodighiero, 1919) differs in a narrower umbilicus and in the lack of inserted ribs. The *O.* aff. *tenuituberculatus* illustrated by Wippich (2001, pl. 11, figs 6, 7) seems to be closer to *O. densicostatus* (Wegner), or to *O. balestrai* (Rodighiero) – pl. 11, fig. 11.

OCCURRENCE: The species is known from the topmost part of the *Vergoliceras salinarium* Zone and from the *Saynoceras verrucosum* Zone (uppermost Lower and basal Upper Valanginian) of the Betic Cordillera, Spain (Company 1987), and from the *Busnardoites campylotoxus* and *Verrucosum* zones of France (Bulot 1990; Bulot and Thieuloy 1995). Wippich's (2001) report of *O.* aff. *tenuituberculatus* from the somewhat younger *Neocomites peregrinus* Zone of Morocco is not included in the synonymy of the species. In Butkov, the species ranges from the *Saynoceras verrucosum* Zone to the base of the *Criosarasinella furcilliata* Zone (Upper Valanginian) of the Ladce and basal Mráznica formations (Level 10; 3 and 13.5 metre levels of the succession; Level 11; 29 metre level of the succession).

Olcostephanus densicostatus (Wegner, 1909)
(Pl. 2, Fig. 1)

1909a. *Astieria Atherstoni* var. *densicostata* n. v.; R. N. Wegner, p. 82, pl. 16, fig. 3.
1909b. *Astieria Atherstoni* var. *densicostata* n. v.; R. N. Wegner, p. 661, pl. 1, fig. 3.
2005. *Olcostephanus densicostatus* (Wegner); J. Klein, pp. 84-86 (cum syn.).

MATERIAL: Five microconchs, represented by imperfectly preserved strongly deformed sculptured moulds (BK10–70/2; BK10-74/2 = SNM Z 24710; BK 11-29/6 = SNM Z 24711; BK11-29/12 = SNM Z 24712; BK11-29/16).

DESCRIPTION: The species is represented by one juvenile and four medium-sized (D up to 55 mm) specimens. The umbilicus is rather wide. The shells bear thin and densely spaced ribs on the phragmocone. On the inner whorls, four secondary ribs (sometimes only three or five) usually arise from the periumbilical tubercles. The number of secondary ribs increases towards the circumference by the bifurcation of at least one of the ribs; either two ribs arise together from the base of the tubercle or one of the secondary ribs bifurcates at one third of the whorl height. Between bundles of ribs, one inserted rib is regularly intercalated.

Ribs on the body chamber are stronger and sparser. The primary ribs are retroverse to bent concavely towards the mouth. They end in rather elongated periumbilical tubercles, from which three to four secondary ribs usually arise. Between bundles of ribs there are one to two inserted ribs. There are three constrictions on the last whorl of Z 24711.

MEASUREMENTS: Z 24711, with maximum diameter of about 58 mm, at D = 49.5 mm, H = 20.2 (0.41) and U = 17.8 (0.36). At D = 49.5 mm it bears 12 primary ribs, and 65 ribs on the circumference of the last half-whorl. Z 24712 bears 22 primary ribs on the last whorl.

REMARKS: The characteristic features of the species are thin and densely spaced secondary ribs on the phragmocone and constrictions on microconchs. Some secondary ribs bifurcate at various whorl heights. The controverse running of retroverse primary and proverse secondary ribs especially at the end of the body chamber are of importance.

Wegner's holotype (1909a) bears less numerous primary ribs (about 17 according to the original illustration); the other specimens described, including the Slovak ones, have a higher primary rib density (more than 20 per whorl).

OCCURRENCE: As stated by Reboulet (1996), *O. densicostatus* ranges from the topmost part of the *Olcostephanus nicklesi* Subzone, the uppermost part of the *Neocomites peregrinus* Zone (Upper Valanginian) to the base of the *Crioceratites loryi* Zone (Lower Hauterivian). The ranges given by Bulot (1990), Bulot and Thieuloy (1995), and Bulot *et al.* (1995) – condensed Upper Valanginian or the Valanginian / Hauterivian boundary – were not confirmed. Besides France, *O. densicostatus* is also known from the Eastern Alps (Switzerland), Spain and Morocco, as well as from the boreal Valanginian of England and Germany. In the Butkov section the species is known from Level 10 (70 and 74 metre levels of the succession, Mráznica Formation), *Criosarasinella furcillata* Zone, and from Level 11 (29 m level of the succession, Mráznica Formation), lower part of the *C. furcillata* Zone.

Olcostephanus guebhardi (Kilian, 1902)
(Pl. 1, Fig. 2, Pl. 2, Fig. 2)

1902. *Holcostephanus (Astieria) Guebhardi* n. sp.; W. Kilian, p. 866, pl. 57, figs 2 a, b.
2005. *Olcostephanus guebhardi* Kilian; J. Klein, p. 88–89 (cum syn.).

MATERIAL: Two microconchs (BK12-04/13 = SNM Z 24714, BK10-0/8, BK10/11-04/4) and one macroconch (BK12-04/10 = SNM Z 24713); all considerably deformed, sculptured moulds; also one fragment (BK10-0/4).

DESCRIPTION: The macroconch is characterized by a deep funnel-shaped umbilicus. The primary ribs are retroverse, strong. They end in distinct clubbed tubercles; nearer the mouth they end in tubercles of even triangular shape, from which arise four to five relatively sparse secondary ribs. One to two inserted ribs are intercalated between bundles of ribs. The ribs do not bifurcate. There are no constrictions.

The ornament of the microconchs is similar to that of the macroconch. However, only three secondary ribs arise from the tubercles. There is one inserted rib between bundles of ribs.

MEASUREMENTS: Macroconch at D = 77.3 mm shows H = 37.1 (0.48) and U = 18.0 (0.23). On the last whorl, there are 23 primary ribs and 65 secondary ribs on the circumference of the last half-whorl. The strongly deformed microconch (Z 24714) reaches a diameter of about 56 mm. On the last half-whorl there are 11 primary ribs, to which 49 ribs on the circumference correspond.

REMARKS: This species is variable in sculpture (see e.g. Bulot, 1990, 1992) and is characterized by relatively sparse, non-bifurcated ribs.

OCCURRENCE: *O. guebhardi* is reported from the upper *Busnardoites campylotoxus* and the *Saynoceras verrucosum* zones of the upper Lower and lower Upper Valanginian. It is noted widely in the Mediterranean province: Bulgaria, Eastern Alps, Switzerland, France, Spain, Morocco. It is also known from Germany and, probably, from the Alexander Island, Antarctica. In Butkov, the species occurs at the Lower/Upper Valanginian boundary of the Ladce Formation (debris material on Level 12 and from the 0–3 metre interval of the succession on Level 10).

Olcostephanus nicklesi Wiedmann and Dieni, 1968
(Pl. 1, Figs 3, 4)

1968. *Olcostephanus (Subastieria) nicklesi* nov. sp.; J. Wiedmann and I. Dieni, pp. 97–98, pl. 12, fig. 4, pl. 15, figs 1–3, text-fig. 67.
2005. *Olcostephanus nicklesi* Wiedmann and Dieni; J. Klein, p. 92–93 (cum syn.).

MATERIAL: Several small, usually fragmentarily preserved, considerably deformed sculptured moulds; BK11-29/17 = SNM Z 24715; BK11-C/3 = SNM Z 24716; BK10-55/9 and BK10-20-06/1 = SNM Z 24717 are the best preserved specimens (sometimes even with a preserved peristome).

DESCRIPTION: The microconchs have relatively low whorls and a wide umbilicus. The primary ribs (9–10 per half-whorl) end in periumbilical tubercles from which arise three, sometimes four, slightly flexuous secondary ribs that bifurcate sporadically. Bundles of ribs are usually intercalated with one inserted rib. The peristome possesses jugal apophyses.

MEASUREMENTS: In Z 24716, at D = 24.3 mm has H = 8.0 (0.33) and U = 10.6 (0.44). It bears nine primary ribs per half-whorl.

REMARKS: The species is characterized by a wide umbilicus and low whorls. The ribbing and number of secondary ribs varies to some extent.

OCCURRENCE: *O. nicklesi* is known from many localities in the Mediterranean bioprovince (Western Carpathians, Eastern Alps, Italy and Sardinia to France, Spain and Morocco). According to Reboulet (1996), it occurs in the Upper Valanginian in the *Olcostephanus nicklesi* Subzone (upper part of the *Neocomites peregrinus* Zone) and in the *Criosarasinella furcillata* Zone. In Butkov, it occurs in the higher part of the *N. peregrinus* Zone and in the *C. furcillata* Zone, Lower Valanginian (see also Vašíček *et al*. 1994), of the Ladce and Mráznica formations (Level 10, 20 and 55 metre levels of the succession; Level 11).

Olcostephanus variegatus (Paquier, 1901)
(Pl. 2, Fig. 5)

1901. *Holcostephanus variegatus* sp. nov.; V. L. Paquier, pp. 550–551, pl. 7, figs 1, 2.
2005. *Olcostephanus variegatus* Paquier; J. Klein, pp. 100–102 (cum syn.).

MATERIAL: A single considerably large sculptured mould (BK10-133/1 = SNM Z 24718).

DESCRIPTION: The specimen is a deformed shell with a relatively wide umbilicus. The primary ribs are initially indistinct, later distinct, bent concavely towards the mouth. Finally, the ribs form tubercle-like bulges. Fourteen primary ribs per last half-whorl. On the inner half-whorl, the number is smaller (about 10). Bundle ribs arising from the tubercles are considerably weakened on the flanks, and thus the number of these ribs is not clear. On the circumference, the ribs are proverse and slightly arcuated. Sporadically bifurcated ribs or short inserted ribs occur here. There are about 70 ribs on the circumference of the last half-whorl.

MEASUREMENTS: Maximum shell diameter is 83 mm.

OCCURRENCE: *O. variegatus* is the index species of the eponymous horizon in the lower part of the *Lyticoceras nodosoplicatum* Zone (Hoedemaeker *et al*. 2003; Reboulet *et al*. 2006). It occurs widely in the Mediterranean province; Western Carpathians (Eristavi 1961), Eastern Alps, Switzerland, France and Morocco. It is also known from England, Tanzania, Columbia and Argentina. In Butkov, *O. variegatus* was found in the *L. nodosoplicatum* Zone of the Kališčo Formation (Level 10, 133 metre level of the succession).

Genus *Jeannoticeras* Thieuloy, 1965

TYPE SPECIES: *Ammonites Jeannotii* d'Orbigny, 1841.

Jeannoticeras is often considered a subgenus of *Olcostephanus* (e.g. Wright *et al*. 1996; Busnardo in Fischer and Gauthier 2006). In accordance with Klein (2005), I regard *Jeannoticeras* as an independent genus.

Jeannoticeras jeannoti (d'Orbigny, 1841) (Pl. 2, Fig. 6)

1841. *Ammonites Jeannotii*, d'Orb. N.; A. d'Orbigny, p. 188–190, pl. 56, figs 3–5.
2005. *Jeannoticeras jeannoti* (Orbigny); J. Klein, p. 105 (cum syn.).
2006. *Olcostephanus (Jeannoticeras) jeannoti* (d'Orbigny); R. Busnardo in Fischer and Gauthier, p. 71, pl. 12, figs 8 a, b.

MATERIAL: A single macroconch represented by a fragment of a sculptured mould (BK7Z-s/4 = SNM Z 24719).

DESCRIPTION: The specimen is of medium size with an arched venter and slightly arched flanks passing continuously into a low umbilical wall. The primary ribs are distinct, retroverse, ending in indistinct tubercles elongated in the direction of the ribs. Two to three secondary ribs arise from the tubercles. They are slightly proverse, gently flexuous. Between bundles of ribs there is usually one inserted rib.

MEASUREMENTS: The whorl height of the incomplete shell is 33 mm; the umbilicus width is 17.5 mm.

