GEOLOGICA CARPATHICA, 46, 5, BRATISLAVA, OCTOBER 1995
303 – 310

THE LAST LAMELLAPTYCHI IN THE HAUTERIVIAN SEQUENCE OF THE KRÍŽNA NAPPE, CENTRAL WESTERN CARPATHIANS

ZDENĚK VAŠÍČEK[1] and JOZEF MICHALÍK[2]

[1]Department of Geology and Mineralogy, Mining University, Třída 17. listopadu, 708 33 Ostrava-Poruba, Czech Republic
[2]Geological Institute, Slovak Academy of Sciences, Dúbravská 9, 842 26 Bratislava, Slovak Republic

(Manuscript received March 14, 1995; accepted in revised form June 14, 1995)

Abstract: The topmost Hauterivian aptychi collection from the Pseudothurmannia Beds of the Mráznica Formation consists of three subspecies of *Lamellaptychus angulocostatus* (Peters) (*L. a. angulocostatus, L. a. angulicostatus, L. a. radiatus*), accompanied by rare *L. filicostatus* Stefanov. These forms represent the stratigraphically youngest lamellaptychi association at all. The decline of the lamellaptychi-bearing ammonites is interpreted as an effect of contemporaneous changes in both paleoceanographic (sea current system) and paleobiogeographic ("Urgonian" carbonate platform development) patterns, as well as in the composition of marine microplankton associations, traceable in the area studied.

Key words: Western Carpathians, Hauterivian, aptychi.

Introduction

General setting

Lower Cretaceous pelagic marly limestones of the Krížna Nappe cropping out on the Polomec Hill near Žilina (Fig. 1) are exploited by the Lietavská Lúčka cement factory. The litho- and biostratigraphy of these sediments exposed by a complex of quarries have been studied by Borza et al. (1984), Vašíček et al. (1994), Michalík & Reháková (1994), etc. A rich collection, comprising many hundreds of ammonites, dozens of aptychi and belemnite specimens has been obtained from this sequence during several years of field works in the Polomec quarries (Fig. 2). Part of this cephalopod fauna has already been studied by Vašíček & Michalík (1988), Duraj et al. (1990) and Vašíček et al. (1994).

This paper, contributing to the IGCP Project No. 362 UNESCO "Tethyan and Boreal Cretaceous Correlations" deals with the taxonomy and distribution of aptychi derived from the sequence well dated by ammonites as Late Hauterivian in age. This conclusion is in accordance with the modern Mediterranean Early Cretaceous ammonite zonal division (cf. Hoedemaeker et al. 1993). These aptychi represent remnants of the last descendants of Early Cretaceous evolutionary stocks. The paper was supported by the Grant Agency for Science in the framework of the Grant Project No. 1081.

Lithostratigraphic setting

The Lower Cretaceous sequence in the Austroalpine and central Carpathian units was characterized (Reháková 1991, 1993, 1995) by the dominance of hemipelagic nannoconid and calpionellid wackestones (the "Neocomian facies" of older authors, cf. Vašíček et al. 1983). The Valanginian to Lower Aptian part of this sequence is more argillaceous (a large admixture of terrigene material was connected with paleogeographical and paleobiological changes). A considerable part of these deposits in the Fatric Zone of Central Western Carpathians is formed of well bedded spotted marly limestones with marly intercalations belonging to the **Mráznica Formation** (Borza et al. 1987) and its equivalents (Fig. 3).

The base of the Mráznica Formation is diachronic, getting younger towards the shallower parts of the basin. The stratigraphic span of this formation is also changeable: it is Valanginian in the Butkov Unit, but its cherty equivalents named as the **Hlboč** and **Koscieliska Formations** are principally Valanginian and Hauterivian in age. The typical Mráznica Formation in the Zliechov Unit was deposited from the latest Berriasian until the middle Aptian, being completely substituted by the black shale development of the **Párnica Formation** (Fig. 3). Several members have been distinguished in the Mráznica Fm. Breccia beds composed of carbonate clasts derived from underlying Tithonian and Berriasian limestones close to the base of the formation were designated as the **Nozdrovice Breccia** by Borza et al. (1980). A pronounced fluxoturbidite complex in the middle of the formation has been named as the **Strážovce Turbidite Member** by the same authors. Overlying dark grey marlstones and marly limestones were named the **Ptychoceras Beds** by Vašíček & Michalík (1988). An important level of fossiliferous limestones occurring in several sections were described as the **Pseudothurmannia Beds** by Adamíková et al. (1983). Although regarded by Borza et al. (1984) as earliest Barremian in age, they belong to the top of the Hauterivian sequence.

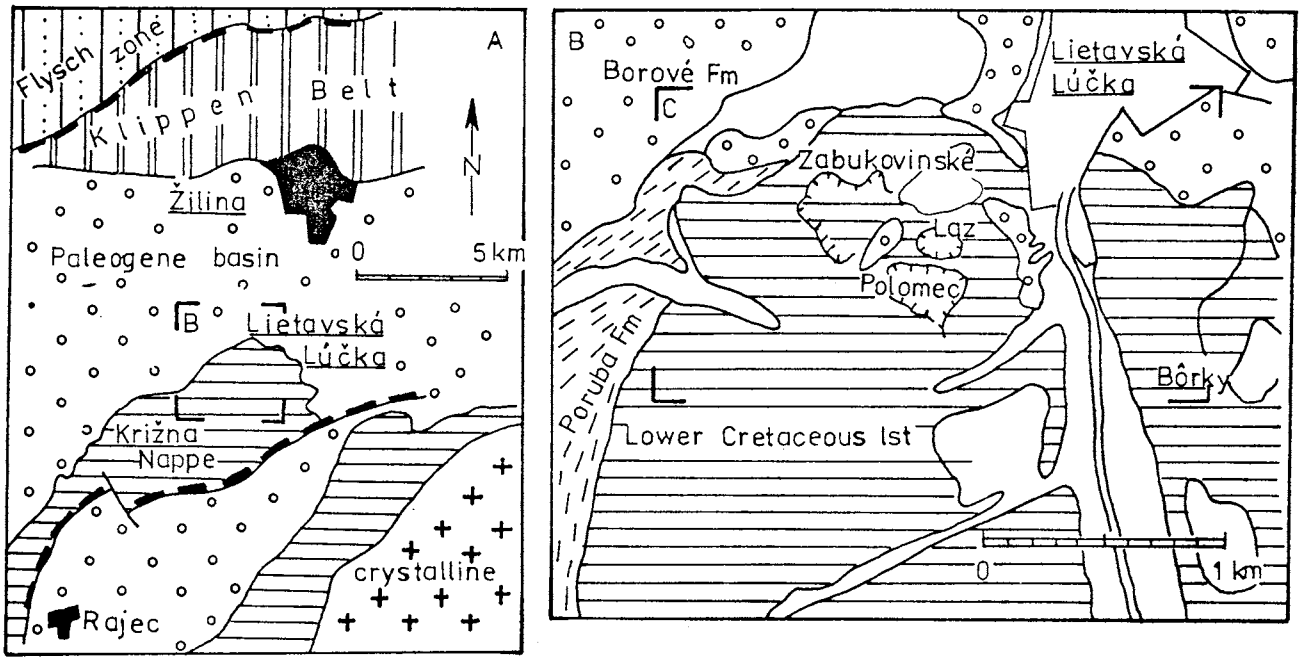


Fig. 1. Localisation of the Polomec Hill near Žilina (NW Slovakia).

