The oldest (Late Valanginian) Crioceratitinae (heteromorphic ammonoids) from the Central Western Carpathians (Slovakia)

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Abstract: An Upper Valanginian ammonoid collection from the Manín Unit (the Butkov Quarry of the Ladce cement works, middle Váh Valley) obtained recently contains true Crioceratitinae and other related subcriocone ammonoid shells belonging to six species of *Crioceratites, Criosarasinella* and *Himantoceras*. The occurrence of *Crioceratites* in the ammonite *furcillata* Zone represents the first known Valanginian record of this genus from the Central Western Carpathians. On the basis of the morphology of its early whorls, *Criosarasinella* is taxonomically assigned to the family Ancyloceratidae, the same as *Crioceratites* and *Himantoceras.*

Key words: Lower Cretaceous, Central Carpathians, taxonomy, heteromorphs.

Introduction

A large collection of well preserved ammonoids has been obtained from Upper Valanginian strata of the Manín Unit during fieldworks in the Butkov Quarry in the period from 2000 until 2003 (Skupien et al. 2003). The research done by a team of Czech and Slovak paleontologists continued older field studies by K. Borza, J. Michalík and the author of this article during 1980–1995. The newly collected ammonoids enabled more precise dating of the sequence studied up to the level of ammonite zones and subzones used at present by Hoedemaeker & Reboulet (2003).

The taxonomic and stratigraphic knowledge on Lower Cretaceous ammonoids has been enhanced during the last decade. Primarily, Reboulet (1996) described the French ammonoid successions of the Vocontian Trough comprising Late Valanginian representatives of *Crioceratites*. Previous findings (before 1996) of the stratigraphically oldest *Crioceratites* specimens were only inaccurately dated. This was the reason for distrust about whether the first *Crioceratites* could have evolved prior to the Early Hauterivian. However, Reboulet (1996) unambiguously documented that this genus already appeared during the Late Valanginian.

The ammonoid association from the Butkov Quarry also comprises ribbed evolute shells (with whorls in contact) and shells with slightly gyrocone up to gyrocone, or in older literature criocone shells (planispirally coiled shells in which the whorls do not touch one another), including the first *Crioceratites* of Late Valanginian age.

Geological setting

The Manín Unit holds a special position in the geological structural plan of the Western Carpathians. It is a nappe unit incorporated into the Paleoalpine Accretionary Belt masking the suture zone of both the Central and Outer Western Carpathians. The complicated geological setting of this nappe unit resulted in a non-uniform manifold interpretations of its relation to the units of the Pieniny Klippen Belt and/or to the units of the Central Carpathians. A brief survey of previous opinions on the position and assignation of the Manín Nappe has been compiled by Michalík & Vašíček (1987).

During the Paleoalpine compression, the Manín Nappe was thrusted along with the West Carpathian superficial nappes system across the Tatric Superunit. Therefore, it is believed that the original sedimentation basin of the Manín Unit was situated along the western Fatric periphery (Vašíček & Michalík 1999).

The Butkov Quarry yields the best exposures of the Mesozoic sequence of the Manín Unit. The uppermost Jurassic and Cretaceous carbonates are exploited here as the raw material for cement production in the Považské cementárne cement works, Ladce (Fig. 1). The Upper Jurassic and Lower Cretaceous sequence of the Manín Unit at Butkov, its microfauna and Lower Cretaceous cephalopods have been studied by Vašíček & Michalík (1986), Borza et al. (1987), Michalík & Vašíček (1987), Michalík et al. (1990), Vašíček et al. (1994), Michalík et al. (1995), and Skupien et al. (2003).

The Butkov Lower Cretaceous sequence was divided by Borza et al. (1987) into several lithostratigraphic units. The uppermost part of the Ladce Formation (forming the basal parts of the Lower Cretaceous sequence here) passes upwards into the overlying Mráznica Formation. The fossils dealt with in the paper submitted were collected just from these transitional beds. The lithology of the rock sequence mentioned along with the composition of the Upper Valanginian ammonoid association collected on the 11th level of the Butkov Quarry is presented in the Fig. 2.

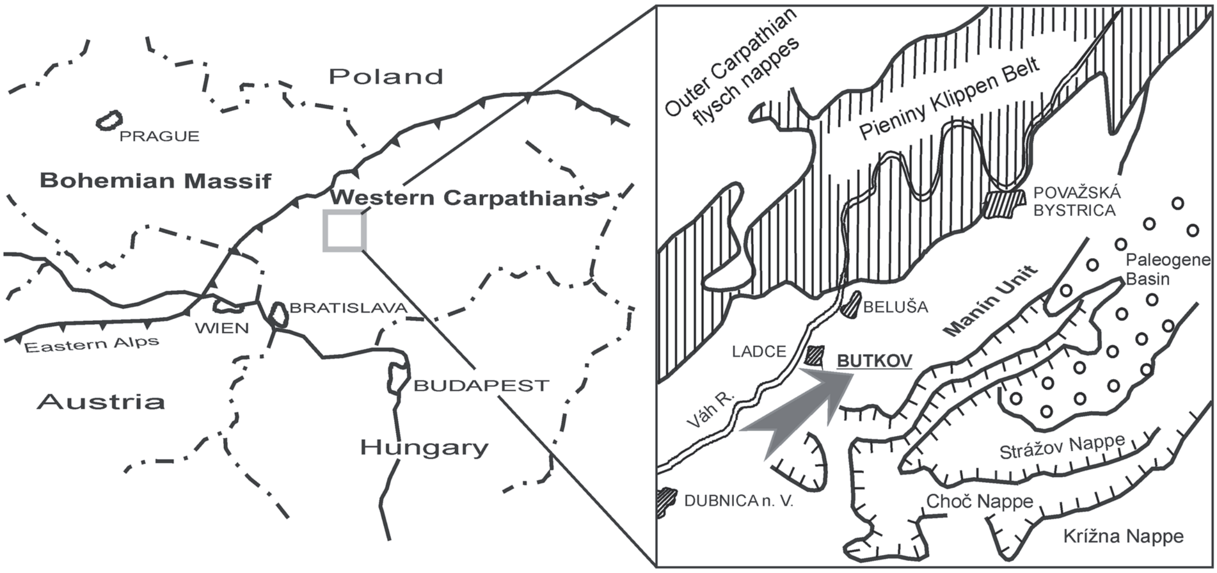

Fig. 1. Geographical and geological situations of the Butkov Quarry.