OCCURRENCE: *J. jeannoti* is the index species of the eponymous subzone in the upper part of the Early Hauterivian *Crioceratites loryi* Zone (Hoedemaeker et *al*. 2003). It is known from Bulgaria, Eastern Alps, Italy, France, Spain and Morocco, and also from England. Andrusov and Scheibner (1960) listed the species from the Klippen Belt of the Western Carpathians. The Butkov specimen comes from the upper *Crioceratites loryi* Zone of the Kališčo Formation (debris near gallery No. 10 on Level 7).

Genus *Valanginites* Kilian, 1910

TYPE SPECIES: *Ammonites nucleus* Roemer, 1841.

Valanginites bachelardi (Sayn, 1889) (Pl. 2, Figs 3, 4)

1889. *Holcostephanus Bachelardi* nov. sp.; G. Sayn, pp. 679–680, pl. 17, figs 1 a, b.
2005. *Valanginites bachelardi* (Sayn); J. Klein, pp. 108–109 (cum syn.).

MATERIAL: A single incomplete, strongly deformed sculptured mould (BK10-17/2 = SNM Z 24720).

DESCRIPTION: The specimen, originally spheroidal, is of small diameter, with a narrow umbilicus, and is covered with equally thin and densely-spaced ribs, the majority of which bifurcate near the umbilicus.

REMARKS: Ploch (2003) considers *V. bachelardi* a synonym of *V. nucleus* (Roemer). The traditional view of Sayn (1889), Company (1987), and others is followed herein.

OCCURRENCE: Company (1987) reported *V. bachelardi* from the *Saynoceras verrucosum* Zone and its immediately overlying Upper Valanginian strata.

The species occurs in the *S. verrucosum* Zone and in the lower *Neocomites peregrinus* Zone in France (Bulot and Thieuloy 1995, tab. 3), Romania, Italy, France, Spain, and in boreal Poland (e.g. Ploch 2003). An imperfectly preserved specimen is known from the Lower Cretaceous of the Štramberk area (Outer Western Carpathians) (Houša and Vašíček 2005). The Butkov specimen comes from the *N. peregrinus* Zone of the Ladce Formation (Level 10, 17 metre level of the succession).

Family Neocomitidae Salfeld, 1921
Subfamily Neocomitinae Salfeld, 1921

Genus *Clavithurmannia* Thieuloy, 1979

TYPE SPECIES: *Clavithurmannia foraticostata* Thieuloy in Busnardo, Thieuloy, Moullade, 1979.

Clavithurmannia cf. *foraticostata* Thieuloy in Busnardo, Thieuloy, Moullade, 1979
(Pl. 2, Fig. 7)

1979. *Clavithurmannia foraticostata* n. sp.; J.-P. Thieuloy in Busnardo, Thieuloy, Moullade *et al*., pp. 43–45, pl. 1, figs 7, 8; pl. 2, fig. 1 (cum syn.).

MATERIAL: A single fragment of a deformed sculptured mould (BK7Z(02)~45/6 = SNM Z 24721) of an apparently large specimen, with part of the phragmocone and the beginning of the body chamber preserved.

DESCRIPTION: The shell is evolute, relatively tightly coiled, as indicated by the shallow furrow of the previous whorl. The ornament is composed of distinct, loosely spaced, trituberculate main ribs. At the early stage the ribs are straight; then they are inclined towards the mouth. After each main rib, there is a wide, shallow constriction, delimited by a simple, thin rib on the anterior side. A small number of inserted ribs occur between the main ribs and the associated depressions in the vicinity of the phragmocone; these ribs disappear on the body chamber. The maximum height of deformed whorl is 47 mm.

REMARKS: The studied fragment represents a part not preserved on the holotype. Because of its incomplete preservation it is left in open nomenclature.

OCCURRENCE: The species was originally described from the *Thurmanniceras otopeta* Subzone of the uppermost Berriasian of south-east France. The Butkov specimen comes from the basal part of the Ladce Formation, however, its exact stratigraphic position is unclear because this part of the succession is disturbed tectonically.

Genus *Rodighieroites* Company, 1987

TYPE SPECIES: *Rodighieroites cardulus* Company, 1987.

Rodighieroites cardulus Company, 1987
(Pl. 3, Figs 1–3)

1987. *Rodighieroites cardulus* nov. sp.; M. Company, pp. 160–161, pl. 12, figs 11, 12 a, b.
1996. *Rodighiroites belimelensis* (Mandov); S. Reboulet, pp. 99–100, pl. 5, figs 1–3.
2005. *Rodighieroites cardulus* Company; J. Klein, pp. 297–298 (cum syn.).

MATERIAL: Five microconchs (BK11/10-04/1, 10, 16, BK11/10-04/2 = SNM Z 24722, BK10-20-06/32) and one macroconch (BK10-15-06/2 = SNM Z 24723); all represented by laterally compressed, deformed sculptured moulds, with the inner whorls missing.

DESCRIPTION: The shells are evolute; because of deformation the original whorl sections cannot be determined. The microconchs bear sparse ribs of two types. The main ribs are strong and trituberculate. On the shell circumference, distinct spines corresponding to marginal tubercles are preserved in two cases. Between the main ribs, there are two inserted ribs on the early whorls, and three to four ribs on the later whorls. On the majority of these ribs there are tiny lateral and marginal tubercles.

The last half-whorl of the macroconch (Z 24723), the inner whorls of which have ornamentation similar to that of the microconchs, bears different ribbing from that of the previous whorls. It is characterized by sparse trituberculate main ribs, on the the anterior side of which there is a distinct shallow depression or constriction delimited on the anterior side by a thinner rib without tubercles. Thinner ribs are developed indistinctly between the trituberculate ribs in the vicinity of the phragmocone but disappear gradually towards the mouth.

MEASUREMENTS: The best preserved microconch (Z 24722), reaches a diameter of about 55 mm. At D = 54 mm (measured between the main deformation

axes), H = 21 (0.39) and U = 18.5 (0.34). The macroconch reaches a shell diameter of more than 120 mm.

REMARKS: The increasing number of inserted ribs with increasing shell diameter is one of the features differentiating *R. cardulus* from the closely related *R. belimelenis* (Mandov, 1976).

OCCURRENCE: *R. cardulus* occurs in the *Neocomites peregrinus* Zone of the Upper Valanginian (Reboulet 1996 and Wippich 2001). It is known from Romania, Italy, Eastern Alps, France, Spain and Morocco. The Butkov macroconch comes from the *N. peregrinus* Zone of the Ladce Formation (Level 10; 13.5, 15 and 20 metre levels of the succession).

Genus *Sarasinella* Uhlig, 1905

TYPE SPECIES: *Hoplites ambiguus* Uhlig, 1902.

REMARKS: The genus is characterized by an evolute, ribbed shell. Its juvenile whorls bear trituberculate major ribs. The lateral tubercles persist longer early in ontogeny then in later ontogenetic stages. The early ribs have bullate marginal tubercles.

OCCURRENCE: The genus starts in the Early Valanginian and ranges to the earliest Hauterivian; its main occurrence is in the Late Valanginian (e.g. Bulot et al. 1993; Reboulet 1996).

Sarasinella subdensicostata sp. nov.
(Pl. 4, Figs 1–3)

HOLOTYPE: Specimen SNM Z 24724, depicted here in pl. 4.

NAME DERIVATION: From Latin *densus* – dense and *costatus* – ribbed.

TYPE LOCALITY: Butkov Quarry, level 10; Lower Hauterivian, Kališčo Formation.

DIAGNOSIS: Shell evolute, small in size. Sculpture composed of dense ribs; the main trituberculate ribs initially alternate with secondary atuberculate ribs, after which equally strong, dense, S-shaped ribs arise from thin umbilical tubercles. Weak marginal tubercles occur periodically on some of the ribs of the last whorl.

MATERIAL: A single sculptured mould (holotype) compacted flat, with the juvenile whorls missing (BK10-87,5/6 = SNM Z 24724). The body chamber occupies the final quarter of the last whorl.

DESCRIPTION: The shell is small, evolute, with a slowly increasing whorl height. The umbilicus is wide. The sculpture is preserved from a diameter of about 9 mm. It consists of trituberculate main ribs. The umbilical tubercles are indistinct, the lateral and marginal are markedly stronger. Between the main ribs, two simple ribs are inserted. On one of them, a marginal tubercle, as strong as those on main ribs, may occur. At a shell diameter of about 15 mm, the lateral tubercles disappear. In ontogeny, the umbilical tubercles become more distinct and ribs become more S-shaped. From these tubercles arise paired ribs between which there are one or two simple inserted ribs. After a shorter part, in which the circumferential region of whorl is missing, the umbilical tubercles are dense. They are elongated (bullate) and bent concavely towards the aperture. From these tubercles arise paired ribs with no inserted ribs. All ribs are S-shaped and equally strong. On the shell circumference, in an interval after four or five ribs without tubercles, weak bullate marginal tubercles occur periodically on one of the ribs. In the final part, simple inserted ribs, which do not arise from tubercles, can be intercalated singly between the paired ribs. A shorter inserted rib may also occur sporadically on the external whorl side. In the final part, in an interval after five to six atuberculate ribs, there is a weak marginal tubercle on ribs that are as strong as the other ribs. The ribs are proverse and, at least in the final part of the shell, are not interrupted on the external side.

MEASUREMENTS: At D (close to maximum diameter) = 44.3 mm, its H = 17.6 (0.40) and U = 16.0 (0.36). There are 58 ribs on the external side of the last half-whorl.

REMARKS: The generic classification of this new species, represented by a microconch, remains a problem. Its characteristic features are the presence, on the juvenile whorls, of trituberculate main ribs which weaken early, and the lack of lateral tubercles. Thin ribs of equal strength on the remaining part of the shell arise largely in pairs from numerous tiny umbilical tubercles. On the circumference of the last whorl, tiny marginal tubercles occur on a rib after five to six inserted ribs without tubercles. Inserted as well as bifurcated ribs occur only exceptionally in the vicinity of the shell circumference. The ribbing of the juvenile whorls corresponds to the pattern in

Criosarasinella Thieuloy, 1977 or *Sarasinella*. The features of the last whorl, i.e. the lack of short inserted and bifurcated ribs and the presence of weak bullate tubercles on the circumference, make it close to the genus *Sarasinella*.

Sarasinella subdensicostata, as already indicated by the species name, resembles *S. densicostata* Imlay, 1960 in rib density. However, Imlay's species differs at a comparable shell diameter in sparser ribbing on the last half of the whorl (about 45 ribs in contrast to almost 60 ribs in *S. subdensicostata*) and by the fact that the ribs of *S. densicostata* do not bear any periodic bullate tubercles on the circumference.

S. subdensicostata also resembles *Sarasinella* aff. *varians* Uhlig (illustrated in Thieuloy 1977, pl. 5, fig. 1). However, the ribbing in the latter is sparser and more robust. Also, *S. subdensicostata* seem to be related to *Sarasinella* n. sp. 1 of Reboulet (1996, pl. 23, figs 9, 10), from the uppermost Valanginian. Reboulet's form differs in the later disappearence of lateral tubercles (at D about 25 mm compared to at D = 15 mm in *S. subdensicostata*) and by less flexuous ribs on the last whorl.

OCCURRENCE: The studied specimen comes from the upper *Acanthodiscus radiatus* (= *Teschenites flucticulus* in the Western Carpathians) Zone, Lower Hauterivian, of the Kališčo Formation (Level 10, 87.5 metre level of the succession).

Genus *Neocomites* Uhlig, 1905
Subgenus *Eristavites* Nikolov, 1966

TYPE SPECIES: *Neocomites platycostatus* Sayn, 1907.

Neocomites (*Eristavites*) *platycostatus* (Sayn, 1907)
(Pl. 4, Fig. 5)

1907. *Neocomites platycostatus* nov. sp.; G. Sayn, p. 33, pl. 3, fig. 1 a, b.
2001. *Neocomites (Neocomites) platycostatus* Sayn; M. Wippich, pp. 108–109, pl. 26, fig. 4, pl. 39, fig. 4, ?fig. 3 (cum syn.).
2005. *Neocomites (Eristavites) platycostatus* (Sayn); J. Klein, pp. 312–313 (cum syn.).