Systematic part

Basic morphology of aptychi

Calcitic pair-arranged aptychi valves served as ammonite jaw elements closing the mouth of the ammonite shell (Lehmann & Kulicki 1990) of the retracted animal. Formerly, the supposition of this combined function has been rejected by authors who regarded these shell elements either as lids (Trauth 1927; Houša 1974 etc.), or jaws of ammonites (Lehmann 1972; Lehmann et al. 1980 etc.).

The morphological nomenclature of aptychi valves and their sculpture is not commonly used by different authors. The terminology used here was derived from that introduced by Trauth (1927) and modified by Gasiorowski (1959, 1960, 1962a, b) and Houša (1974). There are several morphological elements on the aptychus valve, which can be regarded as principal (Vašíček et al. 1994). The direct contact line of the valves is described as the **symphysal (harmonic) margin**. This margin starts below the **apex** of the valve and ends near the opposite **terminal area**. The vaulted area opposite to the direct symphysal margin is designated as the **outer (terminal) margin**, the part near the apex as the **anterior margin**. The studied valves are highly vaulted with a **distinct keel**, passing obliquely from the apex to the terminal part of the valve. More-or-less distinct **lateral depression** can be seen below keel on several valves.

In a coincidence with Gasiorowski (1960), the following size parameters could be measured on the aptychi valves (see Fig. 4): S - length of the symphysal margin, L - maximum length of the valve, L_{at} - height of the valve at the maximum vaulting. The ratios of S/L_{at}, L/L_{at} and S/L, counted from the measured parameters can characterize the shape of the valves. Gasiorowski used another parameter designated as l (the distance from the projection of maximum vaulting of outer margin on symphysal margin to the terminal apex). However, this parameter is an extremely unprecise value because of problems with designating the limiting point on the outer margin of imperfectly preserved valve contours. Highly vaulted valves must also be excluded from measuring. This is because the ratio l/L was neglected in our study. Besides length parameters, several angle values on angular ribs of the outer valve surface can also help in making verbal descriptions of species and subspecies categories more precise (see Fig. 4).

Taxonomy of aptychi

As pointed out above, the aptychi classification is artificial. Beside the "species" category, the term "variety" has also been currently used in former papers dealing with aptychi. In accordance with the more modern Renz's (1972-1985) conception, trinominal nomenclature roughly equivalent to the "subspecies" category of the natural taxonomical system will be used here by us instead of the "variety" (var.).

In 1854, Peters described (but never illustrated) *Aptychus angulocostatus*. Four years later, Pictet & Loriol (1858) described (and also illustrated) a sole aptychus valve, only slightly different from the Peters' species (they probably never knew his paper) as a new species, called *Aptychus angulicostatus*. By such a way, the inconsistence of Peters resulted in one of the major persistent problems of all the history of the *Lamellaptychus* Trauth literature: designation of the principal morphotype either as *"angulocostatus"* or *"angulicostatus"*. Trauth, the founder of a new aptychi classification, in his monography of *Lamellaptychus* (1938) used the name *L. angulocostatus* (Peters) for the morphotype with angularly arched ribs. However, he illustrated the type- and several paratype specimens of Pictet & Loriol (1858), instead of the holotype specimen of Peters. A hundred and twenty years later, Houša (1974, Pl. 7) selected a lectotype from four specimens in the Peters original collection.

All the aptychi found in the Polomec Hill belong to cumulative morphotype called *Lamellaptychus angulocostatus* (Peters) of the artificial genus *Lamellaptychus* Trauth 1927 with angularly bro-

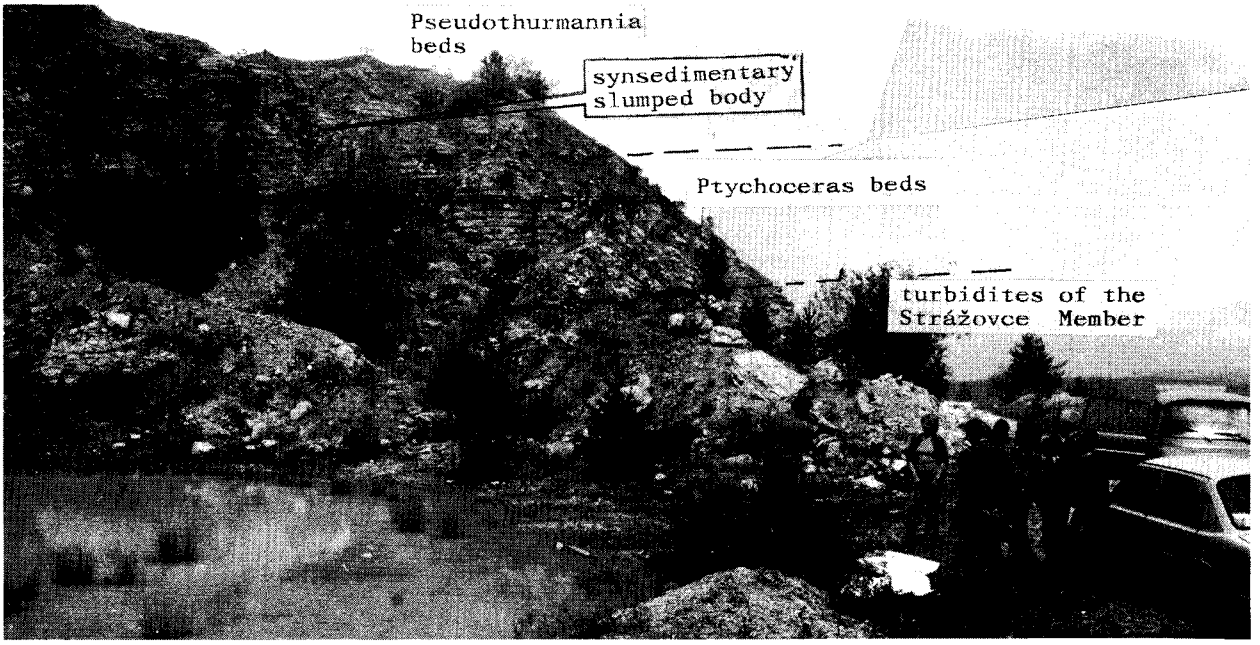


Fig. 2. View on the rock wall of the Polomec Quarry (fourth level) exposing almost complete section of Upper Hauterivian deposits.