Material preservation, abbreviations and symbols in text

The ammonoid shells are preserved as sculptural moulds; however, they (especially the gas chambers of the fragmocone) were strongly flattened. As a rule, the earliest whorls of the shells corresponding to the shell diameter of about 7–10 mm are not observable.

On the well preserved shells, the following parameters were measured:

D — shell diameter; D_{max} — preserved maximum shell diameter of the specimen measured (not the maximum of the given species); Wh — whorl height; Uw — umbilicus width. In brackets placed after the values measured in mm the calculated ratios, Wh/D and Uw/D, follow.

Particular specimens are designated by composite symbols expressing: the symbol of the locality (BK); then the number of the quarry level (BK11, or BK7Z), the number denoting distance in meters on the section line after a hyphen (BK11-26) and the serial number of the finding after broken line (BK11-26/6). The specimens illustrated, or referred to in the text, were deposited in the collections of the Slovak National Museum in Bratislava (SNM). The Museum assigned depository numbers to them (e.g. SNM Z 23555).

Taxonomic part

Suborder: **Ancyloceratina** Wiedmann, 1960
Superfamily: **Ancyloceratoidea** Gill, 1871
Family: **Ancyloceratidae** Gill, 1871
Subfamily: **Crioceratitinae** Gill, 1871
Genus: *Criosarasinella* Thieuloy, 1977
Type species: *Criosarasinella furcillata* Thieuloy, 1977

From the original generic diagnosis by Thieuloy (1977) it follows, that the juvenile growth stage should be characterized by trituberculate main ribs and the slightly criocone (= subcriocone) coiling of whorls. The trituberculate ribs disappear in the medium stage. A typical feature is represented by frequent rib bifurcation on the external side. Adult whorls are in contact.

Reboulet (1996), who differentiated microconchs from macroconchs in all the species described by himself, emends partially the original description especially by the fact that the shells may be evolute in all growth stages.

The Slovak material represented by 3 species is characterized by trituberculate ribs on juvenile whorls. *C. mandovi* Thieuloy and *C. subheterocostata* Reboulet have whorls in contact for the whole time of growth; whereas one of favourable preserved specimens of *C. furcillata* has the last but one whorl in the shorter part subcriocone. A similar situation may be seen in one of Thieuloy's specimens (1977: Pl. 5, Fig. 4) as well. Early stages in two of the figured specimens of *C. mandovi* by Reboulet (1996: Pl. 21, Figs. 3, 7) seem to be subcriocone coiled, too.

On the basis of the last mentioned facts, the generic characteristics should be completed by a mention that the whorls of the *Criosarasinella* shells are evolute, or may be in early growth stages subcriocone.

The early whorls of *Criosarasinella* bearing trituberculate main ribs differ from the more simply ribbed early whorls (without trituberculate ribs) of the other subfamily representatives of Neocomitinae Salfeld 1921 (maybe with the exception of *Sarasinella* Uhlig, 1905). On the other hand, the style of ribbing and the tendency towards criocone coiling are closer to *Crioceratites.* For the given reasons, *Criosarasinella* is supposed to be reclassified from the family of Neocomitidae (Neocomitinae subfamily) to the heteromorphic ammonoid family of Ancyloceratidae (Crioceratitinae subfamily).

Criosarasinella furcillata Thieuloy, 1977
Fig. 3.1

1977 *Criosarasinella furcillata* n. sp. — Thieuloy, p. 109, Pl. 5, Figs. 3, 4, ?5