MATERIAL: Single macroconch fragment (ca. one quarter of last whorl), compressed flat, of a sculptured mould, with indistinct inner whorls (ex. BK12-v16/6 = SNM Z 24725).

DESCRIPTION: The specimen is represented by the last whorl, which has flat flanks and a rather high whorl section. It bears flat ribs that broaden markedly towards the venter. The ribs are S-shaped, with some slightly narrower. They arise in pairs from somewhat bullate umbilical tubercles. Some bear weak lateral tubercles which strengthen markedly towards the mouth. At this growth stage one or two ribs without tubercles appear. All ribs end in ventrolateral clavi. The siphonal region is smooth. The estimated complete diameter of the specimen is about 90 mm.

REMARKS: The well-preserved macroconch fragment shows well the typical ornament of the species. The fact that this is a macroconch is proved not only by its large diameter but also by the presence of trituberculate ribs. The macroconchs are reported very rarely; neither the specimen illustrated by Wippich (2001, pl. 39, fig. 3), because of its unclear ribbing and tubercles, nor the one figured by Reboulet (1996, pl. 6, fig. 1) is convincing.

OCCURRENCE: Reboulet (1996) reported *E. platycostatus* from the uppermost *Busnardoites campylotoxus* Zone and from the *Saynoceras verrucosum* Zone of the Valanginian. Reboulet *et al*. (2006), in the report on Valanginian ammonite zonation, regard the species an index taxon for the uppermost *B. campylotoxus* Zone of the uppermost Lower Valanginian. The species is known from France, Spain, Morocco, Bulgaria and the Klippen Belt in Slovakia. The Butkov macroconch comes from the *B. campylotoxus* Zone of the Ladce Formation (Level 12, layer 16). Its stratigraphical position is supported by the last occurrence of *Calpionellites darderi* in the underlying beds (14.5 metre).

Genus *Busnardoites* Nikolov, 1966

TYPE SPECIES: *Ammonites desori* Pictet and Campiche, 1860.

REMARKS: Baraboshkin and Mikhailova (2000) excluded the species *B. campylotoxus* (Uhlig) from the genus *Busnardoites*, and instead created a new genus *Campylotoxia*, based on Uhlig's (1902) species. According to them, their new genus differs from representatives of the genus *Busnardoites* in the ornament of its most juvenile whorls. However, because of the lack of information on the juvenile whorls in the Carpathian material (Busnardo et al. 2003 and Klein 2005), Uhlig's species *campylotoxus* is retained here in the genus *Busnardoites*.

The following description and the synonymy of *B. campylotoxus* are limited to macroconchs.

Busnardoites campylotoxus (Uhlig, 1902)
(Pl. 5, Fig. 4)

1991. *Busnardoites* gr. *campylotoxus* (Uhlig); M. Ettachfini, pl. 7, fig. 7 a, b.
1991. *"Busnardoites"* grandes affinités avec le gr. *campylotoxus*; M. Ettachfini, pl. 9, fig. 4.
1996. *Busnardoites campylotoxus* (Uhlig); S. Reboulet, pp. 54–56, pl. 17, fig. 1.
2004. *Busnardoites campylotoxus* (Uhlig); M. Ettachfini, pl. 16, fig. 7.

MATERIAL: Single macroconch preserved as a sculptured mould, represented by a fragment of body chamber (ex. BK12-v17/11 = SNM Z 24726).

DESCRIPTION: The height of the specimen is about 95 mm. It bears sparse, simple ribs, straight on the flanks but near the venter inclined markedly towards the mouth. The ribs are of two types of which the trituberculate main ribs predominate. They bear distinct umbilical tubercles, elongated in the direction of the ribs, strong, almost conical lateral tubercles and weak, rather clavate marginal tubercles. A single complete secondary rib bears a weak lateral tubercle and a weak marginal tubercle.

REMARKS: In the synonymy only macroconch specimens are listed. The most convincing is the specimen of Ettachfini (1991, pl. 9, fig. 4 and 2004, pl. 16, fig. 7), to which the Butkov fragment corresponds well. Whereas macroconchs of the species are rare the microconchs occur commonly.

OCCURRENCE: Macroconchs of *B. campylotoxus* are known from the upper *Busnardoites campylotoxus* Zone (uppermost Lower Valanginian) of southeastern France and the Atlas Mountains in Morocco. The studied specimen comes from the *B. campylotoxus* Zone of the Ladce Formation (Level 12, 17 metre level of the succession). This is supported by the last occurrence of *Calpionellites darderi* in the immediate underlying beds (14.5 metre). Microconchs of *B. campylotoxus* are known in the Butkov Quarry from the eponymous zone (Level 8; Level 10; the exit road from Level 10 to Level 11; and the exit from Level 12 to Level 13 – Vašíček 1997, and the new finds).

Busnardoites neocomiensiformis (Uhlig, 1902)
(Pl. 4, Fig. 4)

1902. *Hoplites neocomiensiformis* d`Orb. var. (*neocomiensiformis* Hohenegger msc.); V. Uhlig, p. 56, pl. 3, fig. 2, pl. 4, Fig. 11, ?pl. 3, fig. 1.
1989. *Busnardoites campylotoxus* (Uhlig); J. Michalík and Z. Vašíček, pl. 1 fig. 1.
1995. *Busnardoites campylotoxus* (Uhlig); Z. Vašíček, pl. 1, fig. 1.
2003. *Busnardoites neocomiensiformis* (Hohenegger); R. Busnardo *et al*., p. 43.
2005. *Busnardoites? neocomiensiformis* (Uhlig); J. Klein, pp. 323–324 (cum syn.).

MATERIAL: Three fragments of laterally compressed sculptured moulds. The largest specimen (illustrated in Michalík and Vašíček, 1989, pl. 1, fig. 1 as *Busnardoites campylotoxus* and again in Vašíček, 1995) has the juvenile whorls preserved as an imperfect imprint. Its last whorl, 2/3 of which belongs to the body chamber, has the peri-umbilicus area poorly preserved. The middle-sized specimen (BK13-04/2s = SNM Z 24727) represents a half-whorl, of which the body chamber occupies the greater part. The smallest fragment (BK13-04/3s = SNM Z 24728) is a phragmocone.

DESCRIPTION: The shells are semi-involute, with high whorls and a rather narrow umbilicus. The whorl sections and the inner whorls are imperfectly known. The ribbing of the phragmocone is formed by proverse, slightly S-shaped ribs. The ribs arise singly or in pairs from umbilical tubercles inclined towards the mouth. Each rib splits into two or three branches at around whorl mid-height. Single, short inserted ribs occur sporadically near the external side. All the ribs are equally strong on the circumference. The ribs are interrupted onto the external side. On the shell circumference, in the space delimited by two constrictions, there are about 11 distinct, slightly bent ribs inclined towards the mouth. The sculpture is different near the end of the phragmocone (shell diameter of about 40 mm) and especially on the body chamber. The only distinct features are very wide, triangular umbilical tubercles inclined obliquely towards the mouth and falcoid ribs on the shell circumference.

MEASUREMENTS: Z 24727 has a preserved maximum diameter of 52 mm. At D = 52.0 mm, H = 24.0 (0.46) and U = 12.2 (0.25). At the stated diameter, there are 11 to 12 umbilical tubercles and 39 ribs on the circumference of a half-whorl.

REMARKS: The characteristic feature of the described specimens is their considerably weakening ribbing on the flanks of adult shells. The juvenile whorls are either imperfectly preserved or are not preserved at all, as in the type specimen illustrated by Uhlig (1902).

In the type of ribbing the studied specimens greatly resemble some closely allied Valanginian representatives of *Karakaschiceras* Thieuloy, 1971 and *Bodrakiceras* Baraboshkin and Mikhailova, 2000, particularly the species *Bodrakiceras inostranzewi* (Karakasch, 1899). The latter species differs from *Busnardoites neocomiensiformis* in higher whorls (H/D = 0.53, according to Karakasch 1889) and in another type of ribbing and density of tubercles (at a comparable shell diameter, only 15 umbilical tubercles per whorl in the Karakasch specimens against more than 20 tubercles per whorl in *B. neocomiensiformis*). Representatives of *Bodrakiceras* and *Karakaschiceras* are generally characterized by more or less conspicuous constrictions, a narrow umbilicus and high whorls. The material from Butkov lacks constrictions, at least on adult whorls. The concept applied herein follows the interpretation of Busnardo (in Busnardo *et al*. 2003).

OCCURRENCE: The species is only definitely known from the latest Early Valanginian of the Western Carpathians. The precise stratigraphical location of the lectotype is unknown. Earlier, the species was commonly regarded as of Late Valanginian or Early Hauterivian age. However, according to Uhlig (1902), the type area (Dolní Třanovice, Silesian Unit, Outer Western Carpathians) provided almost exclusively Early Valanginian species. The specimens studied most probably come from the upper *Busnardoites campylotoxus* Zone of the Ladce Formation (Level 13). This dating is supported additionally by its co-occurrence with *Calpionellites darderi* Colom (identified by K. Borza in 1983) on Level 10 (94 metre level of the succession).

Family Oosterellidae Breistroffer, 1940
Genus *Oosterella* Kilian, 1911

TYPE SPECIES: *Ammonites cultratus* d'Orbigny, 1841.

Oosterella cultrataeformis (Uhlig, 1882)
(Pl. 3, Fig. 4)

1882. *Schloenbachia cultrataeformis* n. f.; V. Uhlig, p. 381, pl. 4, figs 1, 2.
2005. *Oosterella cultrataeformis* (Uhlig); J. Klein, pp. 382–383 (cum syn.).

MATERIAL: A single microconch, with imperfectly preserved juvenile whorls and an incomplete but better preserved last half-whorl that probably belongs to the body chamber (ex. BK11B/7 = SNM Z 24729).

DESCRIPTION: The shell is evolute, of small diameter, with high whorls. On the circumference of the shell there is a keel. The well-preserved final part of the last whorl bears simple, S-shaped ribs. They alternate with stronger ribs arising in pairs from indistinct umbilical tubercles. A single shallow constriction is preserved.

MEASUREMENTS: At D = 25.4 mm, H = 10.2 (0.40) and U = 9.7 (0.38).

REMARKS: *Oosterella cultrataeformis* differs from its close relative *O. cultrata* (d'Orbigny) in the presence of constrictions.

OCCURRENCE: Bulot and Thieuloy (1995) and Reboulet (1996) reported the species from the upper *Himantoceras trinodosum* Zone (i.e. *Criosarasinella furcillata* Zone in a modern concept), Upper Valanginian, to the *Acanthodiscus radiatus* Zone of the basal Hauterivian. It is known from Bulgaria (Western Balcanides), Hungary (Gerecse Mts.), Eastern Alps (e.g. Reichraming Nappe), Switzerland (Outer Pre-Alps), France (Vocontian Trough), and Morocco (Atlantic Atlas). In the Butkov section, the species occurs in the upper *C. furcillata* Zone of the Mráznica Formation (Level 11, horizon B = P2 in Vašíček 2005).

Oosterella cf. *vilanovae* (Nicklès, 1892)
(Pl. 5, Fig. 2)

1996. *Oosterella gaudryi* morphe *vilanovae*; S. Reboulet, pl. 28, fig. 12.

MATERIAL: A single specimen compressed flat; one half preserved as an impression and the other as sculptured mould (BK11/10-04/12 = SNM Z 24730).

DESCRIPTION: The shell is evolute, with low whorls and a wide umbilicus. The ventral margin is marked by a keel. The shell is almost smooth; very fine, simple, slightly S-shaped ribs occurs in early stages, and at the end of the last whorl several short ribs inclined to the aperture occur on the ventral margin.

MEASUREMENTS: At D = 32 mm (measured with the keel, close to the maximum diameter), H = 11.8 (0.37), U = 12.2 (0.38).

REMARKS: At first sight, the smooth shell with its slowly increasing whorl height, makes the Butkov specimen close to *Paquiericeras paradoxum* Sayn or

to *Oosterella begastrensis* Company. However, it differs from both in the fine ribbing on the last whorl. Accordingly, it certainly belongs the variable species group *Oosterella gaudryi* (Nicklès), being closest to its morpha *vilanovae* (see Reboulet 1996), interpreted herein as an independent species.