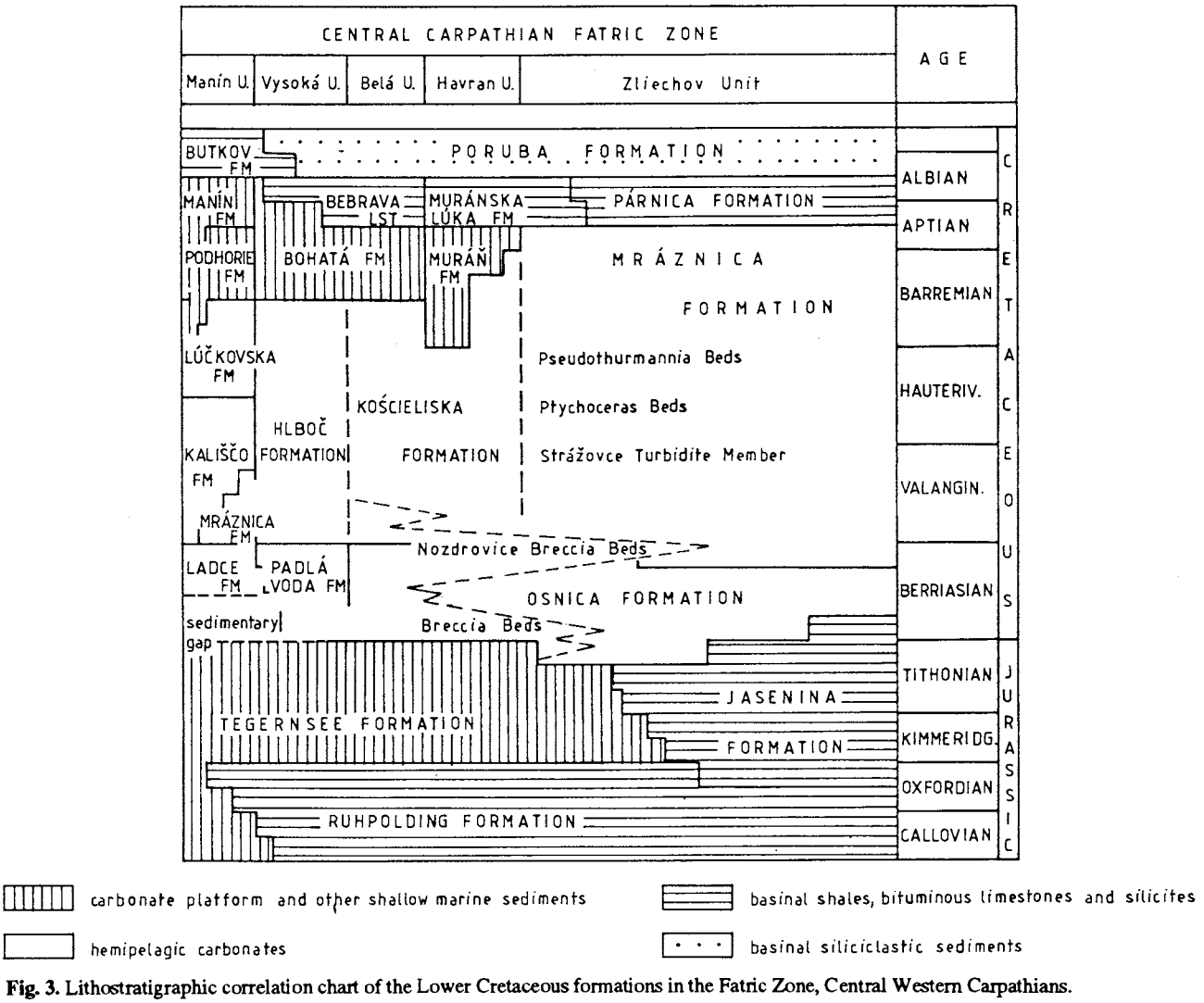


Fig. 3. Lithostratigraphic correlation chart of the Lower Cretaceous formations in the Fatric Zone, Central Western Carpathians.

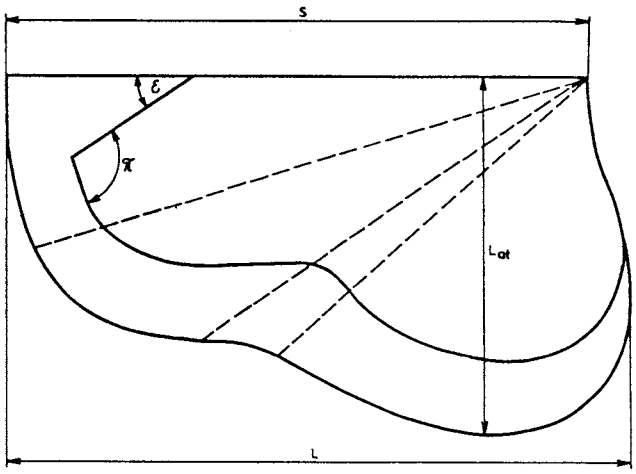


Fig. 4. Schematic illustration of the aptychus valve morphology with indication of the parameters measured.

ken ribs. We correlated them with the species holotypes in the Peters' collection in Geologische Bundesanstalt in Vienna, as well with a gypsum mold and photography of the type specimens of Pictet and Loriol lent by the Museum of Natural History in Geneva. Following systematical part (containing also detailed description of morphotypes) attempts to solve this nomenclatoric problem on the base of this comparison.

Descriptions

Genus *Lamellaptychus* Trauth 1927

Lamellaptychus angulocostatus (Peters 1854)

Strongly vaulted valves with a prominent keel, sometimes also with lateral depression. In certain distance from symphysal margin, prominent lamellar ribs are curved back to apex. The angle between arms of angularly curved ribs is unusually sharp on juvenile forms, but it reach 100–115° in adult and gerontic specimens. The curvature of the latter could be less sharp, more gently bended. The ribs are cut at a sharp angle by symphysal margin. Valve wall is thicker in terminal part; thin-walled apex part is usually less well preserved.

The presence or absence of a lateral depression, curvature of ribs in the lateral depression, the possible presence of radial striation on the valve surface, as well as other morphological details allow us to distinguish four morphological subtypes of *Lamellaptychus angulocostatus* in a subspecies category: *L. angulocostatus angulocostatus, L. angulocostatus angulicostatus, L. angulocostatus fractocostatus* and *L. angulocostatus radiatus*: the former two types being connected by transitional forms. As usual, the valves without preserved juvenile stage are not distinguishable on this subspecific level.