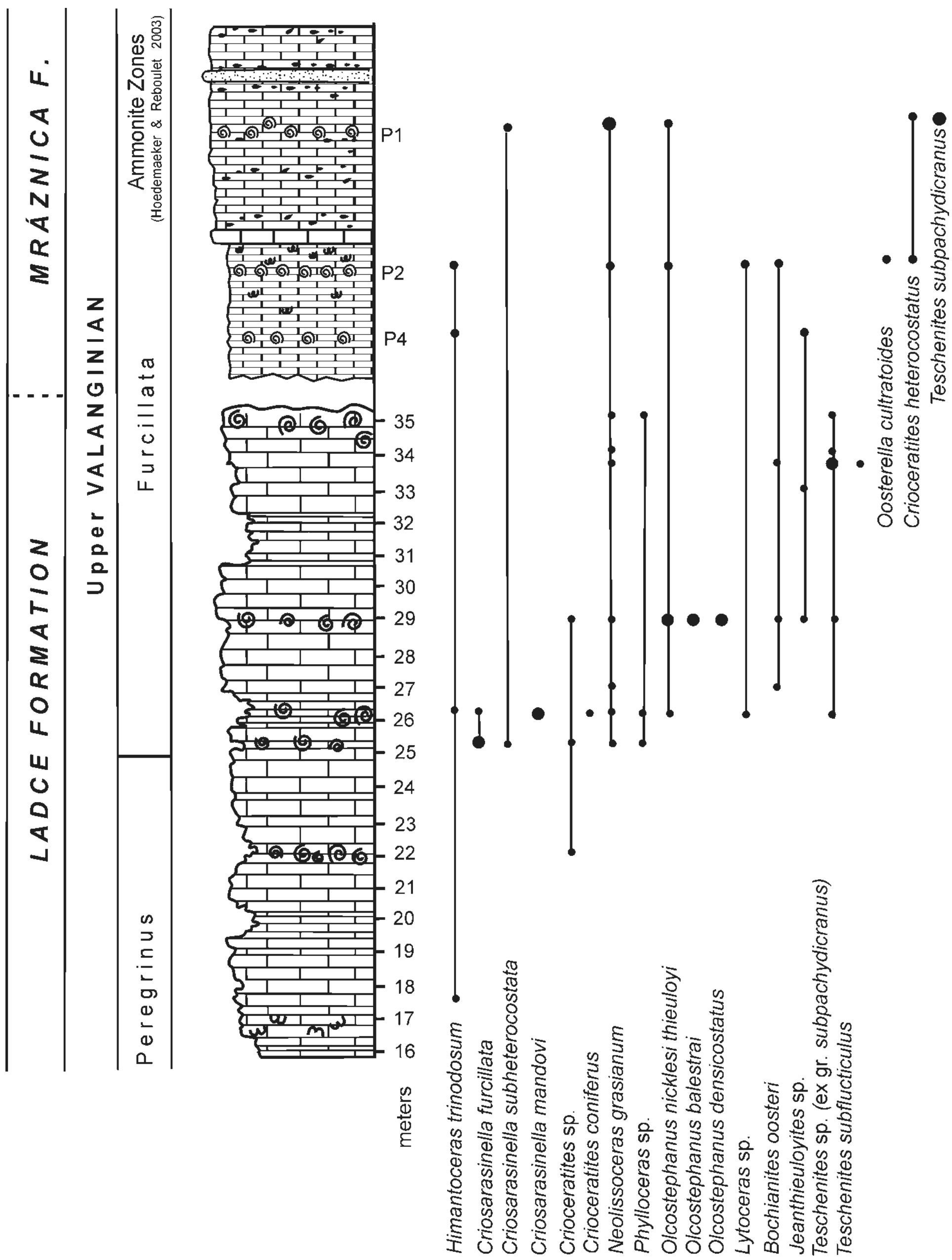

Fig. 2. Section on the 11th level of the Butkov Quarry with the distribution of ammonoids.

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: Several fragments and two favourably preserved shells (field numbers BK11-25/14 = SNM Z 23553 and BK11-25/5) were added to the shell illustrated in Vašíček et al. (1994). In both cases, the most juvenile whorls are not preserved and shells end somewhere near to the beginnings of the body chambers; the latter of the given specimens being preserved as an impression.

Description: Evolute microconchs; some shells subcriocone in the early growth stage. Trituberculate ribs of the specimen 25/14 alternate with simple ribs without tubercles up to the diameter of about 18 mm. The former ribs are usually accompanied by thinner subsidiary ribs running from a common umbilical tubercle. In the next stage, thin and dense ribs follow without differentiation between the main and the subsidiary ones. At first, they are straight, slightly proverse, then they become slightly S-shaped. Ribs run partly in pairs from the umbilical tubercles at the umbilicus, partly in single, and they are not accompanied by any tubercles. On the periphery of the shell, short ribs are inserted between most of the ribs, or are split from them, and their number is higher.

Remarks: In addition to shells coiled evolutely in the whole course of growth, specimens of *Criosarasinella furcillata* in non-adult stages may also occur with temporarily subc-