OCCURRENCE: The specimen comes from the *Neocomites peregrinus* Zone, Upper Valanginian, of the Ladce Formation (Level 10, 13.5 metre level of the succession).

Oosterella ondulata Reboulet, 1996
(Pl. 5, Fig. 1)

1996. *Oosterella ondulata* n. sp.; S. Reboulet, pp. 145–148, pl. 28, figs 1–8, pl. 29, figs 1, 2.
2005. *Oosterella ondulata* Reboulet; J. Klein, p. 384 (cum syn.).

MATERIAL: A single, incomplete and strongly deformed sculptured mould; partly preserved as an impression (ex. BK10-82/2 = SNM Z 24731).

DESCRIPTION: The shell is a large macroconch, semi-involute, with high whorls. The ventral margin bears a distinct keel. The ribs are best preserved on the outer half of the whorl. They are faintly retroverse, bent. They begin near the umbilicus as indistinct simple ribs. In the lower third of the whorl-height the ribs bifurcate or trifurcate. Some of the latter may have the character of inserted rib.

MEASUREMENT: Because of deformation the measured values are approximate. The maximum shell diameter is about 90 mm. At D = 84 mm, H = 36.0 (0.43) and U = 22.5 (0.27).

REMARKS: In sculpture and size the macroconch studied resembles *O. fascigera* Thieuloy and Bulot, 1993. The latter differs from *O. ondulata* in its wider umbilicus (U/D = 0.33) and in the presence of rib bundles, separated from each other by shallow depressions.

OCCURRENCE: *O. ondulata* ranges from the *Criosarasinella furcillata* Zone to the *Acanthodiscus radiatus* Zone, Upper Valanginian to basal Hauterivian (Reboulet 1996). Convincing reports of the species are from France (microconchs and macroconchs), Hungary (microconchs), ?Italy, and a single specimen is known from the Podbranč locality (Slovakian Klippen Belt, Outer Carpathians). The Butkov specimen comes from the *Acanthodiscus radiatus* Zone of the Kališčo Formation (Level 10, 82 metre level of the succession).

Family Polyptychitidae Wedekind, 1918
Subfamily Polyptychitinae Wedekind, 1918

Genus *Dichotomites* Koenen, 1909
Subgenus *Dichotomites* Koenen, 1909

TYPE SPECIES: *Ammonites bidichotomus* Leymerie in d'Orbigny, 1841.

Dichotomites (*Dichotomites*) *evolutus* Kemper, 1978
(Pl. 6, Figs 1, 2)

1978. *Dichotomites* (*Dichotomites*) *evolutus* n. sp.; E. Kemper, pp. 208–210, pl. 12, figs 1 a, b, 2, pl. 14, figs 1 a, b, pl. 15, figs 1, 2 a, b, text-figs 11, 12.
1996. *Dichotomites bidichotomus* (Leymerie); S. Reboulet, pl. 31, fig. 5 (non figs. 4, 6).
2006. *Dichotomites* (*Dichotomites*) *evolutus* Kemper; J. Klein, pp. 114–115 (cum syn.).

MATERIAL: A single strongly deformed last whorl, preserved as a sculptured mould, probably representing the body chamber (BK10-13,5/3 = SNM Z 24738).

DESCRIPTION: The whorl section is unknown. The umbilicus, in spite of deformation, is rather wide. At the beginning of the last whorl, the shell bears quite dense, bifurcated ribs, later becoming much sparser. The ribs start near the umbilicus as short primary ribs, concave towards the aperture. Farther on, the ribs have a tubercular to bullate character. Pairs of ribs arise from them and bifurcate usually at different heights on the flanks (bidichotomic ribs sensu Kemper, 1978, text-fig. 1). On the ventral side the ribs are markedly inclined towards the aperture. Sporadically, the anterior rib of a pair does not bifurcate in the more juvenile part of the whorl (trivirgatipartid sensu Kemper, 1978). In a single case, a shorter simple inserted rib is developed, the base of which does not reach the level of the umbilical tubercles. In the upper half of the whorl, the rib bifurcates.

MEASUREMENTS: The deformed shell reaches in the axis of elongation a diameter of 75 mm. At D = 70.5 mm (between the main axes of deformation), H = 28.5 (0.40) and U = 19.5 (0.28). Half of the whorl has 10 primary ribs and 39 ribs on its ventral margin.

REMARKS: The regular uniform dichotomic branching of ribs on the body chamber makes the species closer to the subgenus *Dichotomites* than to the subgenus *Prodichotomites* Kemper or the genus *Polyptychites* Pavlow. In addition to the presence of the bidichotomic ribs the inner part of the last whorl of the Butkov specimen is characterized by somewhat more variegated ribbing – trivirgatipartid, or simple inserted ribs.

The density and particularly the style of ribbing of the Slovak specimen make it close to *D. bidichotomus* (Leymerie, 1842), *D.* cf. *bidichotomus* Pawlov (non Leym.) in Thieuloy (1977), and *D. bidichotomoides* Kemper, 1978.

As stated by Kemper (1978), the type material of *D. bidichotomus* is unclear. Two specimens were originally illustrated: one in d'Orbigny (Leymerie in d'Orbigny, 1841, pl. 57, figs 3, 4) and another one in Leymerie (1842, pl. 18, fig. 2). However, the originals of both are lost. Thieuloy (1977) distinguished two morphologic variants of *D. bidichotomus*: *bidichotomus* sensu Leymerie, 1842, and cf. *bidichotomus* sensu Pawlov, 1892. The neotype of *D. bidichotomus* was designated by Busnardo (in Fischer and Gauthier 2006, p. 72, pl. 10, figs. 4 a, b) from d'Orbigny's original collection.

Kemper (1978) put *D. bidichotomoides* in the rank of *D. bidichotomus* (in the concept of Leymerie 1842). From the synonymy of *D. bidichotomoides* he justifiably excludes *D. bidichotomus* sensu d'Orbigny, 1841 and *D.* cf. *bidichotomus* sensu Thieuloy, 1977. The d'Orbigny (1841, pl. 57, fig. 3) specimen differs from *D. bidichotomoides* in its polyptychid rib arrangement. The difference between *D.* cf. *bidichotomus* (in Thieuloy, 1977) and *D. bidichotomus* sensu Leymerie, 1842 consists in the straight, not inclined course of ribs on the ventral margin in the former. On the inner whorls of *D. bidichotomoides*, tri- to quadrivirgatipartid ribbing may occur (Kemper 1978).

None of the species discussed above is conspecific with the Slovak specimen, however, it seems to represent *D. evolutus*. Unfortunately, the strong deformation of the specimen prevents measurement of the actual width of its umbilicus. Similarly preserved specimens of *D. evolutus* are known from the Valanginian of Tomaszow, central Poland (Dziadzio *et al.* 2004). One of the three specimens referred to *D. bidichotomus* by Reboulet (1996, pl. 31, fig. 5), but not included in its synonymy by Klein (2006), looks identical to *D. evolutus*.

OCCURRENCE: The species is known from the *Neocomites peregrinus* Zone, Upper Valanginian, of northwest Germany (from where it was originally described), central Poland, and south-eastern France (Thieuloy *et al*. 1991; Reboulet 1996; Dziadzio *et al*. 2004). The Butkov specimen comes from the *N. peregrinus* Zone of the Ladce Formation (Level 10, 13.5 metre level of the succession).

Superfamily Silesitoidea Hyatt, 1900
Family Holcodiscidae Spath, 1923
Subfamily Spitidiscinae Vermeulen and Thieuloy, 1999

REMARKS: Following Vermeulen and Thieuloy (1999), the genus *Spitidiscus* is here classified in the family Holcosdiscidae and not in the family Desmoceratidae and subfamily Barremitinae, as accepted in Wright et *al*. (1996), or in the family Neocomitidae as in Klein (2005). Following Vermeulen's (2007) proposal, the family Holcodiscidae is placed in the Silesitoidea.

Genus *Spitidiscus* Kilian, 1910

TYPE SPECIES: *Ammonites rotula* J. de C. Sowerby, 1827.

Spitidiscus ex gr. *rotula* (Sowerby, 1827)
(Pl. 4, Figs 6, 7)

?1912. *Spitidiscus (Holcodiscus) rotula* Sow. sp. (Pawl. sp.) var. *inflata* Kil.; W. Kilian and P. Reboul, p. 2, pl. 1, figs 2 a, b.
?1914. *Holcodiscus inflatus* n. sp.; J. Zwierzycki, pp. 70–72, pl. 7, figs 7, 8.
1972. *Spitidiscus rotula inflatus* Kilian; J.-P. Thieuloy, pp. 32–34, pl. 2, figs 4, 5, pl. 3, figs 2, 3, text-figs 4 c–e, 5.
1985. *Spitidiscus rotula* (Sowerby); V. Tzankov and S. Breskovski, pp. 7–8, pl. 1, figs 4–6.
non 1986. *Spitidiscus rotula inflatus* Kilian; Z. Vašíček and J. Michalík, p. 476, pl. 5, fig. 2.
1996. *Spitidiscus rotula* (Sowerby); S. Reboulet, pp. 160–161, pl. 32, figs 12, 13.

MATERIAL: Three incomplete and deformed sculptured moulds: one juvenile (BK10-105/x = SNM Z 24732), and two subadult (BK10-105/9 = SNM Z 24733, BK10-105-06/4).

DESCRIPTION: Owing to deformation, the whorl section is not known. The umbilicus is narrow. On the flanks of the last whorl of the largest shell, there are six wide constrictions, bent concavely toward the aperture to S-shaped. The constrictions are accompanied by inflated ribs on both sides. Numerous thin, subradial

inter-ribs, complicated in form, occur between the constrictions. Usually three to four short simple ribs, of uneven length, occur on the posterior side of the constrictions. Their length is determined by the subradial shape and the distinct bend of the ventral part of the constrictions towards the aperture. In areas between constrictions, near the line of coiling, the ribs usually begin to bifurcate near the umbilicus, and then often bifurcate again on the whorl flanks. The number of secondary ribs between two consecutive constrictions varies, being three, five or seven at the umbilicus, and 11, 12, or sometimes even 15 on the ventral side.

MEASUREMENTS: The diameter (deformed) of the smallest specimen (Z 24 732) is 27 mm, and 47 mm of the largest one.

REMARKS: The concept of *Spitidiscus rotula* is very inconsistent. The holotype (J. de C. Sowerby 1827, pl. 570, fig. 4) is a juvenile shell with narrow constrictions. Specimens also occur, however, with ornament like that of the holotype but with wide constrictions. To such forms belong, e.g. *S. rotula* var. *inflata* Kilian in Kilian and Reboul (1912) (the ribbing of which, compared to that of other shells depicted later, is problematic), and especially *Holcodiscus inflatus* n. sp. illustrated by Zwierzycki (1914). Thieuloy's (1972) specimens of *S. rotula inflatus* are very close to the subadult specimen from Butkov. Thieuloy (1972) discusses a number of closely related species, varying slightly from each other in their whorl section; *S. inflatus* (Zwierzycki) he referred e.g. to a new species, *S. mikadiensis*. To forms listed in the synonymy without a question mark, comprising those with wide contrictions, the closest are the subadult Butkov specimens (unfortunately their whorl sections are not known). The holotype of *S. rotula* and specimens illustrated e.g. by Kemper (1992, pl. 55) and Mutterlose *et al*. (1997, fig. 70), from the Cretaceous of Germany, are different.

OCCURRENCE: The French specimens, to which the Butkov specimens are closest, are from the *Lyticoceras nodosoplicatum* Zone of the Lower Hauterivian. The Butkov specimens are from the *L. nodosoplicatum* Zone of the Kališčo Formation (Level 10, 105 metre level of the succession).