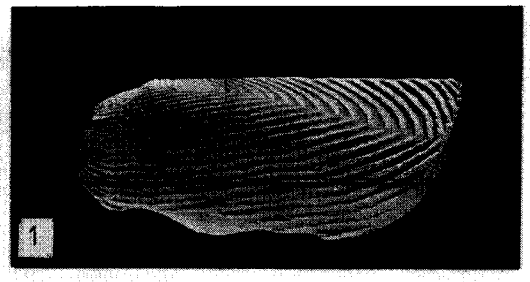
The distinguishing of *L. angulocostatus longus* Trauth as independent subspecies, which ought to be characterized by the value of $L_{at}/L < 0.40$ according to its author (Trauth 1938), remains problematic. Relying on our material, we assume that this subspecies has been estimated on the basis of inprecise measurement of the height parameter L_{at}, when the real outer margin of valves with higher value was either incompletely preserved, or covered by sediment. "Slender" valves of this subspecies resulted from a false lower value of L_{at} in the ratio of L_{at}/L.

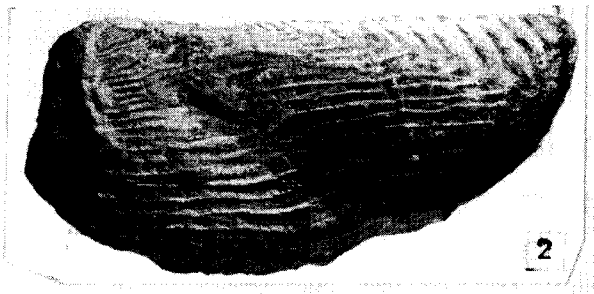
L. filicostatus Stefanov with very sharp angle of angularly broken ribs and *L. cristobalensis* O'Connell with initial ribs gradually loosing angular curvature and with crenulation of final ribs in the angular area represent two independent, but morphologically close species of *L. angulocostatus*.

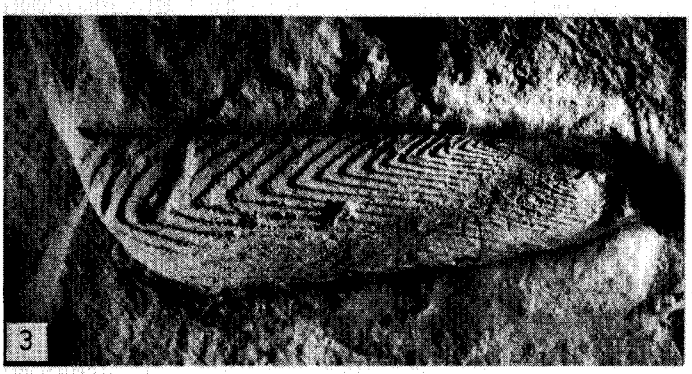
Lamellaptychus angulocostatus angulocostatus (Peters 1854)
Pl. I: Figs. 1, 5

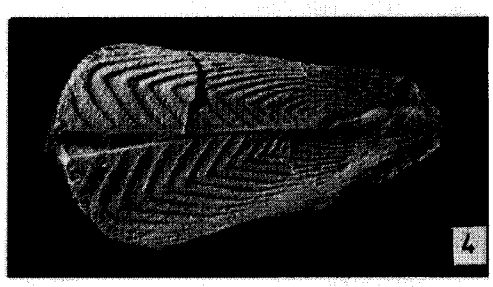
1854 *Aptychus angulocostatus* Peters; Peters, p. 441
1857 *Trigonellites Didayi* Giebel; Ooster, p. 28, Pl. 7, Figs. 14, 15
?1921 *Aptychus pimientensis*, new species; O'Connel, p. 10, Figs. 15–18
non 1938 *Lamellaptychus angulocostatus* (Pet.) f. typ.; Trauth, p. 204, Pl. 14, Figs. 12, 13 (= *L. angulocostatus angulicostatus* Pictet & Loriol)
?1938 *Lamellaptychus angulocostatus* (Pet.) var. n. *longa*; Trauth, p. 209, Pl. 14, Fig. 18
1942 *Lamellaptychus angulocostatus* (Peters); Imlay, p. 1459, Pl. 11, Figs. 8–9, ?10
1956 *Lamellaptychus angulocostatus* (Pet.) cf. f. typ. Trauth; Gasiorowski, p. 292, Pl. 1, Figs. 2, ?1
1959 *Lamellaptychus angulocostatus* (Pet.) cf. f. typ. Trauth; Birkenmajer & Gasiorowski, p. 350, Pl. 47, Fig. 2
1960 *Lamellaptychus angulicostatus* Pictet & Loriol; Drushtchits & Kudryavcev, p. 308, Pl. 41, Fig. 7a, non Fig. 7b (= *?L. atlanticus* Hennig)
1961 *Lamellaptychus angulocostatus* (Peters); Stefanov, p. 212, Pl. 1, Figs. 1–4, non Fig. 6 (= *L. angulocostatus angulicostatus* Pictet & Loriol)
1962a *Lamellaptychus angulocostatus* (Pet.) f. typ. Trauth; Gasiorowski, p. 258, Text-fig. 16, Fig. 12
1962b *Lamellaptychus*, group D (d γ), *angulocostatus* (Pet.) var. 1; Gasiorowski, Pl. 8, Fig. 3
1962b *Lamellaptychus*, group D (d γ), *angulocostatus* f. typ. Trauth; Gasiorowski, Pl. 8, Fig. 4
1965 *Lamellaptychus angulocostatus* Peters; Fazzini, p. 22, Pl. 1, Figs. 1–8
1968 *Lamellaptychus angulocostatus* (Pet.); Jaksch, p. 118, Figs. 85–88
1974 *Lamellaptychus angulocostatus* (Peters); Houša, p. 31, Pls. 1, 2, Figs. 1–3, Pl. 3, Pl. 4, Figs. 1, 6, non Figs. 2–4, 7, 8 (= *L. angulocostatus angulicostatus*), Pl. 5, Figs. 1, ?2–6, Pl. 7
1976 *Lamellaptychus angulocostatus* (Peters) forma typica Trauth; Avram, p. 58, Pl. 10, Fig. 10
1978 *Lamellaptychus angulocostatus planus* n. ssp.; Renz, Pl. 1, Fig. 16
1985 *Lamellaptychus angulocostatus* (Peters); Renz & Habicht, p. 413, Pl. 5, Figs. 10, ?15, non Fig. 9 (= *L. filicostatus* Stefanov), non Fig. 12 (= *?L. angulocostatus fractocostatus* Trauth)