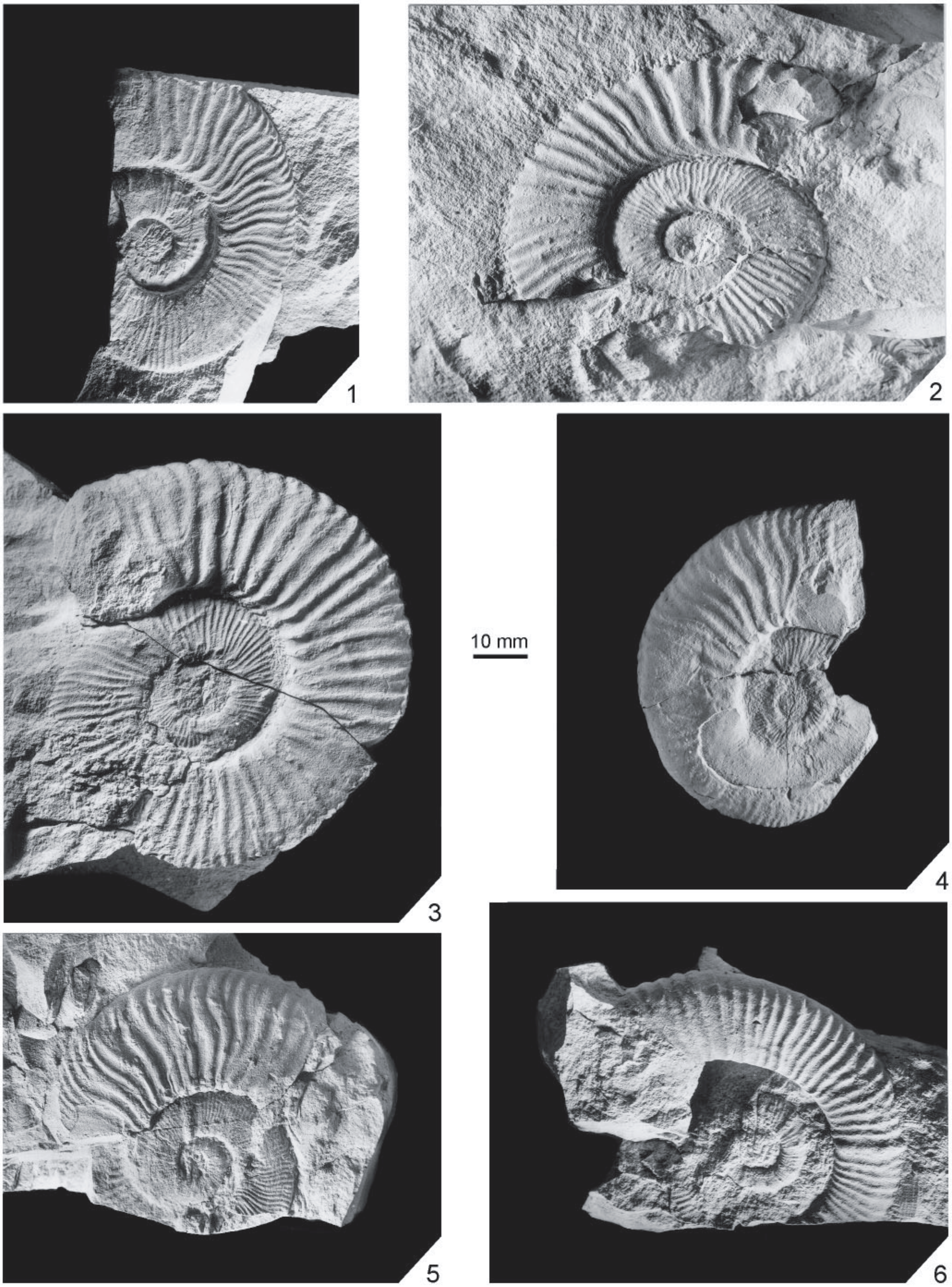

Fig. 3. 1 — *Criosarasinella furcillata* Thieuloy; Spec. SNM Z 23553, microconch (m); 11th level, layer No. 25. **2** — *Criosarasinella mandovi* Thieuloy; Spec. SNM Z 23554, (m); 11th level, layer No. 26. **3** — *Criosarasinella mandovi* Thieuloy; Spec. SNM Z 23555, (m); 7th level, layer No. 51. **4** — *Criosarasinella subheterocostata* Reboulet; Spec. SNM Z 23556, (m); 11th level, P1 horizon. **5** — *Criosarasinella subheterocostata* Reboulet; Spec. SNM Z 23557, (m); 11th level, layer No. 25. **6** — *Crioceratites heterocostatus* Mandov; Spec. SNM Z 23558, (m); 11th level, P2 horizon. Ladce Formation, lower part of the *furcillata* Ammonite Zone (figures 1–5); Figure 6 — Mráznica Formation, *furcillata* Zone. All specimens are figured in natural size.

riocone whorls. This can be documented primarily by the Thieuloy's specimen (1977: Pl. 5, Fig. 4), or by the specimen 25/14 from the Butkov locality. Reboulet (1996) in his synonymy designated Thieuloy's above mentioned specimen of *C. furcillata* (Pl. 5, Fig. 4) on the basis of criocone coiling as *Crioceratites* n. sp. 1 (= *Crioceratites coniferus* in Busnardo et al. 2003). The assignation to *Cr. coniferus* is inconsistent with the fact that the given species bears periodical trituberculate main ribs on all whorls. Numerous bifurcate ribs characteristic just of *Criosarasinella* completely exclude any resemblance to *Crioceratites.*

Measurement: At D=53.5 mm (almost D_{max}), spec. 25/14 has Wh=18.5 mm (0.345) and Uw=21.4 (0.40). At D=59 mm, spec. 25/5 has Wh=20.8 (0.35) and Uw=25.0 (0.42).

Distribution: According to Reboulet (1996), the species given occurs in the Vocontian Trough in the ammonite *furcillata* Zone (Late Valanginian, Reboulet & Atrops 1999).

Occurrence: The new findings come from the Ladce Formation on the 11th level of the Butkov Quarry, 25 m above the base of the section (Fig. 2); fragments of whorls also occur in the horizon of 26 m.

Criosarasinella mandovi Thieuloy, 1977
Fig. 3.2,3

1977 *Criosarasinella mandovi* n. sp. — Thieuloy, p. 110, Pl. 5, Figs. 6, 7 (cum syn.)
1996 *Criosarasinella mandovi* Thieuloy — Reboulet, p. 78, Pl. 16, Fig. 4, Pl. 20, Figs. 1, 7, Pl. 21, Figs. 1, 3–7 (cum syn.)

Material: 4 incomplete shells and 4 relatively well preserved, partly deformed shells (BK7Z-51/8 = SNM Z 23555; BK11-26/21, 24 and 23 = SNM Z 23554, the last one with a more complete counter-impression).

Description: Early whorls of evolute microconchs are well preserved (in spec. 26/23 the shell diameter 8 to 25 mm). Whorls remain in contact on the whole shell. Main trituberculate ribs are somewhat stronger than simple subsidiary ribs. A subsidiary thinner simple rib runs simultaneously from each umbilical tubercle of the main ribs. The subsidiary ribs (usually two ribs between the last trituberculate ribs) are simple. Further, rather thin ribs follow that bear sporadically umbilical tubercles from which ribs in pairs run. The other equally strong ribs are simple. On the external side, rather short ribs are more and more frequently inserted between the ribs. Ribbing changes in the zone of passing the phragmocone into the body chamber. Ribs are stronger and conspicuously sparse. Sometimes, umbilical tubercles are only indicated on them there; but sometimes, they are quite conspicuous. Only rarely, two ribs run from the umbilical tubercles; simple ribs occur most frequently. On the periphery, the majority of ribs bifurcate, or the bifurcation is replaced by short inserted ribs.

Measurement: Microconchs with the average diameter of 70–77 mm. On shell 51/8, at D=76 mm, Wh=25.0 (0.33) and Uw=32.7 (0.43).

Distribution: Reboulet (1996) states *C. mandovi* from Upper Valanginian in the Vocontian Trough (ammonite *furcillata* Zone, Reboulet & Atrops 1999). According to Thieuloy (1977) the species also occurs in Bulgaria (Western Balkanides) — see Mandov (1976), and in the High Tatras in Poland in the Kościeliska Formation (Lefeld 1974).

Occurrence: The findings come from the Ladce Formation on the 11th level (26 m above the base of the section — Fig. 2) and on the 7th level (at 51 m).

Criosarasinella subheterocostata Reboulet, 1996
Fig. 3.4,5

1996 *Criosarasinella subheterocostata* n. sp. — Reboulet, p. 81, Pl. 22, Figs. 1–9 (cum syn.)