Spitidiscus incertus (d'Orbigny, 1840)
(Pl. 5, Fig. 3)

1840. *Ammonites incertus* d'Orb. N.; A. d'Orbigny, pp. 120–121, pl. 30, figs 3, 4.
1996. *Spitidiscus intermedius* (d'Orbigny); S. Reboulet, pp. 161–162, pl. 32, figs. 6, 7.
2005. *Spitidiscus incertus* (Orbigny); J. Klein, pp. 149–150 (cum syn.).
2006. *Spitidiscus incertus* (d'Orbigny); R. Busnardo in Fischer and Gauthier, pp. 32–33, text-fig. 6, pl. 11, fig. 4.

MATERIAL: A single mould, compressed flat (BK10-130-06/1 = SNM Z 24734).

DESCRIPTION: The shell is involute; the whorl section is unknown due to deformation. The flanks of the last whorl bear six almost straight, moderately wide constrictions. Near the line of coiling the constrictions are bent slightly concavely towards the aperture, and are bow-shaped on the ventral side. The constrictions are accompanied by stronger ribs on both sides; the posterior rib is slightly more distinct. Between two consecutive constrictions occur relatively thin and dense secondary ribs. Simple ribs, some already bifurcate, arise from the line of coiling. The next bifurcation takes place at whorl mid-height. Six ribs reach the line of coiling and 20 ribs are noted in the ventral margin in the final preserved part of the shell. Of the latter, four to five are represented by shorter ribs ending in the main rib behind the constriction.

MEASUREMENTS: The maximum diameter is about 73 mm. At D = 67.4 mm, H = 29.4 (0.44) and U = 15.1 (0.22).

REMARKS: The Butkov specimen is close to those illustrated and described by Reboulet (1996), under the name *S. intermedius*, referred subsequently to *S. incertus* by Busnardo *et al*. (2003, p. 49).

OCCURRENCE: *S. incertus* is reported from the *Lyticoceras nodosoplicatum* Zone of the upper Lower Hauterivian of France, Spain, Hungary and Romania. The Butkov specimen comes from the *L. nodosoplicatum* Zone of the Kališčo Formation (Level 10, 130 metre level of the succession).

Genus *Plesiospitidiscus* Breistroffer, 1947

TYPE SPECIES: *Ammonites ligatus* d'Orbigny, 1841.

Plesiospitidiscus fasciger (Thieuloy, 1972)
(Pl. 6, Figs 4, 5)

1972. *Spitidiscus fasciger* nov. sp.; J.-P. Thieuloy, pp. 35–37, pl. 3, figs 4–9, text-figs 4 f–h, 6.

1985. *Spitidiscus darderi fasciger* (Thieuloy); V. Tzankov and S. Breskovski, p. 6, pl. 1, fig. 3.
?1985. *Spitidiscus darderi darderi*(Fallot and Termier); V. Tzankov and S. Breskovski, pp. 5–6, pl. 1, fig. 2.
1994. *Spitidiscus fasciger* Thieuloy; Z. Vašíček *et al*., pp. 61–62, pl. 18, fig. 6.
1996. *Spitidiscus fasciger* Thieuloy; S. Reboulet, pp. 160–161, pl. 32, figs 8, 9.

MATERIAL: Four incomplete and deformed sculptured moulds, usually with poorly preserved umbilical region (BK10-105-06/2 = SNM Z 24735, BK10-105/3 = SNM Z 24736, BK10-105/6, 7).

DESCRIPTION: The shells are involute, medium-sized (D usually slightly exceeds 30 mm) with an unknown original whorl section. The ornament is composed of six to seven main ribs per half-whorl, accompanied by a slight constriction on the posterior side. The main ribs are straight, proverse. The inter-rib spaces are covered with poorly or well developed dense lines or thin secondary ribs.

MEASUREMENTS: Z 24736 has in the axis of elongation D = 32.5 mm, H = 17.3 (0.53), U = 6.1 (0.19).

REMARKS: The specimens are characterised by a high number of main ribs and considerable variability of the secondary ribs in between. Some specimens resemble *Plesiospitidiscus ligatus* (d'Orbigny). *S. fasciger* is usually compared to *S. darderi* (Fallot and Termier); however, the latter species has a distinctly lower number of main ribs (six on the last whorl). The high number of main ribs in *S. fasciger* and the fact that its constrictions form specific notches along the line of coiling makes it close to representatives of the genus *Plesiospitidiscus*, to which, following Vermeulen (1999, p. 75) it is referred here.

OCCURRENCE: The species is reported from the *Crioceratites loryi* and *Lyticoceras nodosoplicatum* zones of the upper Lower Hauterivian (Thieuloy 1972, Bulot et *al*. 1993, Reboulet 1996). The Butkov specimens come from the *L. nodosoplicatum* Zone of the Kališčo Formation (Level 10, 105 metre level of the succession).

BIOSTRATIGRAPHY

The succession studied herein, on exploitation Level 10 (Text-fig. 4), starts near the Lower/Upper Valanginian boundary. This is indicated by the common occurrence of *Busnardoites campylotoxus* (see Pl. 6, Fig. 3) and *Olcostephanus guebhardi* (Kilian). The latter species also occurs relatively frequently on other exploitation levels (Pl. 2, Fig. 2). It cannot, however, be excluded that it actually starts as late as the Late Valanginian *Saynoceras verrucosum* Zone (the upper part of the zone as is shown by some other data), although the zonal index species, *S. verrucosum* (d'Orbigny), has not been found. This part of the succession contains, moreover, *Bochianites neocomiensis* d'Orbigny*, Neolissoceras grasianum* (d'Orbigny), *Olcostephanus tenuituberculatus* Bulot (Pl. 1, Fig. 5)*, Neocomites teschenensis* (Uhlig) and *Vergoliceras salinarium* (Uhlig). *Vergoliceras salinarium,* found in a bed just above the basal breccia of the Ladce Formation (see also Michalík *et al*. 1995, 2005) starts, according to Company (1987), late in the Early Valanginian *Tirnovella pertransiens* Zone, and Bulot and Thieuloy (1995) reported it already from the latest Berriasian *Thurmanniceras otopeta* Subzone.

The stratigraphical position is unclear of two species found in the basal part of the Cretaceous succession of Butkov (on exploitation levels 7 and 8), namely *Spiticeras simplicostatum* (Nikolov) and *Clavithurmannia* cf. *foraticostata* Thieuloy (Pl. 1, Fig. 1 and Pl. 2, Fig. 7). The former is known so far only from Bulgaria, where it occurs in the *Subthurmannia boissieri* Zone of the Upper Berriasian (Nikolov 1960). The latter is known from the Vocontian Trough of southeastern France, where it occurs in the *Thurmanniceras otopeta* Subzone of the uppermost Berriasian (Thieuloy in Busnardo *et al*. 1979). Based on these two ammonite species, it may be inferred that the sedimentation of the Ladce Formation started as early as the latest Berriasian. The basal Valanginian *Tirnovella pertransiens* Zone remains, however, undocumented; the finds of *B. campylotoxus* prove the presence of the higher *Busnardoites campylotoxus* Zone. The presence of the latter zone in the Butkov succession is also supported by *Neocomites* (*Eristavites*) *platycostatus* (Sayn) [a specimen from Level 12, 16 metre level of the succession] (see Reboulet *et al*. 2006) and, on exploitation Level 13, by *Busnardoites neocomiensiformis* (Uhlig) (Pl. 4, Fig. 4), accompanied by *Vergoliceras salinarium, B. campylotoxus* and representatives of the genus *Kilianella*. It is interesting that no representative of *Karakaschiceras* has been found in the Ladce Formation.

A change in ammonite fauna is noted at the 13 metre level of Level 10 (Text-fig. 4). This change is associated with a marked change in lithology, expressed by the transition from monotonous, flesh-coloured, marly limestones to grey limestones, resembling those of the Mráznica Formation. These grey limestones contain,

among other taxa: *Rodighieroites cardulus* Company (Pl. 3, Fig. 1), *Dichotomites evolutus* Kemper (Pl. 6, Fig. 1), *Oosterella* cf. *vilanovae* (Nicklès) (Pl. 5, Fig. 2), *Bochianites neocomiensis* and *Olcostephanus tenuituberculatus* Bulot. The presence of *R. cardulus* indicates *Neocomites peregrinus* Zone age of this association, although the zonal index, *N. peregrinus* (Rawson and Kemper), has not been found in the Butkov quarry. Slightly higher, at the 15 metre level, Ladce type limestones re-occur. *Valanginites bachelardi* (Sayn) and *Vergoliceras salinarium* (Uhlig) (Pl. 2, Fig. 1), first appear two metres higher and, at the 20 metre level of the succession, there is a mass-occurrence of *Bochianites neocomiensis* and the first appearance of *Olcostephanus nicklesi* Wiedmann and Dieni (Pl. 1, Figs 3, 4). The appearance of the latter species indicates the base of the *Olcostephanus nicklesi* Subzone of the upper *Neocomites peregrinus* Zone (Reboulet *et al*. 2006). *R. cardulus* and *V. salinarium* range up to this level. The mass occurrence of *B. neocomiensis* (together with abundant *Neolissoceras grasianum* and *Rodighieroites cardulus*) suggests the bochianitid event that was first recognized in the Northern Calcareous Alps (Vašíček and Faupl 1996, 1998, 2000; see also Lukeneder 2005). In the latter area, this event was regarded as of *Saynoceras verrucosum* Zone age; however, this should probably be revised to lower *Neocomites peregrinus* Zone age. The bochianitid event, marked by the mass occurrence of *B. neocomiensis* was also reported from the Central Western Carpathians in Slovakia (Mráznické lúky area) by Borza *et al*. (1982), albeit then dated incorrectly as Early Hauterivian.

Higher up, the succession is characterized by an almost 20 m thick, poorly fossiliferous interval, with a lithological change to grey limestone of the Mráznica Formation in its topmost part (Text-fig. 4). The overlying sequence, starting approximately at the 50 metre level of the succession, yielded the first large shells of *Crioceratites coniferus* Busnardo and *C. heterocostatus* Mandov, as well as representatives of the genus *Criosarasinella* (*C. mandovi* Thieuloy – Pl. 6, Fig. 6) and *Himantoceras trinodosum* Thieuloy. This association marks the *Criosarasinella furcillata* Zone.

The next distinct change in ammonite fauna is noted between the 80 and 89 metre levels of the succession (Text-fig. 4). This change is again accompanied by a change in lithology, expressed by the appearance of cherts. Slightly below (76.5 metre level) appears the sandy-calcareous turbidite bed that defines the base of the Kališčo Formation. The change in ammonite fauna is primarily expressed by the abundant appearance of teschenitids. The dominant taxon, *Teschenites flucticulus* (Thieuloy), usually poorly preserved, is accompanied by *T. pachydicranus* (Thieuloy), *Spitidiscus cankovi* Vašíček and Michalík, *Oosterella ondulata* Reboulet (Pl. 5, Fig. 1) and other taxa.

The Valanginian/Hauterivian boundary is located at a level somewhere close to and below the turbidite bed, albeit neither *Teschenites callidiscus* Thieuloy, the index species of the uppermost Valanginian, nor *Acanthodiscus radiatus* (Bruguière), the index species of basal Hauterivian, has been found. The interval above the turbidite bed represents, however, the *Acanthodiscus radiatus* Zone of the Lower Hauterivian, marked by the appearence of *Teschenites flucticulus* Thieuloy (see Pl. 3, Fig. 5). The latter species occurs in several Carpathian localities (e.g. in the Klippen Belt – Vašíček 2002) and seems to be a good marker of the *Acanthodiscus radiatus* Zone, the index taxon of which is confined to shallow-water deposits, not known from the Western Carpathians. The base of the *Teschenites flucticulus* Zone would thus be a very good marker of the base of the Hauterivian in the Carpathian regional stratigraphy.