Plate I: Aptychi from the Mráznica Formation, Polomec quarries near Lietavská Lúčka. Photo 1 taken by Mrs. M. Grmelová (Mining University, Ostrava), photo 2 by Mr. E. Lanterno (Geneva Museum), photos 3–11 by Mrs. K. Mezihoráková (Ostrava University). All the specimens were whitened by ammonium chloride. Magn. 2×. With the exception of lectotypes, all the specimen figured are deposited in the collection of the Slovak National Museum in Bratislava. **Fig. 1.** *Lamellaptychus angulocostatus angulocostatus* (Peters). Lectotype, "Neocomian" at Waidhofen an der Ybbs, Austria. Collection of Geologische Bundesanstalt in Vienna. **Fig. 2.** *Lamellaptychus angulocostatus angulicostatus* (Pictet & Loriol). Lectotype, "Neocomian" at Hivernages (Voirons), France. Collection of the Museum de Histoire Naturelle, Geneva. **Figs. 3, 4.** *Lamellaptychus angulocostatus angulicostatus* (Pictet & Loriol). Specimens No. LL V-250/5 (Fig. 3), SNM Z 21175. Topmost Hauterivian, "Na piatej" Polomec Quarry (250 m). **Fig. 5.** *Lamellaptychus angulocostatus angulocostatus* (Peters). Specimen No. PL LL 3/2, "Na Laze" Polomec Quarry, Upper Hauterivian. **Fig. 6.** *Lamellaptychus cristobalensis* (O'Connel). Specimen SNM Z 21174. Upper Hauterivian, 4th level of the Polomec Quarry (50 m). **Figs. 7–9.** *Lamellaptychus angulocostatus radiatus* Trauth. Specimen LL IV-270/8, Upper Hauterivian, 4th level of the Polomec Quarry (section 270/8). Two views on the same specimen. **Fig. 10.** *Lamellaptychus filicostatus fractocostatus* Vašíček, Michalík & Reháková. Specimen PL III/39, Upper Hauterivian, "Na Laze" Polomec Quarry, Ptychoceras Beds. **Fig. 11.** *Lamellaptychus filicostatus filicostatus* Stefanov. Specimen LL V 250/A. Topmost Hauterivian, "Na piatej" Polomec Quarry (section 250/A).


1


2

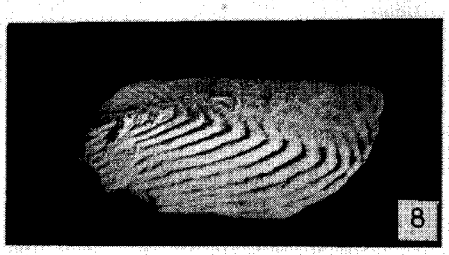

3

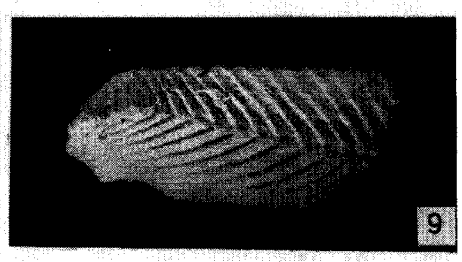

4

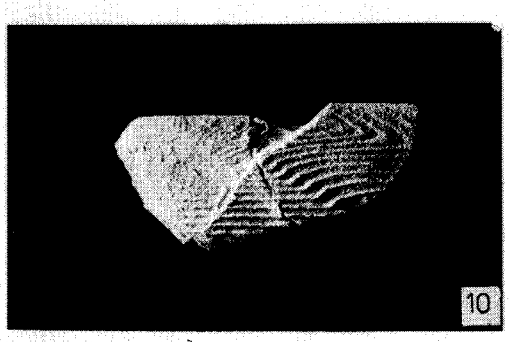

5

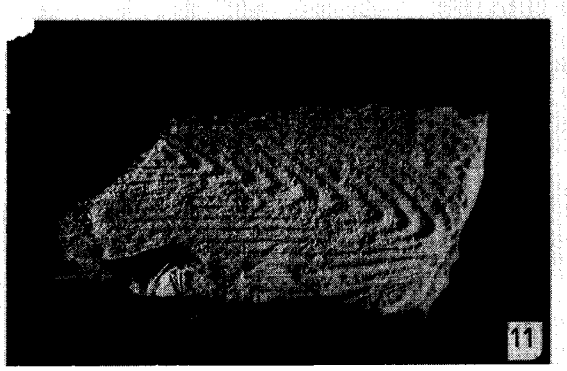

6


7


8


9


10


11

Lectotype: Selected by Houša (1974, Pl. 7: Figs. 1-4) from the original collection of Peters (1854). This type is re-illustrated in this paper, Pl. I: Fig. 1.

Material: 21 mostly incomplete valves, usually with incompletely preserved apex area.

Description: Small and medium-sized valves with prominent keel, but without (or only indicated) lateral depression. The frequence of relatively dense ribs is approximately equal on the flanks and in the symphysal area of the valves. The ribs on the flanks are usually straight, parallel with symphysal margin up to slight curvation in the keel area.

The ribs are bent between the keel and the symphysal margin: the bending angle of juvenile ribs is sharp (about 30°), later increases (up to 65°), in consequence of widening of arched part of the post-juvenile ribs. The angle measuring of these ribs is less precise. Adult ribs are arch bent, the angle of arms is 90, later 100-105°. Two or three last ribs are incompletely developed. The ribs terminate with sharp angle (in juvenile area about 25°, in the terminal part 40-60°) on symphysal margin.

Measurements: Due to its incompletness, the lectotype is unsuitable for precise measurements of the length parameters. Incomplete lengths and (in brackets) estimated original values in milimeters are introduced here for a rough comparison:

L = 26.5	(27.0)	π′ = 35°	π = 66°
S = 21.5	(24-25.0)	ε′ = 25°	ε = 33°
L_{at} = 11.0	(12.5-13.0)		

The parameters of our complete specimen No. 3190/10 (Strážovce section) are as follows:

L = 28.1	S/L = 0.85	π′ = 28°	π = 28°
S = 24.0	L_{at}/L = 0.42	ε′ = 27°	ε = 40°
L_{at} = 11.8			

Remarks: The lectotype selected by Houša (1974) from four original valves of the Peters collection in Vienna is characterized by absence of a lateral depression, arching of the last part of ribs prior to their termination on the symphysal margin and gradual smoothing of originally angular bending of the last ribs.

Occurrence: *L. angulocostatus angulocostatus* occurs only in Upper Hauterivian deposits of the Western Carpathians in the sequence overlying the Strážovce Turbidite Member and limited from above by the last representatives of *Pseudothurmannia*. Apart from the Lietavská Lúčka localities, we recorded its occurrence in the Central Western Carpathians (Strážovce, Butkov, Bralo, Kamenná sections, cf. Vašíček et al. 1994) and in the Pieniny Klippen Belt of the Outer Carpathians (Rochovica section, Vašíček et al. 1992).

Distribution: According to diverse authors (e.g. Gasiorowski 1962a), this subspecies has been reported from various strata of Berriasian to Barremian age. Barremian findings have been introduced recently by Renz & Habicht (1985). Geographically, it occurs in the Caribbean and Mediterranean regions between Cuba, Blake Bahama Basin, Spain, SE France, Alpine - Carpathian area, Balcan Chain and Crimea.