Material: Two incomplete sculpture moulds (BK11-P1/1 = SNM Z 23556, BK11-25/4 = SNM Z 23557).

Description: Evolute shells of medium size (preserved by D of about 60 mm). Whorls are not high, approximately correspond to the width of the umbilicus. The whorls overlap one another little. The sculpture of juvenile whorls is clear from the diameter of about 10 mm. They consist of trituberculate main ribs with subsidiary ribs in singles, sometimes occur in pairs. Lateral and marginal tubercles are strong, umbilical ones are weak. Subsequently, the conspicuousness of the lateral ribs is suppressed and at the diameter of about 20 mm, the lateral tubercles fade out. The umbilical tubercles become rather emphasized. From the umbilical tubercles three thin ribs usually run out. Equally strong subsidiary ribs are embedded between bundled ribs.

After the part with imperfectly preserved ribbing, the body chamber follows according to markedly stronger, rather heterogeneous ribbing. From the umbilical tubercles, S-shaped ribs run out in singles, or in pairs. With few exceptions, the ribs bifurcate approximately at the half of the whorl height. On the external side, the ribs are inclined towards the mouth. Over the external side they pass without any interruption.

Measurement: On spec. 25/4, Wh=19.1 (0.38) and Uw=20.6 (0.41) were measured at D=50 mm. The maximum preserved diameter was about 60 mm.

Remarks: *C. subheterocostata* differs from *C. furcillata* and *C. mandovi* by bundles of three ribs running from the umbilical tubercles after the early trituberculate stage and by the lesser number of short inserted ribs on the periphery. The ribbing of the body chamber of *C. subheterocostata* is rather unlevelled, S-shaped. The prevailing majority of the ribs bifurcate at about half the height of the whorl, i.e. far lower than the ribs of the remaining species are inserted (which is the dominating variant), or split. The last whorl has a greater height in comparison with the former species. The height of the whorl and the character of the sculpture of the last whorl remind us somewhat of *Teschenites subpachydicranus* Reboulet, the juvenile whorls of which, however, lack the trituberculate stage.

C. subheterocostata should be, according to its name, close to *C. heterocostata* Mandov sensu Thieuloy (1977). With reference to the fact that shells of *C. heterocostata* are distinctly criocone, *C. heterocostata* does not belong to *Criosarasinella* but to *Crioceratites.*

Distribution: Reboulet (1996) states the uppermost part of the *furcillata* Subzone (Subheterocostata Horizon) from France.