The teschenitids disappear at about 85 m of the succession. The 20 m-thick interval which follows yielded no biostratigraphically significant ammonite. The appearance of *Spitidiscus* ex gr. *rotula* (Sowerby) and *Plesiospitidiscus fasciger* (Thieuloy) (Pl. 4, Figs 6, 7 and Pl. 6, Figs 4, 5), at the 105 metre level of the succession, marks the Early Hauterivian *Lyticoceras nodosoplicatum* Zone. The interval between the last teschenitids and the first occurrence of *Pl. fasciger*, is referred to the *Crioceratites loryi* Zone. *C. loryi* Sarkar was not found on exploitation Level 10 but the species is known from another level in the quarry (Vašíček and Michalík 1986). The presence of the zone is also supported by the record of *Jeannoticeras jeannoti* (d'Orbigny) (Pl. 2, Fig. 6), from exploitation level 7, which is the index taxon of the eponymous subzone of the upper *Crioceratites loryi* Zone.

The *Lyticoceras nodosoplicatum* Zone is the highest zone recognised on Level 10, although its index species, *L. nodosoplicatum* (Kilian et Reboul), has not been recorded either from the Butkov Quarry or from the entire Western Carpathians. The presence of *Ptychoceras meyrati* Ooster and of *Olcostephanus variegatus* (Paquier) (Pl. 2, Fig. 5) in the upper part of the zone (Text-fig. 4) document the *Olcostephanus variegatus* Horizon, well dated in the ammonite standard scheme (Reboulet *et al*. 2006).

COMMENTS ON EVOLUTION AND PALAEOBIOGEOGRAPHY

Besides quite common microconchs, the Butkov succession yielded several macroconchs that had not

been recorded previously in the Carpathians. Some of these had so far only been reported from the Vocontian Trough (Reboulet 1996) or from Morocco (Ettachfini 2001, 2004).

Eristavites platycostatus (Pl. 4, Fig. 5), from the lower part of Ladce Formation, is the best preserved macroconch of the species. At approximately the same stratigraphic level, a fragment of the body chamber of the macroconch of *Busnardoites campylotoxus* (Pl. 5, Fig. 4) was found.

In the Upper Valanginian, a trituberculate macroconch of *Rodighieroites cardulus* (Pl. 3, Fig. 3) was found, and slightly higher, in the overlying Mráznica Formation, a macroconch of *Criosarasinella mandovi* (Pl. 6, Fig. 6), with trituberculate main ribs on the body chamber. Both taxa are known exclusively from fragmentarily preserved body chambers, the generic determinations of which may be difficult. A similar difficulty arises if only fragments of the body chamber of *Neocomites peregrinus* (Rawson and Kemper 1978), (with similar trituberculate ribs) are found. These problems disappear if the inner whorls are preserved as the well body chambers. *R. cardulus* and *C. mandovi* have evolute shells; all the inner whorls of the former are trituberculate, while in the case of the latter, with the exception of the earliest whorls, trituberculation is not present on the phragmocone. Shells of *N. peregrinus* are semi-involute in contrast to the evolute shells of the two other taxa.

In the Lower Hauterivian, incomplete macroconchs of *Teschenites pachydicranus* Thieuloy occur in the Kališčo Formation.

From an evolutionary point of view, the occurrences of *R. cardulus* and the first representatives of the genera *Crioceratites* and *Criosarasinella* are highly significant. *Crioceratites* ex gr. *coniferus* Busnardo, Charollais, Weidmann and Clavel, 2003 first appears just above the last occurrences of *R. cardulus*, and before the first occurrence of *Cr. mandovi* (41 m on the section). *Criosarasinella furcillata* appears a little bit higher. If earlier appearance of the genus *Crioceratites* than of *Criosarasinella* were to be documented in other places, then the assumption of Vašíček (2005, p. 253) that *Crioceratites* was derived from *Criosarasinella,* would no longer be valid. It seems more probable that the genus *Crioceratites* is derived from *Rodighieroites*.

Until recently, the known ammonites from the Butkov Quarry, and from the whole of the Central Western Carpathians, were represented exclusively by taxa representing the Mediterranean bioprovince (Vašíček and Michalík 1999). The first representatives of the Boreal province were found in 2005; these are *Dichotomites evolutus* and *Valanginites bachelardi*. The former is known exclusively from the Boreal province. *V. bachelardi,* or valanginitids in general, were formerly regarded formerly as limited to the Boreal province, but appear to have a much wider geographic range. According to recent finds, the earliest *Valanginites* are known from Colombia (Etayo Serna 1985) and Argentina (Aguirre-Urreta and Rawson 1999) and the genus is also known from France (Bulot *et al*. 1990) and Morocco (Ettachfini 1991; Wippich 2001). In contrast to the previous assumptions, data from the Western Tethys do not confirm the migration of *Valanginites* from the Lower Saxony Basin through the Polish Furrow into the Tethys but actually confirm migration in the opposite direction.

CONCLUSIONS

A rich ammonite material from the Butkov Quarry made it possible to describe taxonomically twenty-one ammonite species. Most of the specimens come from exploitation Level 10. The ammonites represent an interval spanning the Valanginian and Lower Hauterivian, with most of them characteristic of the ammonite zones of *Busnardoites campylotoxus* and of *Lyticoceras nodosoplicatum*. The biostratigraphically most important taxa recognized are *Busnardoites campylotoxus, Olcostephanus nicklesi, Criosarasinella furcillata, Crioceratites loryi, Jeannoticeras jeannoti* and *Olcostephanus variegatus.* The key taxa of the Upper Valanginian and the Lower Hauterivian, which are restricted especially to a shallow-water environment, are missing.

A new ammonite zone, the *Teschenites flucticulus* Zone, characteristic of the basal Hauterivian in the Western Carpathians, is here proposed. It is the equivalent of the standard *Acanthodiscus radiatus* ammonite Zone.

The ammonite assemblage of the Butkov Quarry is a warm-water Mediterranean assemblage. Only a single specimen of the Boreal species, *Dichotomites evolutus*, was collected in the *Neocomites peregrinus* Zone of the Upper Valanginian. The fauna is dominated by microconchs.

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PLATE 1

1 – *Spiticeras simplicostatum* Nikolov; SNM Z 24706; basal part of the Ladce Formation, between exploitation levels 7 and 8; close the Berriasian/Valanginian boundary.

2 – *Olcostephanus guebhardi* (Kilian); SNM Z 24713; macroconch (M); Ladce Formation, exploitation Level 12; debris near the Lower/Upper Valanginian boundary.

3, 4 – *Olcostephanus nicklesi* Wiedmann and Dieni; 3 – SNM Z 24717, Ladce Formation, exploitation Level 10, 20 metre level of the succession; Upper Valanginian, *Neocomites peregrinus* Zone; 4 – SNM Z 24715, Mráznica Formation, exploitation Level 11, 29 metre level of the succession; Upper Valanginian, *Criosarasinella furcillata* Zone.

5, 6 – *Olcostephanus tenuituberculatus* Bulot; 5 – SNM Z 24708, microconch (M), Grey layer Ladce Formation, exploitation Level 10, 3 metre level of the succession; Upper Valanginian, *Saynoceras verrucosum* Zone; 6 – SNM Z 24709, macroconch (M), Grey layer in Ladce Formation, exploitation Level 10, 13.5 metre level of the succession; Upper Valanginian, *Neocomites peregrinus* Zone.

All specimens are in natural size

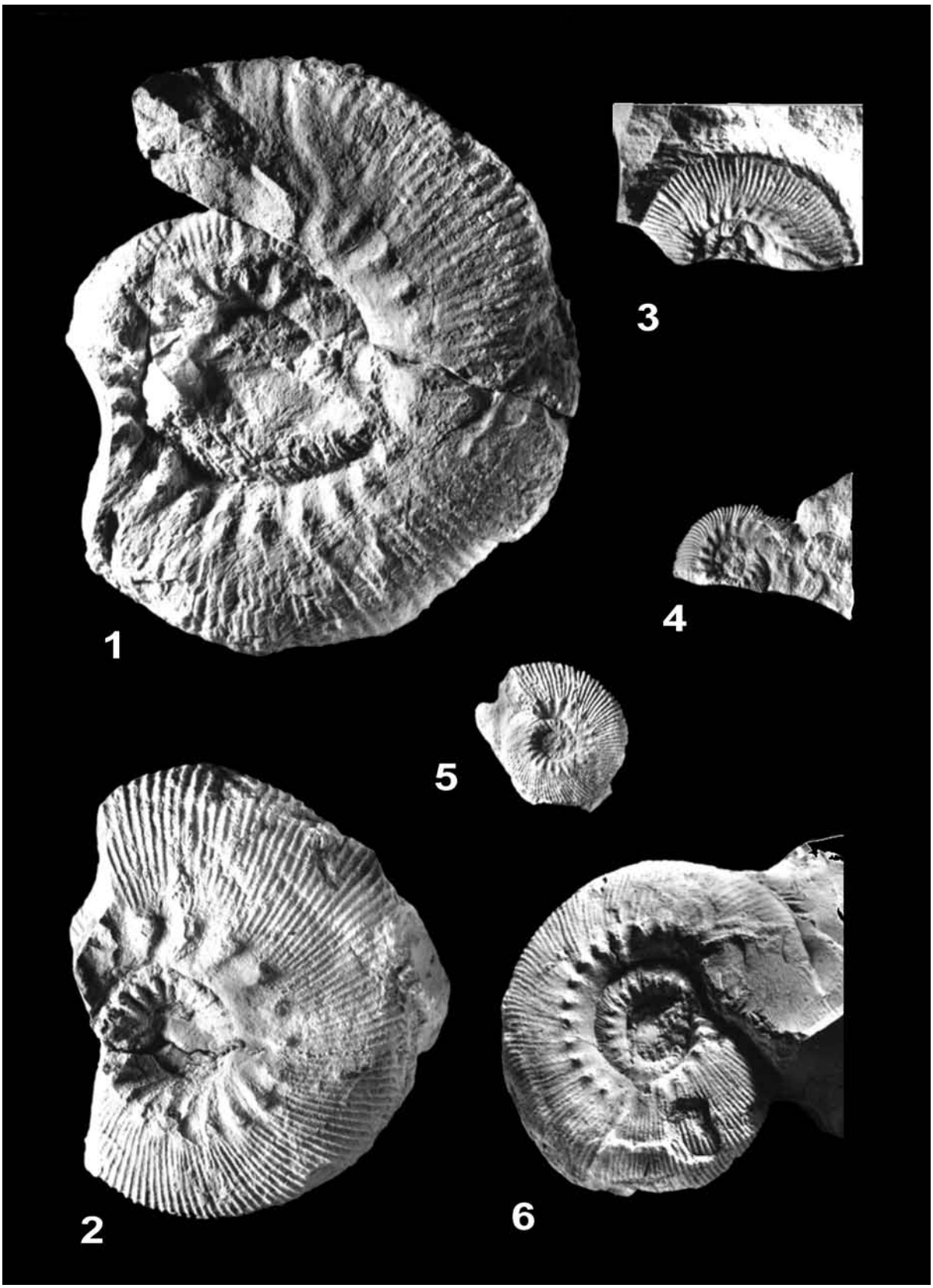
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PLATE 2

1 – *Olcostephanus densicostatus* (Wegner); SNM Z 24710, Mráznica Formation, exploitation Level 10, 74 metre level of the succession; Upper Valanginian, *Criosarasinella furcillata* Zone.

2 – *Olcostephanus guebhardi* (Kilian); SNM Z 24714, microconch (m), Ladce Formation, exploitation Level 12, debris near the Lower/Upper Valanginian boundary.

3, 4 – *Valanginites bachelardi* (Sayn); SNM Z 24720; Ladce Formation, exploitation Level 10, 17 metre level of the succession; Upper Valanginian, *Neocomites peregrinus* Zone; 3 ×1, fig. 4 ×2.

5 – *Olcostephanus variegatus* (Paquier); SNM Z 24718; Kališčo Formation, exploitation Level 10, 133 metre level of the succession; Lower Hauterivian, *Lyticoceras nodosoplicatum* Zone.

6 – *Jeannoticeras jeannoti* (d'Orbigny); SNM Z 24719; Kališčo Formation, exploitation Level 7, debris on exploitation Level 10; Lower Hauterivian, upper *Crioceratites loryi* Zone.