Lamellaptychus angulocostatus angulicostatus (Pictet & Loriol 1858)

Pl. I: Figs. 2-4

1857 *Trigonellites Didayi* Giebel; Ooster, p. 28, Pl. 7, Figs. 9, 17
1858 *Aptychus angulicostatus*, Pictet et de Loriol; Pictet & Loriol, p. 46, Pl. 10, Figs. 3-7, ?8-12
?1868 *Aptychus angulocostatus* Peters; Winkler, p. 30, Pl. 4, Fig. 17
1938 *Lamellaptychus angulocostatus* (Pet.) f. typ.; Trauth, p. 204, Pl. 14, Figs. 12-13
?1959 *Lamellaptychus angulocostatus* (Pet.) cf. f. typ. Trauth; Birkenmajer & Gasiorowski, p. 350, Pl. 47, Fig. 1
1960 *Lamellaptychus angulocostatus* (Pet.); Gasiorowski, Pl. 12, Fig. 7
1961 *Lamellaptychus angulocostatus* (Peters); Stefanov, p. 212, Pl. 1, Fig. 6; non Figs. 1-4 (= *L. angulocostatus angulocostatus*)
1962a *Lamellaptychus angulocostatus* (Pet.) f. typ. Trauth; Gasiorowski, p. 258, Text-fig. 16, Fig. 13
1962b *Lamellaptychus*, group D (d γ), *angulocostatus* (Pet.), f. typ. Trauth; Gasiorowski, Pl. 8, Fig. 1
1968 Angulocostate Lamellaptychen; Jaksch, p. 118, Figs. 81-84
1972 *Lamellaptychus angulocostatus* (Peters); Renz, p. 616, Pl. 4, Figs. 1 a, b
1974 *Lamellaptychus angulocostatus* (Peters); Houša, p. 31, Pl. 2, Fig. 4; ?Pl. 4, Figs. 2-4, 7, 8; ?Pl. 5, Figs. 2-6; ?Pl. 6; Pl. 8, Fig. 4, ?3; Pl. 9, Figs. 6, 9
1977 *Lamellaptychus angulocostatus* (Peters); Renz, p. 506, Pl. 2, Figs. 1, 2; ?Pl. 1, Figs. 34, 35
1977 *Lamellaptychus angulicostatus angulicostatus* (Pictet et Loriol); Vašíček, p. 131, Pl. 1, Figs. 4-5
1978 *Lamellaptychus angulocostatus* (Peters); Renz, p. 905, Pl. 1, Fig. 17
1978 *Lamellaptychus angulicostatus angulicostatus* (Pictet & Loriol); Khalilov, p. 55, Pl. 1, Figs. 15 a, b
1994 *Lamellaptychus angulocostatus* (Peters); Vašíček, Michalík & Reháková, Pl. 24, Fig. 13

Holotype: The valve illustrated in Pictet & Loriol (1858) on their Pl. 10, Fig. 3 designed as *Aptychus angulicostatus*, was again illustrated here on Pl. I: Fig. 2.

Material: Gypsum cast of the holotype and several others more or less complete specimens.

Description: Medium to large valves with prominent keel and with visible, but shallow depression. Dense ribs are mostly subparallel with symphysal margin, being slightly arcuated in lateral depression. They are angularly broken between symphysal margin and the keel. The bending angle is 40° in juvenile, but 55° to 75° in adult (and/or even more rounded in gerontic) part of the valve. The costation sems to be denser on the flanks than in the central part of the valve. Symphysal arm of the rib (which after bending runs towards the apex) is mostly straight. The last three ribs are incompletely developed (the angular part being mostly missing). The ribs terminate on the symphysal margin with a sharp angle (30-40° in juvenile area, but around 55° in adult terminal part of large valves).

Measurements: The size parameters of the valve illustrated in Pictet & Loriol (1858, Pl. 10: Figs. 3-7) have been measured by Dr. E. Lanterno from the Museum of Natural History in Geneva:

L = 36.9	S/L = 0.95	π′ = 40°	π = 60°
S = 35.-	L_{at}/L = 0.46	ε′ = 32°	ε = 50°
L_{at} = 17.-	l = 26.2		

Only several length parameters could have been measured on the specimen LL V-250/5/2 due to the impossibility of establishing an exact width (L_{at}) value:

L = 38.1	S/L = 0.95	π′ = 42°	π = 52°
S = 36.3	L_{at} = 11.8	ε = 35°	

Remarks: The subspecies is characterized by lateral depression and moderate curvature of ribs inside it, by distinct angular bending of the ribs on the valves shorter than 35 mm, by straight course of the part of ribs between the angular bending and their termination on the symphysal margin, by more constant value

of the angle of arcual bending of ribs in all stages, as well as by different ribs density on the flanks and in the region of angular bending.

As the width of valves (L_{at}) is never exactly measurable in the specimens of the Slovak collection, the possible appurtenance of some of them to the subspecies *L. angulocostatus longus* Trauth (if it exists at all), which should be characterized by slender valves ($L_{at}/L < 0.40$), cannot be definitively excluded.

Occurrence: *L. angulocostatus angulicostatus* occurs at the same Western Carpathian localities as the former subspecies. Moreover, it has been found in Moravia in the Silesian Unit of the Outer Carpathians.

Distribution: Similar to that of the *L. angulocostatus angulocostatus*.

Lamellaptychus angulocostatus radiatus Trauth 1938
Pl. I: Figs. 7-9

1938 *Lamellaptychus angulocostatus* (Pet.) var. n. *radiata*; Trauth, p. 207, Pl. 14, Fig. 14
1961 *Lamellaptychus angulocostatus* (Peters) var. *radiata* Trauth; Stefanov, p. 213, Text-figs. 1, 2; Pl. 1. Figs. 10, ??
1962a *Lamellaptychus angulocostatus* (Pet.) var. *radiata* Trauth; Gasiorowski, p. 259, Pl. 16, Fig. 16
1962b *Lamellaptychus*, group D (d γ), *angulocostatus* (Pet.) var. *radiata* Trauth; Gasiorowski, Pl. 8, Fig. 7
1976 *Lamellaptychus angulocostatus* (Peters) forma *radiata* Trauth; Avram, p. 59, Pl. 10, Fig. 13
1976 *Lamellaptychus angulocostatus* (Peters) forma *radiata* Trauth; Patrulius & Avram, p. 194, Pl. 10, Fig. 18

Holotype: The specimen figured by Trauth (1938) on Pl. 14, Fig. 14.

Material: Two incomplete valves only.

Description: Overall morphology of incomplete valves and the course of the ribs on their surface answer to characteristics of *L. angulocostatus angulocostatus*. The only different mark is the presence of fine radial striae running from the apex to the terminal margin between the axis of angular bending of ribs and the symphysal margin. Presence of a shallow lateral depression cannot be excluded on the specimen illustrated.

Measurements: Due to incompleteness of our material, only the statement that both the valves are longer than 30 mm is possible.

Remarks: The material from the Slovak Western Carpathians fits almost ideally with the Trauth's type. Radial lines are developed between the symphysal margin and keel, as in the Bulgarian material.