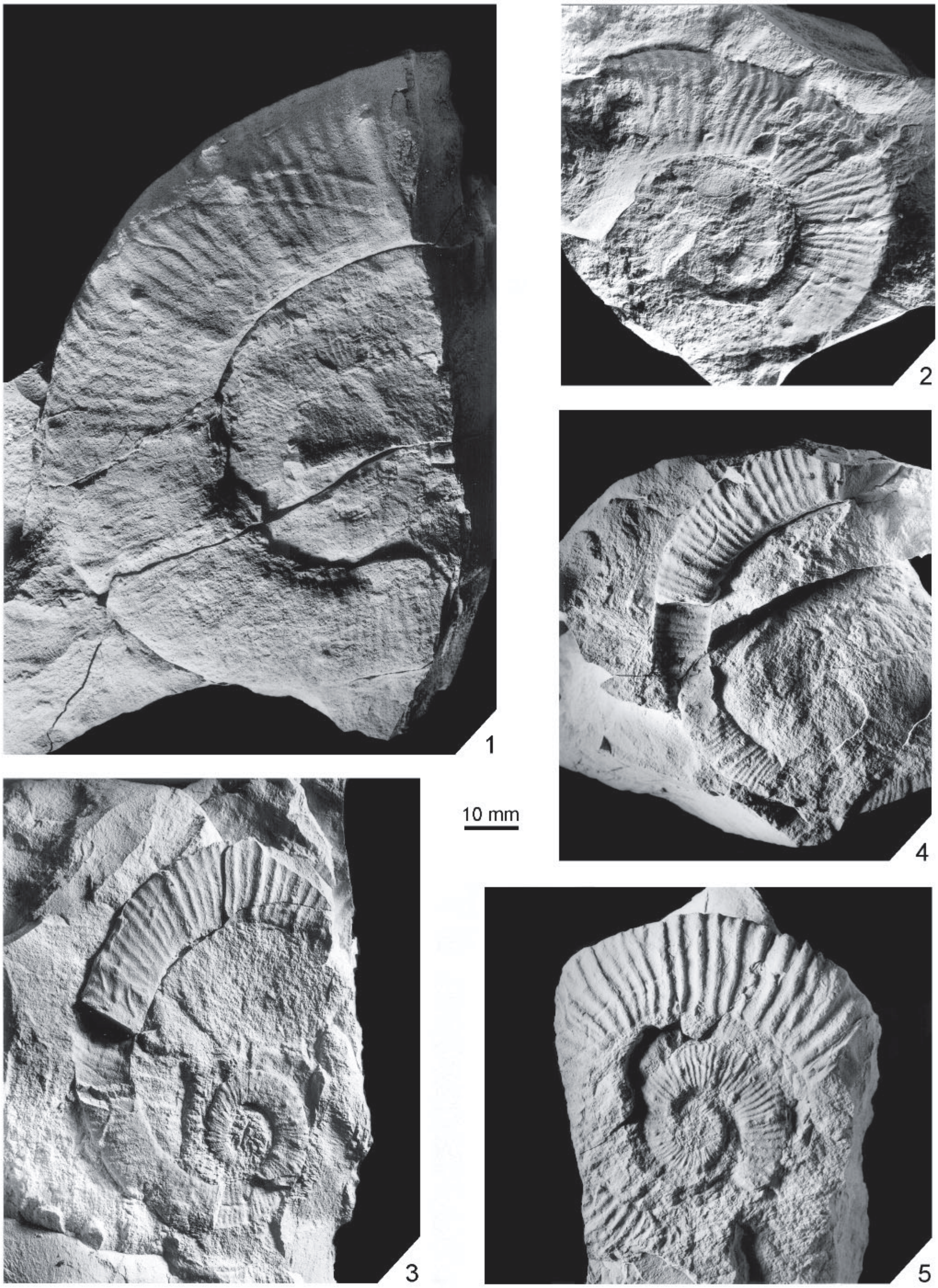

Fig. 4. 1 — *Crioceratites coniferus* Busnardo, Charollais, Weidmann et Clavel; Spec. SNM Z 23560, macroconch (M); 11th level, layer No. 26. **2** — *Crioceratites coniferus* Busnardo, Charollais, Weidmann et Clavel; Spec. SNM Z 23561, microconch (m); 11th level, debris between P1 and P2 horizons. **3** — *Himantoceras trinodosum* Thieuloy; Spec. SNM Z 23562; 11th level, layer No. 26. **4** — *Himantoceras trinodosum* Thieuloy; Spec. SNM Z 23563; 11th level, horizon P2. **5** — *Crioceratites heterocostatus* Mandov; Spec. SNM Z 23559, (m); 11th level, debris below P1 horizon. Ladce (figures 1, 3) and Mráznica Formations, the ammonite *furcillata* Zone (Upper Valanginian). All specimens are figured in natural size. Photos taken by K. Mezihoráková, Ostrava. Before photographing, all specimens were bleached by ammonium chloride. All shells figured will be deposited in the Slovak National Museum in Bratislava under inventory numbers SNM Z 23553–23563.

Occurrence: The Ladce Formation (25 m above the base of the section) and the lower part of the Mráznica Formation (horizon P1) on the 11th level (Fig. 2).

Genus: *Crioceratites* Léveillé, 1837
Type species: *Crioceratites duvali* Léveillé, 1837

Crioceratites heterocostatus Mandov, 1976
Figs. 3.6, 4.5

1976 *Crioceratites (Crioceratites) majoricensis heterocostatus* n. subspec. — Mandov, p. 57, Pl. 5, Figs. 1, 3
?1977 *Criosarasinella heterocostata* (Mandov) — Thieuloy, p. 111, Pl. 5, Fig. 8
1983 *Criosarasinella heterocostata* Mandov — Vašíček et al., Pl. 1, Fig. 5
1986 *Criosarasinella heterecostata* (Mandov) — Vašíček et Michalík, p. 469, Pl. 4, Fig. 3
1996 *Crioceratites primitivus* n. sp. — Reboulet, p. 175, Pl. 23, Fig. 3, Pl.24, Figs. 1–5

Material: Three rather well preserved sculpture moulds, in which the earliest whorls have not been preserved (BK11-P1/14, BK11-P2/5 = SNM Z 23558, BK11-P1/1s = SNM Z 23559).

Description: Criocone shells. The sculpture changes in the three basic stages. In the earliest stage, which is merely unclearly preserved and ends at the shell diameter of about eight mm, thin ribs are clear. They bear slight lateral and marginal tubercles from time to time. Any umbilical tubercles are not visible.

The second stage is characterized by main ribs with three rows of tubercles. At the beginning, strongly developed lateral tubercles are conspicuous with the wide base of a circular outline. Umbilical and marginal tubercles are weaker. Between the main ribs, subsidiary ribs are inserted merely in singles at first. Soon the number of ribs inserted increases slowly and the markedness of lateral tubercles fades out. Sporadically, some subsidiary ribs run from the umbilicus in pairs. When about 4–5 subsidiary ribs are found in the interval between two main ribs, some of them bifurcate on the periphery or short inserted ribs are inserted between them on the same level. Before the end of the phragmocone, when the number of subsidiary ribs between the main ribs is up to 7 (somewhere about the diameter of 30 mm), the trituberculate main ribs disappear. On the rear side, these ribs are marked by a shallow, rather wide constriction.

The third stage represents the body chamber. The main feature is represented by rather strong and sparse, straight and slightly S-shaped ribs separated by occasional shallow constrictions. Some of the ribs can run out in pairs from the umbilicus, others bifurcate on the external side, or the bifurcation can be replaced by short inserted ribs. On the other hand, equal, simple, rather sparse ribs seem to prevail on the body chamber. Marginal tubercles are indicated on all ribs, especially at the beginning of the body chamber.

Measurement: The preservation of the shells does not allow desirable measurement accuracy of the parameters required. The largest shell (P1/1s) attains the maximum diameter only slightly over 72 mm. At D = 72.0 mm, H = 19.8 (0.275), U is about 39 mm (0.54).

Remarks: As it follows from the synonymy, I regard *C. primitivus* as a younger synonym of the name *C. heterocostatus* Mandov. As Thieuloy (1977) states, from the stratigraphical point of view, Mandov's material represents a heterogeneous association of ammonoids, the components of which are of Late Valanginian and partly of Early Hauterivian age. Mandov's holotype of *C. heterocostatus* comes most likely from the Valanginian.

The specimens with criocone shells found at Mt Butkov, which are deformed in various degrees, correspond in size, to the category of microconchs, similarly to the type material of Mandov (1976). Reboulet's material (1996) designated as *Crioceratites primitivus* corresponds partly to incomplete, but usually better preserved macroconchs. With the Slovak specimens, the trituberculate stage disappears probably somewhat later (at D of about 35 to 45 mm) than with the French material (at D of about 30 mm). The Slovak specimens correspond perfectly to Mandov's description (1976), including the interruption of ribs on the body chamber in the siphonal area.

Distribution: Reboulet (1996) placed his findings to the uppermost part of the ammonite *trinodosum* Zone, which corresponds to the *furcillata* Subzone according to Reboulet & Atrops (1999) and to Hoedemaeker & Reboulet (2003). The Bulgarian specimens come from the Western Balkanides.