7 – *Clavithurmannia* cf. *foraticostata* Thieuloy; SNM Z 24721; Ladce Formation, basal part of the succession between exploitation Levels 7 and 8; near the Berriasian/Valanginian boundary.

With exception of fig. 4 which is ×2, all other specimens are in natural size

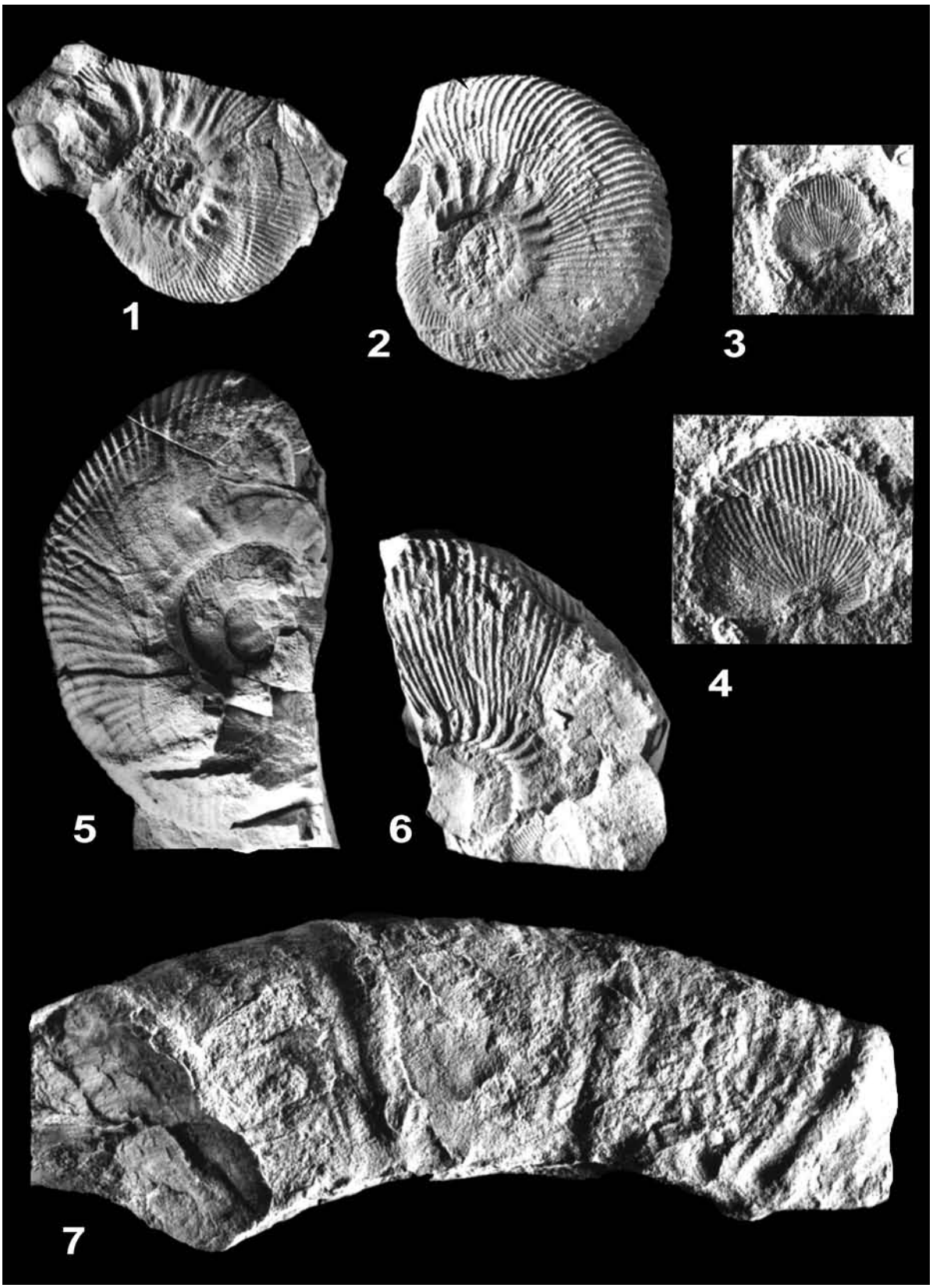
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PLATE 3

1, 2 – *Rodighieroites cardulus* Company; SNM Z 24722, microconch (m); grey layer in the Ladce Formation, exploitation Level 10, 13.5 metre level of the succession; Upper Valanginian, *Neocomites peregrinus* Zone.

3 – *Rodighieroites cardulus* Company; SNM Z 24723, macroconch (M); Ladce Formation, exploitation Level 10, 15 metre level of the succession; Upper Valanginian, *Neocomites peregrinus* Zone.

4 – *Oosterella cultrataeformis* (Uhlig); SNM Z 24729; Mráznica Formation, exploitation Level 11, horizon B; Upper Valanginian, upper *Criosarasinella furcillata* Zone.

5 – *Teschenites flucticulus* Thieuloy; SNM Z 24740; Kališčo Formation, exploitation Level 6, 2 metre level of the succession; Basal Hauterivian, *Acanthodiscus radiatus* (= *Teschenites flucticulus*) Zone.

All specimens are in natural size

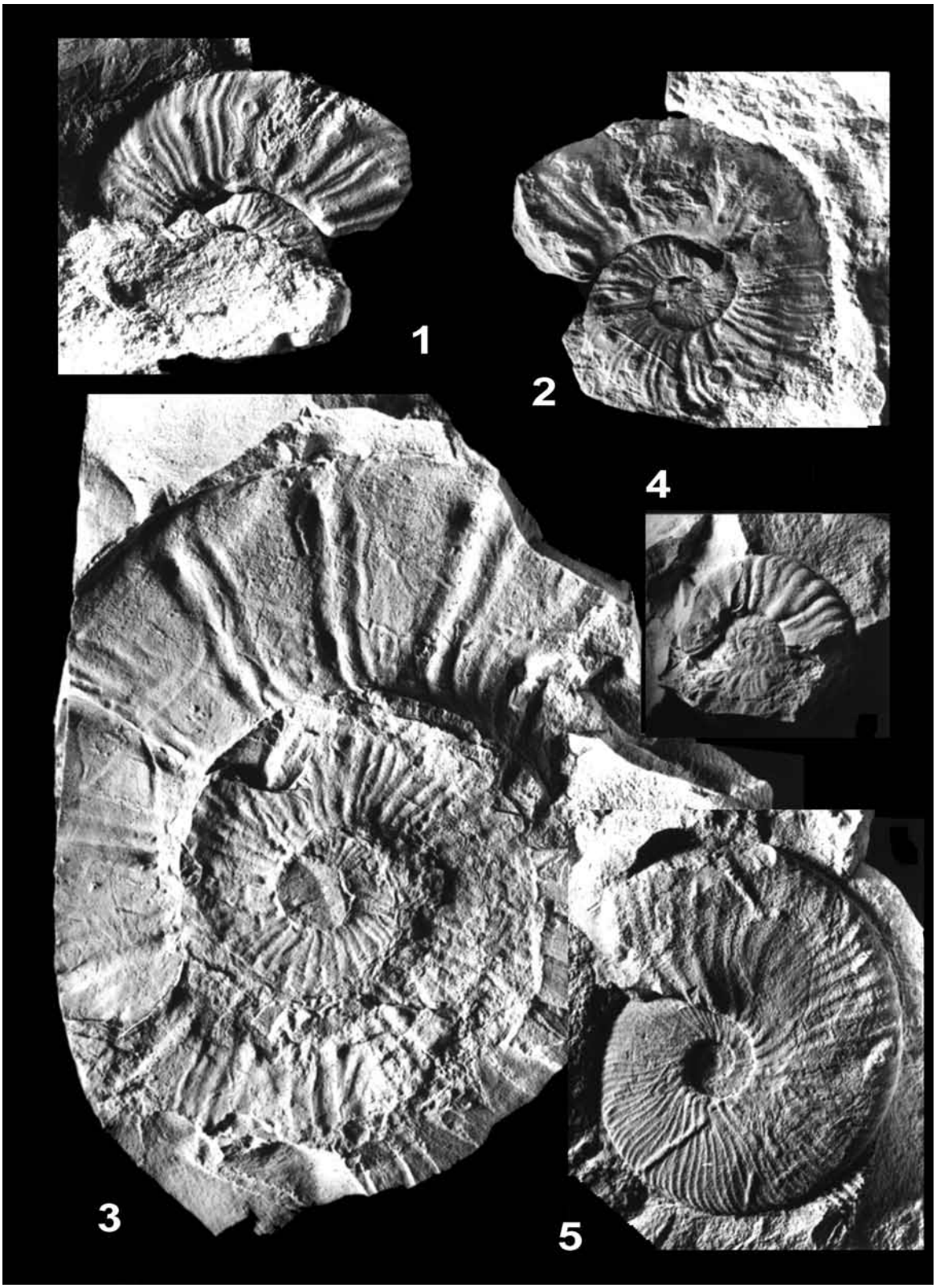
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PLATE 4

1-3 – *Sarasinella subdensicostata* sp. nov.; SNM Z 24724, holotype; 1 – body chamber represented by an imprint of part of the last whorl; Kališčo Formation, exploitation Level 10, 87.5 metre level of the succession; Lower Hauterivian, upper *Acanthodiscus radiatus* (= *Teschenites flucticulus*) Zone; 2 – better preserved, magnified sculpture of body chamber from the side of shell opposite to that on photo in 1; 3 – natural view of the specimen; 1, 2 ×2; 3 × 1.

4 – *Busnardoites neocomiensiformis* (Uhlig), SNM Z 24727; Ladce Formation, debris on exploitation Level 13; Lower Valanginian, *Busnardoites campylotoxus* Zone.

5 – *Neocomites* (*Eristavites*) *platycostatus* (Sayn), SNM Z 24725, macroconch (M); Ladce Formation, exploitation Level 12, layer 16; uppermost Lower Valanginian, *Busnardoites campylotoxus* Zone.

6, 7 – *Spitidiscus* ex gr. *rotula* (Sowerby); 6 – SNM Z 24732, juvenile shell; 7 – SNM Z 24733, subadult shell; Kališčo Formation, exploitation Level 10, 105 metre level of the succession; Lower Hauterivian, *Lyticoceras nodosoplicatum* Zone.

