Bajocian – Bathonian ammonite fauna of the Czorsztyn Unit, Pieniny Klippen Belt (Western Carpathians, Slovakia); its biostratigraphical and palaeobiogeographical significance

JÁN SCHLÖGL1, MILOS RAKÚS2, CHARLES MANGOLD3 & SERGE ELMI3

1Department of Geology and Paleontology, Faculty of Sciences, Comenius University, Mlynská dolina - G, SK-842 15 Bratislava, Slovakia. E-mail: schlogl@nic.fns.uniba.sk
2Geological Survey of Slovak Republic, Mlynská dolina 1, SK-817 04 Bratislava, Slovakia. E-mail: rakus@gssr.sk
3UMR 5125 Paléoenvironnement et Paléobiosphère, 2 rue Dubois, Université Claude Bernard Lyon1, 69 622 Villeurbanne Cedex, France

ABSTRACT:


The Parkinsoni Zone of the Late Bajocian and the Zigzag, Aurigems and Retrocostatum Zones of the Bathonian have been identified on the basis of relatively highly diversified ammonite assemblages within seven ammonitico rosso sections belonging to the Czorsztyn Unit, Pieniny Klippen Belt. The ammonite fauna has features in common with both the Mediterranean Province and the Sub-Mediterranean Province, containing abundant Phylloceratina and Lytoceratina on the one hand, but numerous Parkinsonia on the other. Ammonites of Arabian affinities belonging to the genus Micromphalites occur rarely in the Early Bathonian Zigzag Zone assemblage. Lytoceras joniaki, Lissoceras compressus and Cadomites (Polyplectites) minutus are proposed as new taxa.

Key words: Jurassic, Bajocian, Bathonian, Ammonites, Biostratigraphy, Palaeobiogeography, Systematics, Pieniny Klippen Belt, Carpathians, Slovakia.

INTRODUCTION

Ammonitico rosso deposits are among the most widespread and most fossiliferous facies in the Western Carpathian Jurassic, especially in the Czorsztyn Unit, one of the units belonging to the Pieniny Klippen Belt (PKB). The PKB is an exceptional structure of the Western Carpathians. With its characteristic elongate and narrow shape and a length of several hundred kilometres it forms a dividing zone between the Outer and Central Western Carpathians (Text-fig. 1). It started to develop its identity during the Jurassic at the southern margin of the European plate, but its typical structural and morphological form is a result of younger, mainly Tertiary tectonics. Although the structure of the area is complicated and locally even chaotic, it is basically made of two Jurassic-Cretaceous sequence-groups (the relatively shallow Czorsztyn Unit, and the deep-water Pieniny-Kysuca Unit), with a series of transitional developments (including the Niedzica, Czertezic and Orava Units). The
Czorsztyn Unit is considered to be the shallowest of all the known Pieninic units (for details see e.g. Birkenmaier 1977; Aubrecht & al. 1997), deposited on the former Czorsztyn Ridge and its southern slope.

Although the ammonitico rosso facies has attracted the attention of Carpathian geologists for over 150 years (e.g. Stur 1860; Andrusov 1931; 1945), detailed biostratigraphical research was only rarely the aim of their studies and such work has been concentrated on mainly during the last 20 years. In 1990, Rakus published the first, more detailed biostratigraphical study from selected Slovakian and Ukrainian localities of the Czorsztyn Unit. A part of his fauna is also integrated into this study. In recent years, microfacies, sedimentological and palaeontological research on the facies in the Polish segment of the Pieniny Klippen Belt was summarized by Birkenmaier & Myczynski (1984) and new data were provided mainly by Wierzbowski (1994; Myczynski & Wierzbowski 1994; Wierzbowski & al. 1999).

The data reported in this paper are the main results of the PhD study of the first author (Schögl 2002) and partly also a revision of the fauna published by the second author (M. R.) in 1990.

**GEOGRAPHICAL AND GEOLOGICAL SETTING**

The sections of Dolňy Mlyn, Vršatec and Štepnická skala are situated in the West-Slovakian segment of the PKB, and Jarabina, Údol, Zadné Skálie, Kamenica and Beňatina in its East-Slovakian segment (Text-fig. 1). The Jurassic strata are characterized by a deepening-upward succession. Lias sediments are preserved in the Dolňy Mlyn and Beňatina quarries only. Highly fossili-
ferous Hettangian to Tbarsian oxygen-depleted dark deposits (Dolný Mlyn Formation, Allgäu Formation) were replaced by neritic detritic sedimentation of various crinoidal limestones during the Aalenian and Bajocian (Smolegowa and Krupianka Formations). A sudden facies change during the Late Bajocian or Early
Bathonian is marked by a discontinuity which is accentuated by a Fe/Mn hardground with microbial encrustations. Pelagic sedimentation of different types of nodular limestones (Czorsztyn Limestone Formation) follows. The microfacies changes from crinoidal grainstones and packstones to wackestones with filament microfacies. Ammonitico rosso sediments of this formation vary in thickness, stratigraphical extent, and type of macrofaunal preservation (Schlogl, 2002). Another major discontinuity with a Fe/Mn hardground lies at the boundary between the filament microfacies and the Globuligerina microfacies. In the Carpathian region the bloom of the planktonic foraminifer Globuligerina is already considered to be of Oxfordian age, proved by scarce Middle and Late Oxfordian ammonites collected from these beds just above the hardground (Schlogl, 2002, Wierzbowski et al., 1999).

The overall stratigraphical extent of the ammonitico rosso facies is from the Late Bajocian (Dolný Mlyn, Vršatec, Bešatina) up to the Late Kimmeridgian (Dolný Mlyn) or Early Tithonian (Vršatec, Údol). It passes gradually into pinkish and creamy coloured, massive or bedded micritic limestones of the Dursztyn Limestone Formation (mainly Tithonian and Berriasian).