Occurrence: All the specimens come from the lower part of the Mráznica Formation on the 11th level (horizons P1, P2) from the upper part of the *furcillata* Subzone (Fig. 2).

Crioceratites coniferus Busnardo, Charollais, Weidmann et Clavel, 2003
Figs. 4.1,2

1996 *Crioceratites* n. sp. 1 — Reboulet, p. 174, Pl. 23, Figs. 1, 2, 4, ?Pl. 24, Fig. 7
2003 *Crioceratites coniferus* n. sp. — Busnardo et al., p. 61, Pl. 4, Figs. 3, 6

Material: Two imperfectly preserved sculpture moulds, with which juvenile whorls are not preserved. The lesser shell represents most likely a microconch (BK11-P2/2s = SNM Z 23561), the larger one a macroconch (BK11-26/10 = SNM Z 23560).

Description: The microconch with preserved one and a half of the whorl. The adult whorl is of medium size. The shell is coiled in a free spiral. On the partly preserved phragmocone, on which the sculpture is preserved, there are trituberculate main ribs and thin simple subsidiary ribs, about four in number. The body chamber, indicated by a different mode of fossilization, which forms approximately a half of the whorl, is covered by trituberculate main ribs separated by a bundle of five thinner simple subsidiary ribs. Umbilical tubercles on the main ribs seem to be the weakest tubercles. Lateral tubercles situated considerably high at about 2/3 of the whorl height are conspicuous. Marginal tubercles protrude into nine mm long spines. All the simple subsidiary ribs have indicated marginal tubercles on the last half of the whorl. Subsidiary ribs may sporadically bifurcate at about the height where lateral tubercles are developed. A narrow smooth zone in the siphonal area cannot be excluded.

A criocone macroconch begins with a not high last but one whorl belonging to the phragmocone. The height of the earliest preserved whorl is about 5 mm. Trituberculate ribs are embedded here with 4–5 subsidiary ribs. On the last relatively high half a whorl that probably pertains to the body chamber, trituberculate main ribs can be seen, between which 6–7 subsidiary ribs occur. All the tubercles on the main ribs are roughly equivalent. One to two subsidiary ribs may bifurcate at the lateral tubercles. It cannot be excluded, that all the subsidiary ribs bear weak marginal tubercles and that the ribs in the siphonal area are interrupted, or at least weakened. Shallow constrictions have been observed on the frontal side of the three to four last trituberculate ribs of the final whorl.

Measurement: The microconch attains the shell diameter of a little more than 60 mm, the macroconch about 115 mm. The other parameters could not be measured with the required accuracy. In both the cases, six main ribs fall per half a whorl.

Remarks: Of the specimens given in the synonymy, it is merely Reboulet's juvenile shell (1996) illustrated in Plate 24, Fig. 7 that differs from the Slovak material by coarser ribbing. As it follows from Busnardo's et al. (2003) holotype macroconch morphology, just the other shells illustrated by Reboulet in Plate 23 from *Criosarasinella furcillta* Zone fully correspond to the newly determined *C. coniferus.* Small marginal tubercles on the subsidiary ribs of the body chamber and also the rare bifurcation of inserted ribs on the macroconch of the Slovak criocone material are remarkable. The features presented indicate a link between *C. coniferus* and *C. heterocostatus.*

Busnardo et al. (2003) consider that *Crioceratites* (*C. coniferus*) appear at the base of the Hauterivian stage only. The Valanginian "*Crioceratites primitivus* Reboulet" is either regarded as *Himantoceras* Thieuloy, 1964 or (at least) phyletically related to it. The coiling type of one of the specimens illustrated by Reboulet (1996: Pl. 24, Fig. 1) indicates the latter possibility. However, the shell formation of other specimens of *Cr. heterocostatus (= Cr. primitivus*) and shells of *Himantoceras* is anyhow different (also from the point of view of a growth in whorl height), and thus the opinion presented may be disputed. On the other hand, the *Crioceratites coniferus,* whose generic assignation is undoubted, lacks himantoceratoid coiling. According to the findings described here and to Reboulet's findings (1996) as well, both the above mentioned species and genus appeared as early as in the Late Valanginian *Criosarasinella furcillata* Zone.

Distribution: With the exception of the specimen in his Plate 24, Reboulet (1996) reported *C. coniferus* from the upper part of the Late Valanginian *furcillata* Subzone in the Vocontian Trough; Busnardo et al. (2003) indicated the occurrence of the holotype specimen in the basal Hauterivian *radiatus* Zone in the External Prealps in Switzerland.

Occurrence: The macroconch comes from the upper part of the Ladce Formation on the 11th level of the Butkov Quarry, from horizon 26, where it occurs together with *Criosarasinella furcillata* and *C. mandovi;* the microconch was found in the debris between horizons P1 and P2 on the 11th level (Fig. 2) in the topmost Valanginian rocks.

Genus: *Himantoceras* Thieuloy, 1964
Type species: *Himantoceras trinodosum* Thieuloy, 1964

Himantoceras trinodosum Thieuloy, 1964
Fig. 4.3,4

1996 *Himantoceras trinodosum* Thieuloy — Reboulet, p. 171, Pl. 25, Figs. 6–11 (cum syn.)

The material consists of two fragments of the last whorl and of another two rather complete sculptural moulds. One of them preserved the last but one whorl (BK11-26/19 = SNM Z 23562) and the other one belongs to the adult part of the shell that pertains to the phragmocone in part and to the body chamber in the remaining part (BK11-P2/1 = SNM Z 23563).

Description: The best preserved shell begins with criocone whorls that pass into free, long, arc/like arm in maturity. Even at the preserved most juvenile part, trituberculate ribs can be seen. Umbilical tubercles are the weakest there; marginal tubercles are the strongest. Between the main ribs, variable numbers of thin ribs are inserted (0–3). Further, all the tubercles are as strong as the marginal tubercles and the number of subsidiary ribs increases to 4–6. On the body chamber, subsidiary ribs are markedly stronger and more sparsely distributed. The number of them varies from six to seven.