Occurrence: Both the valves come from lower part of the studied Polomec (Lietavská Lúčka - IVth level) section, from strata closely overlying the turbiditic Strážovce Member attributed to the lower part of Upper Hauterivian deposits.

Distribution: The annotated authors only mentioned the "Neocomian" of the Alpine-Carpathian region (including Romania), Stefanov (1961) added Lower Hauterivian localities in Bulgaria.

Conclusions

The Upper Hauterivian limestone and marly sequence of the Mráznica Formation in the Polomec (Lietavská Lúčka) locality yielded a rich collection of aptychi. These beds contain an abundant ammonite fauna (Vašíček et al. 1994), which indicates several zones, namely Borzai (equivalent of the Sayni/"Ligatus" transition and the Balearis Zone according to Hoedemaeker et al. 1993) and Binelli Zone (equivalent of the Angulicostata Zone of the general Mediterranean division).

The collection studied contains 105 aptychi specimens. With the exclusion of two 7 mm long juvenile valves (founded in close proximity to the underlying Strážovce Turbidite Member) belonging to the range of *L. atlanticus* (Hennig), all the remaining forms are characterized by angularly broken ribs. However, their preservation is not always sufficient (fragments or corroded specimens), so that only 38 valves were well determinable (36 %), 43 could have been attributed to the range of *L. angulocostatus* only (41 %), while the remaining 22 valves belong to the category of closely indeterminable findings (21 %). The determinable 77 % of specimens consist of following taxa (in percent):

53 % *Lamellaptychus angulocostatus* (Peters 1854)
25 % *L. angulocostatus angulocostatus* (Peters 1854)
8.6 % *L. angulocostatus angulicostatus* (Pictet & Loriol 1858)
3.0 % *L. angulocostatus radiatus* Trauth 1938
5.0 % *L. filicostatus filicostatus* Stefanov 1961
1.6 % *L. filicostatus fractocostatus* Vašíček, Michalík & Reháková 1994
3.7 % *L. cristobalensis* (O'Connell 1921)

Lamellaptychus angulocostatus clearly dominates (almost 90 %) in the aptychi association of the whole section. Only *L. a. radiatus* (together with *L. cristobalensis*) is limited to scarce findings in the lower part of the sequence investigated. Another infrequent form, *L. filicostatus*, occurs in the whole sequence.

The last lamellaptychi association occurs in the Polomec Hill (as well as in the other West-Carpathian localities of the Pseudothurmannia Beds, cf. Adamíková et al. 1983) in the beds belonging to Angulicostata Zone. It consists of only two species (*L. angulocostatus* and *L. filicostatus*) separable into several subspecies). The overlying Lower Barremian deposits of the Hugii Zone in Western Carpathians do not contain any aptychi at all. The disappearance of lamellaptychi on the Hauterivian/ Barremian boundary represents an important biostratigraphic event. It was caused by a change in the composition of the ammonite associations: those with the calcareous jaw elements were repleced by groups with aptychi composed of organic (horn) material. This change was connected with more-or-less contemporary changes in the microplankton associations (substitution of declining calpionellids by planktonic foraminifers, cf. Reháková 1993, etc). The cause of all these changes accompanied by contemporaneous development of "Urgonian" carbonate platforms separated by anoxic basins must have been conditioned by reorganization of the sea current regime during the Late Hauterivian (Reháková 1995).

Acknowledgements: Authors thank for valuable comments to Dr. M. Rakús. The paper contributes to the IGCP Project 362. It was supported by the Grant Agency of the Slovak Academy of Sciences (Grant Project GA 1081). The figures were drawn by Mrs. M. Tinková, photos have been made by Mrs. K. Mezihoráková. The specimens were whitened by the ammonium chloride. The shells figured will be deposited in the collection of the Slovak National Museum in Bratislava.

References

Adamíková G., Michalík J. & Vašíček Z., 1983: Composition of the "Pseudothurmannia Fauna", Lower Barremian of the Krížna

Nappe in the Strážovské Vrchy Mts. *Geol. Zbor. Geol. Carpath.* 34, 5, 591-615.

Avram E., 1976: Les fossiles du flysch éocrétacé et des calcaires tithoniques des hautes vallées de la Doftana et du Tirlung (Carpathes Orientales). *Mém. Inst. Géol. Géoph. (Bucharest)*, 24, 5-73.

Birkenmajer K. & Gasiorowski S.M., 1959: Tithonian and Lower Cretaceous aptychi on secondary (Senonian) place of deposition in the Polish Klippen Belt. *Rocz. Pol. Tow. Geol.*, 28, 345-358 (in Polish).

Borza K., Michalík J., Gašparíková V. & Vašíček Z., 1984: The biostratigraphy of the Hauterivian/Barremian boundary beds in the Krížna Nappe, Western Carpathians (Czechoslovakia). *Cretaceous Research*, 5, 349-356.

Borza K., Michalík J. & Vašíček Z., 1987: Lithology, biofacies and geochemical characterization of the Lower Cretaceous pelagic carbonate sequence of Mt Butkov (Manín Unit, Western Carpathians). *Geol. Zbor. Geol. Carpath.*, 38, 3, 323-348.

Khalilov A.G., 1978: Lower Cretaceous aptychi of Great Caucasus (Azerbaijan part). *Izv. Akad. Nauk Azerbaijan SSR, Nauki o Zemle*, 5, 49-59 (in Russian).

Drushtchits V.V. & Kudryavcev M.P. (Eds.), 1960: The Atlas of Lower Cretaceous fauna of Northern Caucasus and Crimea. Ammonites I. *Trudy Vsesoyuznogo Inst. Gazov*, Moskva, 249-308 (in Russian).

Duraj M., Filák P. & Vašíček Z., 1990: Ammoniten des Desmoceratentyps aus Ablagerungen der Hauterive/Barreme-Grenze von der Lokalität Lietavská Lúčka bei Žilina (Westkarpaten, Krížna-Decke). *Sbor. "Biostratigrafické a sedimentologické studie v mezozoiku Českého masívu a Západních Karpat". Knihovnička ZPN*, 9a, 55-68.

Fazzini P., 1965: Sulla presenza del Lamellaptychus angulocostatus Peters al tetto dei dispri nei Monti di Poggiano presso Montepulciano (Siena). *Atti Soc. Natur. Matem. Modena*, 96, 20-26.

Gasiorowski S.M., 1956: On the aptychi fauna of the Tithonian/Berriasian crinoidal limestones of the Czorsztyn environs. *Acta Geol. Pol.*, 6, 287-299 (in Polish).

Gasiorowski S.M., 1959: Succession of aptychi faunas in the western Tethys during the Bajocian-Barremian time. *Bull. Acad. Pol. Sci., Sér. Sci. chim., géol. géogr.*, 7, 715-722.

Gasiorowski S.M., 1960: On the laewaptychi. *Rocz. Pol. Tow. Geol.*, 30, 59-97 (in Polish).