With the exception of 1 and 2, which are × 2, all other specimens are in natural size

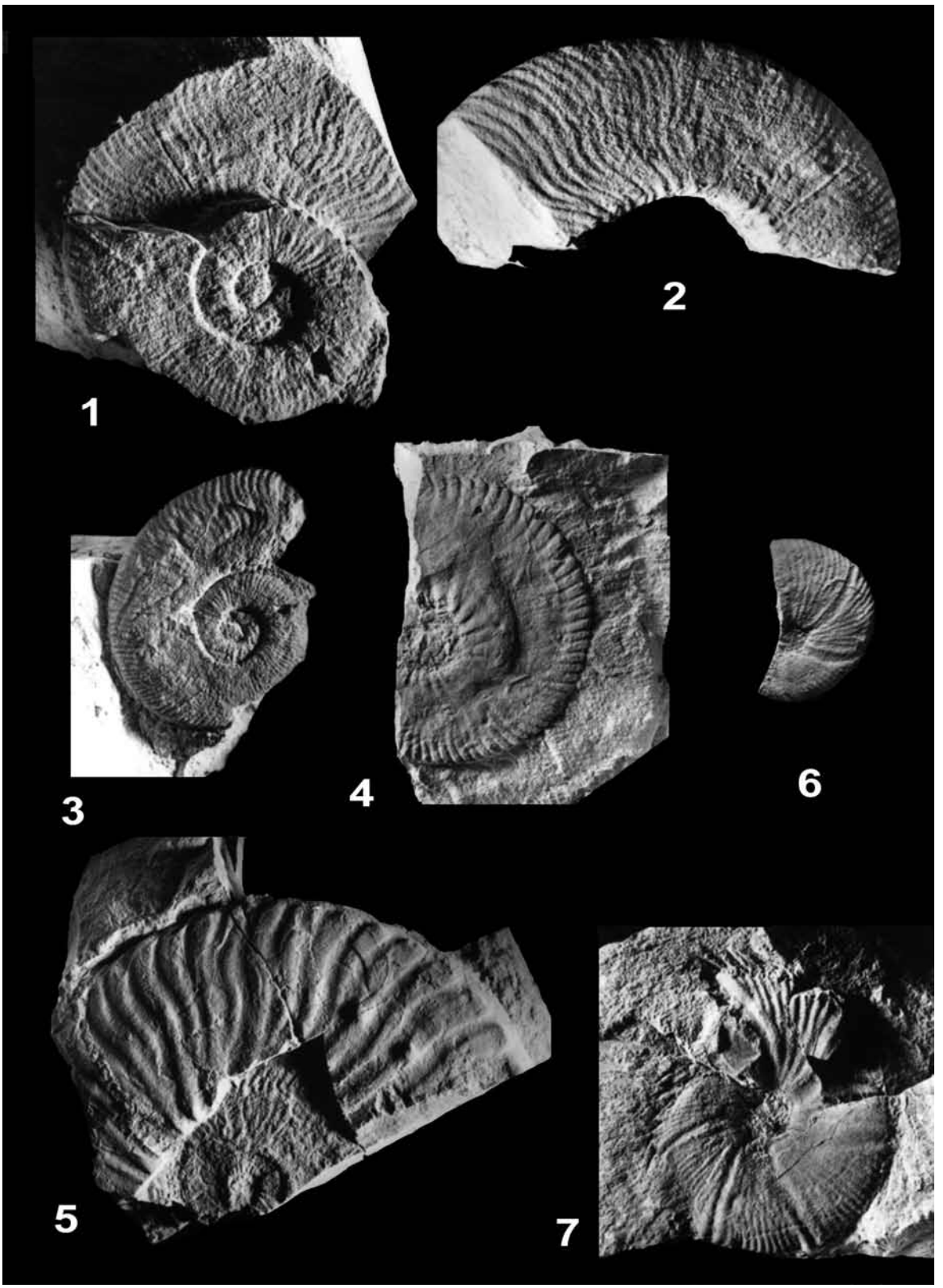
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PLATE 5

1 – *Oosterella ondulata* Reboulet, SNM Z 24731, imperfectly preserved macroconch (M) with a part of keel on the circumference; Kališčo Formation, exploitation Level 10, 82 metre level of the succession; Basal Hauterivian, *Acanthodiscus radiatus* (= *Teschenites flucticulus*) Zone.

2 – *Oosterella* cf. *vilanovae* (Nicklès), SNM Z 24730; grey layer in Ladce Formation, exploitation Level 10, 13.5 metre level of the succession; Upper Valanginian, *Neocomites peregrinus* Zone.

3 – *Spitidiscus incertus* (d'Orbigny), SNM Z 24734; Kališčo Formation, exploitation Level 10, 130 metre level of the succession; Lower Hauterivian, *Lyticoceras nodosoplicatum* Zone.

4 – *Busnardoites campylotoxus* (Uhlig); SNM Z 24726, macroconch (M); Ladce Formation, exploitation Level 12, layer 17; uppermost Lower Valanginian, *Busnardoites campylotoxus* Zone.

All specimens are in natural size

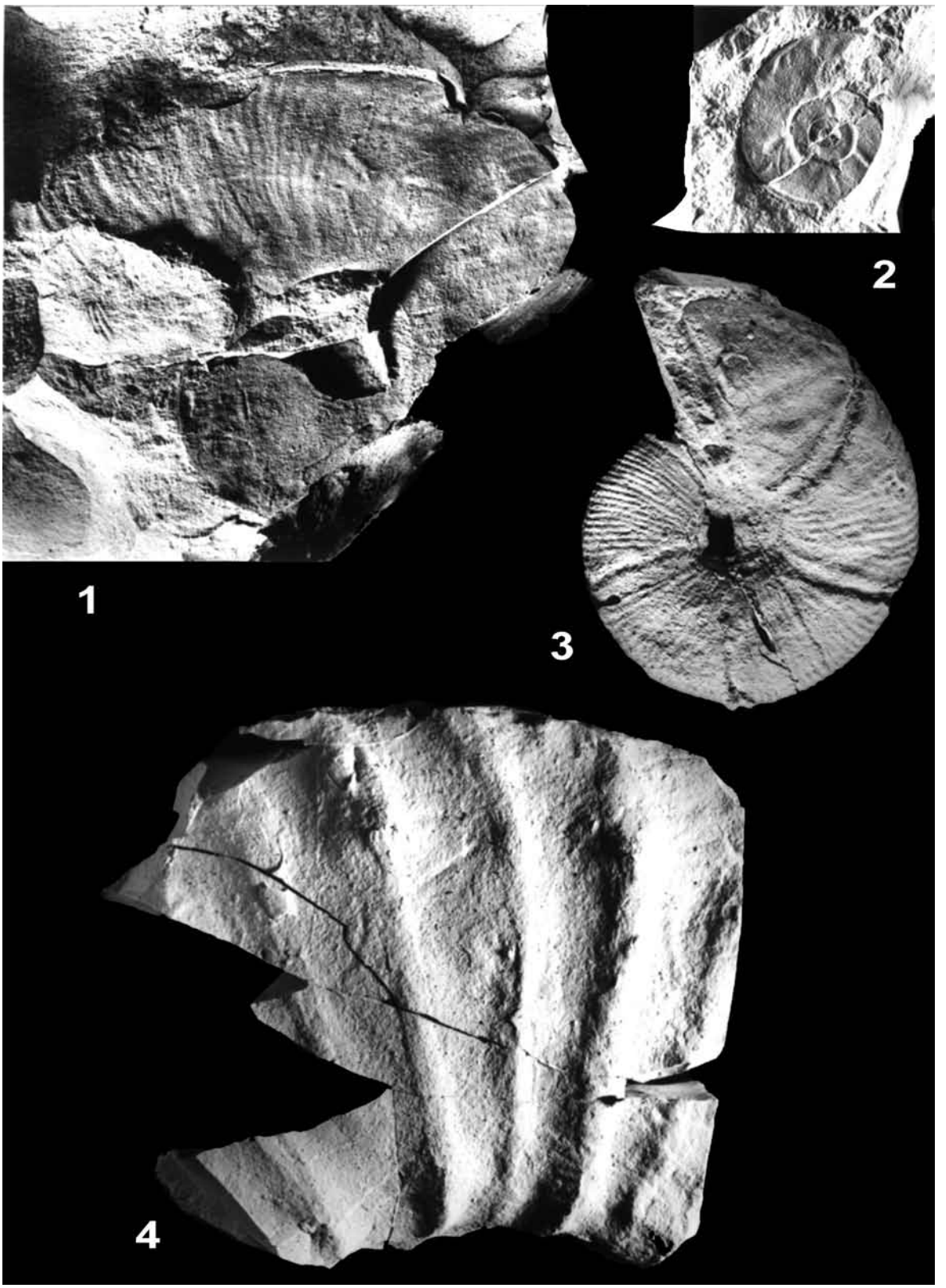
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PLATE 6

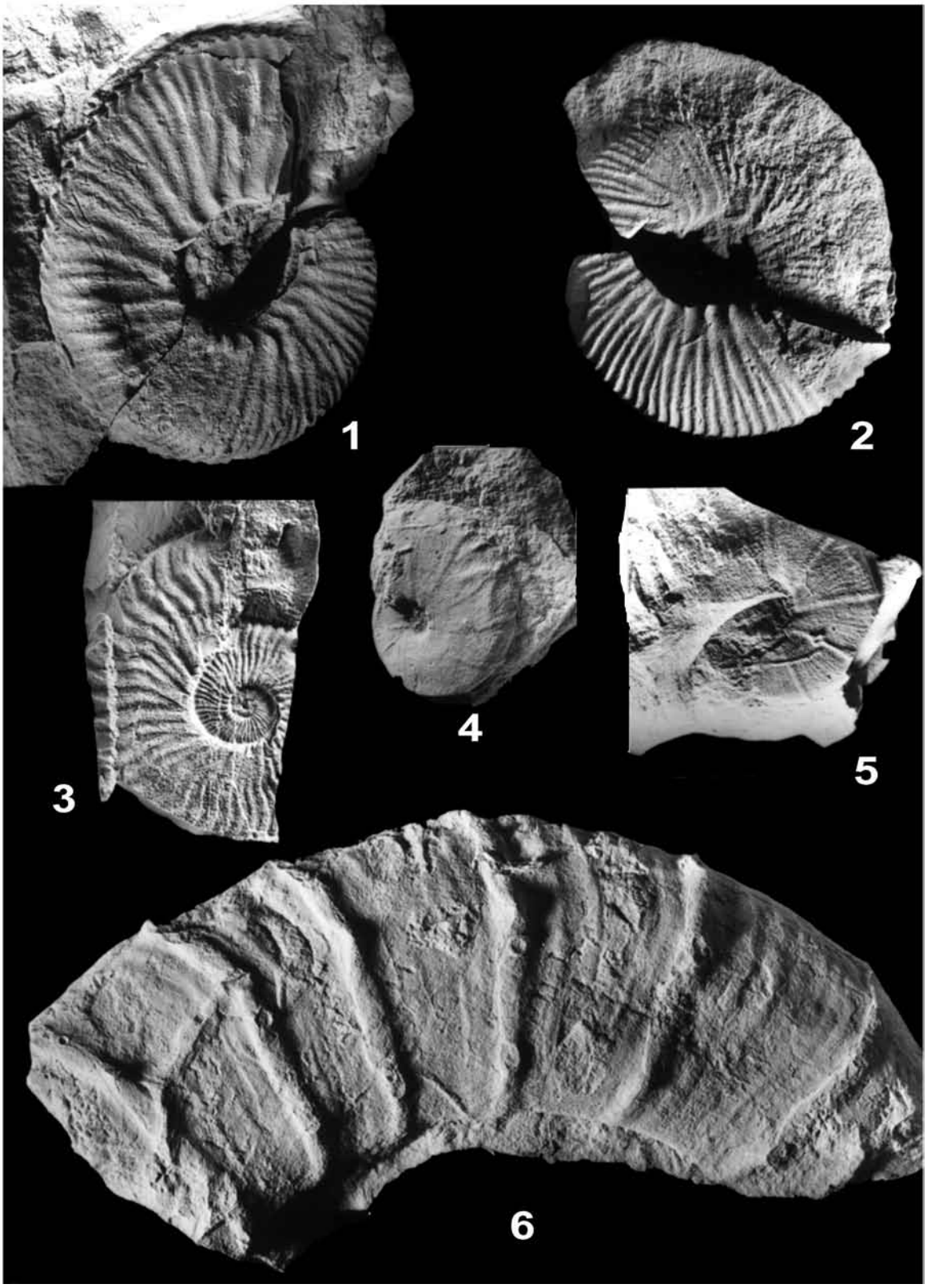
1, 2 – *Dichotomites evolutus* Kemper, SNM Z 24738; 1 – general view, 2 – opposite side with better preserved sculpture of inner whorl part; grey layer in Ladce Formation, exploitation Level 10, 13.5 metre level of the succession; Upper Valanginian, *Neocomites peregrinus* Zone.

3 – *Busnardoites campylotoxus* (Uhlig), SNM Z 24737, microconch (m); Ladce Formation, Level 10, base of the succession; Lower Valanginian, *Busnardoites campylotoxus* Zone.

4, 5 – *Plesiospitidiscus fasciger* (Thieuloy); 4 – SNM Z 24736, shell with indistinct interribs between main ribs; 5 – SNM Z 24735, shell with well developed interribs; Kališčo Formation, exploitation Level 10, 105 metre level of the succession; Lower Hauterivian, *Lyticoceras nodosoplicatum* Zone.

6 – *Criosarasinella mandovi* Thieuloy, SNM Z 24739, macroconch (M); Mráznica Formation, exploitation Level 10, 55 metre level of the succession; Upper Valanginian, *Criosarasinella furcillata* Zone.

All specimens are in natural size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