Measurement: The arch of the last half-whorl of spec. 26/19 has a span (D) of 72 mm. The whorl height of the earliest preserved part is four mm, at the end of the shell it reaches about 15 mm.

Remarks: The Slovak specimens are very close to the material illustrated by Thieuloy (1979: Pl. 3, Figs. 10, 11) from the La Charce section. The coiling of shells of representatives of *Himantoceras* (including *H. lessinianum* Faraoni, Flore, Marini, Pallini et Pezzoni, 1997 described recently) is different from the coiling of typical *Crioceratites* representatives.

Distribution: *H. trinodosum* served as the Late Valanginian zonal species as late as a short time ago (Reboulet & Atrops 1999). In addition to French localities (Vocontian Trough), it is known from Spain (Betic Cordillera), from the Western Carpathians (imperfectly preserved fragments from the Strážovská hornatina Upland and from the Pieniny Klippen Belt) and from Bulgaria.

Occurrence: Two specimens come from the upper part of the Ladce Formation and two from the lower part of the Mráznica Formation on the 11th level (17.5 and 26 m above the base of the section and horizons P4 and P2 — see Fig. 2); the last one comes from the debris at the prospecting gallery No. 3 on the 6th level.

Discussion

Recently, the oldest occurrences of true *Crioceratites* were usually attributed to the upper part of the Lower Hauterivian. However, in 1996, Reboulet proved that the first Crioceratitinae appeared as early as in the Late Valanginian in the Vocontian Trough. On the other hand, Busnardo et al. (2003) have made some critical remarks on Reboulet's taxonomic assignation of his Late Valanginian species.

Criosarasinella, occupying a rather unclear position, is one of three ancyloceratid ammonite genera which occur at Mt Butkov. According to Thieuloy (1977), adult whorls of *Criosarasinella* shells remain in contact. On the other hand, (seldomly preserved) juvenile whorls can be slightly criocone coiled and poses trituberculate ribs. In spite of this fact, Thieuloy (1977) and also subsequent authors (including Wright et al. 1996 — new "Treatise") regard *Criosarasinella* as the representative of Neocomitinae. However, the trituberculation of main ribs on internal whorls, or the subcriocone shells of *C. furcillata* and *C. mandovi* contradicts the rules of phylogenesis to such a degree, that *Criosarasinella* cannot be assigned to the neocomitids. Anyway, Thieuloy himself (1977) has stated subsequently that *Criosarasinella* represents a new element in the conception of the ancyloceratid origin. According to him, juvenile whorls may be interpreted as a new phenomenon passing from the internal whorls to the body chamber.

This peculiar new morphology is distinctly shown by *Criosarasinella mandovi* and by the somewhat younger *Crioceratites heterocostatus.* The shell of the latter species is already conspicuously criocone in the whole range. However, Reboulet (1996) believed that the character of *Criosarasinella* ribbing does not reputedly permit (?) the primitive crioceratids to be derived from it.

In addition to the Late Valanginian *C. heterocostatus*, another species of Crioceratitinae, i.e. *Crioceratites coniferus* Busnardo occurs at Butkov as well. They occur in the same horizon as *Criosarasinella mandovi* (then even somewhat earlier than *C. heterocostatus*). Like *C. heterocostatus*, the shell of *C. coniferus* is also distinctly criocone. In contrast to *C. heterocostatus,* it bears trituberculate main ribs even on the body chamber.

According to Busnardo et al. (2003), *C. coniferus* safely occurs in the Early Hauterivian *radiatus* Zone. Thus, the Swiss findings bridge the gap between Upper Valanginian and Lower Hauterivian *Crioceratites* occurrences, mentioned by Reboulet (1996).

The stratigraphic position of criocone shells and the composition and age of the accompanying association of ammonoids from the Upper Valanginian Ladce and Mráznica Formations at Butkov are very close to those of the Late Valanginian ammonoid association of the same age from the Vocontian Trough (see Reboulet 1996).

In accordance with Cecca's conception (1997), it is supposed that the heteromorphic ammonoids (bochianitids, protancyloceratids, etc.) represented a special Tithonian to Early Valanginian evolutionary branch that was not followed by the ancyloceratid branch. The character of shell coiling of the oldest ancyloceratids considerably varied, similarly to other groups at the beginning of their evolution. The ancyloceratids appeared during the upper Late Valanginian, probably about the end of the ammonite *verrucosum* Zone. A possibly solution was indicated by Reboulet (1996: Figs. 18 and 19) in the phylletic appearance of *Himantoceras* from *Neocomites neocomiensis* (d'Orbigny) via *N. beaumugnensis* Sayn and *Rodighieroites* Company.

Conclusion

In addition to planispirally coiled shells with overlapping whorls, the rich collection of Upper Valanginian ammonoids from the Western Carpathian Mt Butkov locality contains heteromorphic ammonoids with trituberculate ribs. The whorls of *Crioceratites* and *Himantoceras* are mostly not in contact at all, but in other forms (like *Criosarasinella*), they touch one another and may have a tendency towards uncoiling. Of three species of this genus that occur at Butkov, the *C. mandovi* and also *C. furcillata* zonal species document that on some shells, whorls may lose contact with the following whorls, i.e. subcriocone shells appear.

Trituberculate ribs on early whorls of *Criosarasinella* and their sporadic subcriocone coiling indicate a closer relationship to *Crioceratites* than to neocomitids, to which *Criosarasinella* has been assigned so far. In the contribution submitted, the *Criosarasinella* is classified as an ancyloceratid (Crioceratitinae subfamily) and not as neocomitid (Neocomitinae subfamily). As for stratigraphy, the ammonoid association studied belongs to the *Criosarasinella furcillata* Zone, as shown by the occurrence of the zonal species. It also follows that *Crioceratites heterocostatus* and *C. coniferus* represent the oldest representatives of the *Crioceratites,* showing that this genus evolved as early as in the Late Valanginian.

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