Gasiorowski S.M., 1962a: Sur les aptychi a côtes. *Rocz. Pol. Tow. Geol.*, 32, 227-280.

Gasiorowski S.M., 1962b: Aptychi from the Dogger, Malm and Neocomian in the Western Carpathians and their stratigraphical value. *Stud. Geol. Pol.*, 10, 1-144.

Hoedemaeker P. J., Company M. et al. (Eds.), 1993: Ammonite zonation for the Lower Cretaceous of the Mediterranean region; basis for the stratigraphic correlations within IGCP Project 262. *Revista Esp. Paleont.*, 8, 117-120.

Houša V., 1974: Los Apticos de Cuba I: Lamellaptychus angulocostatus (Pet.). *Inst. Geol. Paleont., Geol.*, 14, La Habana, 1-57.

Imlay R.W., 1942: Late Jurassic fossils from Cuba and their economic significance. *Geol. Soc. Amer. Bull.*, 53, 1417-1478.

Jaksch K., 1968: Aptychen aus dem Neokom zwischen Kaisergebirge und Saalach. *Verh. Geol. Bundesanst. (Wien)*, 104-124.

Lehmann U., 1972: Aptychen als Kieferelemente der Ammoniten. *Paläont. Z. (Stuttgart)*, 46, 34-48.

Lehmann U., Tanabe K., Kanie Y. & Fukuda Y., 1980: Über den Kieferapparat der Lytoceratoceae (Ammonoidea). *Paläont. Z. (Stuttgart)*, 54, 319-329.

Lehmann U. & Kulicki C., 1990: Double function of aptychi (Ammonoidea) as jaw elements and opercula. *Lethaia*, 23, 325-331.

Michalík J. & Reháková D., 1994: Stratigraphy, sedimentology and paleogeography of Cretaceous sequences in western part of the Western Carpathians. *Field guide of Annual Assembly, IGCP Project 362: Tethyan and Boreal Cretaceous, Smolenice 1994*, Bratislava, 1-81.

O'Connel M., 1921: New species of ammonite opercula from the Mesozoic rocks of Cuba. *Amer. Mus. Novit.*, 28, 1-15.

Ooster W.A., 1857: Catalogue des céphalopodes fossiles des Alpes Suisses avec la description et les figures des espéces remarquables. - 2. Céphalopodes d'ordres incertains. Zürich, 1-32.

Patrulius D. & Avram E., 1976: Les céphalopodes des couches de Carhaga (Tithonique supérieur - Barremien inférieur). *Mém. Inst. Géol. Géoph. (Bucharest)*, 24, 153-201.

Peters K., 1854: Die Aptychen der Österreichischen Neocomien und oberen Juraschichten. *Jb. K.-kon. Geol. Reichsanst. (Wien)*, 5, 439-444.

Pictet F.-J. & Loriol P., 1858: Description des fossiles contenus dans les terrains néocomiens des Voirons. *Matér. Paléont. Suisse*, 2, Genéve, 1-64.

Reháková D., 1991: Lithostratigraphy, sedimentology and paleogeographic relations of Jurassic and Lower Cretaceopus sequences of the Eastern Alps and Western Carpathians. *MS, Archive of Geol. Institute of Slovak Acad. Sci.*, Bratislava, 1-226 (in Slovak).

Reháková D., 1993: West Carpathian Upper Jurassic/Lower Cretaceous sedimentary record, its microbiostratigraphy and correlation with the neighbour paleogeographic units. *Abstr. 1st General Meeting of IGCP Project 362*, Coimbra, 51-53.

Reháková D., 1995: Upper Jurassic/Lower Cretaceous carbonate microfacies and environmental models from Western Carpathians and adjacent paleogeographic units. *Cretaceous Research*, 16, 12-22.

Renz O., 1972: Aptychi (Ammonoidea) from the Upper Jurassic and Lower Cretaceous of the western North Atlantic (Site 105, Leg 11, DSDP). In: Hollister C.D., Ewing J.I. et al. (Eds.): *Initial Reports DSDP 11*, Washington, 607-629.

Renz O., 1977: Aptychi (Ammonoidea) from the Late Jurassic and Early Cretaceous of the Eastern Atlantic, DSDP Site 367. In: Lancelot Y., Seibold E. et al. (Eds.): *Initial Reports DSDP 41*, Washington, 499-514.

Renz O., 1978: Aptychi (Ammonoidea) from the Early Cretaceous of the Blake-Bahama Basin, leg. 44, Hole 391C, DSDP. In: Benson W.E., Sheridan R.E. et al. (Eds.): *Initial Reports DSDP 44*, Washington, 899-909.

Renz O. & Habicht K., 1985: A correlation of the Tethys Maiolica Formation of the Breggia section (southern Switzerland) with Early Cretaceous coccolith oozes of Site 534A, DSDP Leg 76 in the western Atlantic. *Eclogae Geol. Helv.*, 78, 383-431.

Stefanov J., 1961: Lower Cretaceous ammonite opercula (aptychi) in Bulgaria. *Trud. Geol. Balg., Ser. Paleont.*, 3, 209-235 (in Bulgarian).

Trauth F., 1927: Aptychenstudien I. Über die Aptychen im Allgemeinen. *Ann. Naturhist. Mus. (Wien)*, 41, 171-259.

Trauth F., 1938: Die Lamellaptychi des Oberjura und der Oberkreide. *Palaeontographica A, (Stuttgart)*, 88, 118-240.

Vašíček Z., 1977: Hukvaldy - die neue makrofaunistische Lokalität der Schlesischen Einheit (Hauterive). *Čas. Slez. Muz. A*, 26, 129-136.

Vašíček Z. & Michalík J., 1988: Some heteromorphic ammonites from Polomec (Hauterivian-Barremian, Central Western Carpathians, Czechoslovakia). *Geol. Zbor. Geol. Carpath.*, 39, 655-674.

Vašíček Z., Michalík J. & Borza K., 1983: To the "Neocomian" biostratigraphy in the Krížna Nappe of the Strážovské Vrchy Mts (NW Central Carpathians). *Zitteliana*, 10, 467-478.

Vašíček Z., Michalík J. & Reháková D., 1994: Early Cretaceous stratigraphy, palaeogeography and life in the Western Carpathians. *Beringeria*, 10, 3-169.

Vašíček Z., Reháková D., Michalík J., Peterčáková M. & Halásová E., 1992: Ammonites, aptychi, nanno- and microplankton from the Lower Cretaceous Pieniny Formation in the "Kysuca Gate" near Žilina (Western Carpathian Klippen Belt, Kysuca Unit). *Západ. Karpaty, Ser. Paleont.*, 16, 43-57.

Winkler G.G., 1868: Versteinerungen aus dem bayerischen Alpengebiet mit geognostischen Erläuterungen. I. Die Neocomformation des Urschlauerachenthales bei Traunstein mit Rücksicht auf ihre Grenzschichten. München, 1-48.