This study is focused on the most fossiliferous, Upper Bajocian to Bathonian part of the Czorsztyn Limestone Formation. Although all the sections studied share similar sedimentological features, such as a basal discontinuity with Fe/Mn encrustations or nodular facies prevailing over other facies (bioclastic or pseudonodular, see Text-figs 2-7), nevertheless there are some small but important differences. The Vršatec section (Text-fig. 3) and the exposed part of the Bešatina section (Text-fig. 7) are the only ones consisting entirely of the nodular facies (sensu Clari et al., 1984) and intraclastic nodular facies (sensu Savary, 2000). The upper part of the Dolný Mlyn (Text-fig. 2) and Štepnická skala (Text-fig. 4) sections are made of bioclastic facies (massive limestones or marlstones with the Bostrica coquina). The Kamenica section (Text-fig. 6) is composed of numerous thin intraclastic nodular beds, separated by thin marly intercalations. Its upper part also contains intercalations of thin laminated, non-nodular limestones. Pseudonodular facies (sensu Martire, 1996) predominate in the Štepnická skala (Text-figs 4 and Jarabina sections (see Rakús, 1990, fig. 3). The lower part of the Údol section (Text-fig. 5) is covered by debris, the exposed part consists of both nodular and pseudonodular facies.

BIOSTRATIGRAPHY

The ammonite zonation applied in the study is that of Mangold & Rioült (1997) for the Sub-Mediterranean Province. The ammonites are illustrated in plates 1-15.

Late Bajocian

Parkinsonia (P.) parkinsoni Zone

The first ammonitico rosso bed in the Vršatec section just above the hardground yielded a reworked ammonite association including Phyloceras kunthi, Calliphylloceras disputabile, Holcophylloceras zignodontum, Strigoceras truellei (Pl. 3, Fig. 4) and Vermisphinctes (Prorsisphinctes) aff. meseres. Some specimens show signs of corrosion, encrustation and reworking (inverted geopetal structures). The upper surface of this bed is irregular and mineralized, with hemisphaeroidal Frutexites-like structures growing on it and, in places, even directly on the ammonites. The succeeding bed contains a rich ammonite fauna, composed mainly of Parkinsoniinae of the Late Bajocian Parkinsoni Zone.
**Dimorphinites (D.) dimorphus** was found in the uppermost part of the bed, still indicating the same zone. An abundance ofLate Bajocian **Parkinsonia** is a common feature shared by the Vršatec and Benatina sections (Pl. 11, Figs 1, 5, Pl. 13, Figs 1, 9). They are associated with **Digonioceras excavatum** (Pl. 1, Fig. 6), **Phylloceras trilatatum, Calliphylloceras disputabile, Adabofoloceras** sp. 1 (Pl. 1, Figs 1-2), numerous **Lytoceras, Cadomites** (C.) daumenyi, **Leptospininctes (L.)** sp., **Vermisphinctes** (V.) cf. martius, V. (Prorispinctes) aff. meseres (Pl. 8, Fig. 1-2) and **Bigrunites tuberculatus** (Pl. 10, Fig. 7) in the Benatina section (Text-fig. 7); and with **Phylloceras kaderanschi isomorphum, P. trilatatum, Calliphylloceras disputabile, Holophylloceras zigclazonianum, Adabofoloceras** sp., **Nannolytoceras tripartitum, Lytoceras** cf. adelaee, L. cf. eudesianum, **Oxycerites** sp., **Cadomites** (C.) cf. daumenyi, C. (C.) aff. orbignyi, C. (C.) gr. rectelobatus, C. (C.) cf. arkelli (Pl. 6, Fig. 2), C. (P.) sp. cf. dorni, **Planisphinctes (P.)** tenuissimus and P. (Lobosphinctes) sp. in the Vršatec section (Text-fig. 3).

In contrast, the **Parkinsonia** Zone in the Dolný Mlyn, Vršatec and Benatina sections was proved by ammonite faunas in all of the localities studied except the Údot section, where the lower part of the Czorszyn Limestone Formation is not exposed.

**Zigzagiceras** are generally scarce, and are present by scattered specimens only in the Dolný Mlyn, Vršatec and Benatina sections. **Rakúš** (1990) described **Zigzagiceras** (Z.) zigzag (Pl. 11, Figs 3-4) and Z. (Procerotizag) crassizag (Pl. 11, Fig. 2) from the Benatina section. On the other hand, the strata yielded numerous, well diversified Morphoceratidae, such as **Pseudodimorphinites pinguis** (Pl. 14, Figs 7-10), **Morphoceras** (M.) sp. aff. koteleczense (Pl. 13, Figs 7-8), M. (M.) multiforime (Pl. 14, Figs 4-5), M. (M.) cf. dimorphiformis (Pl. 13, Figs 4-6) and **Ebrayiceras sulcatum** (Pl. 14, Fig. 12), enabling the correlation of these strata with the NE European or Sub-Mediterranean zonal scheme. These are associated with mass-occurrences of **Nannolytoceras tripartitum** (Pl. 2, Figs 5, 8), abundant **Lytoceras jonlatki** (Text-fig. 2), and rare **Nannolytoceras sturani** (Pl. 2, Figs 6-7), **Lytoceras** sp. aff. **Valentolytoceras elegans** (Pl. 3, Figs 6-7), **Micromphalites** (O.) aff. **pastuliferus** (Pl. 5, Fig. 8), **Oecotraustes** (O.) aff. **costiger** (Pl. 3, Figs 5, 9-10), O. (O.) sp. (Pl. 5, Figs 5, 7), **Cadomites** (C.) cf. **deslongchampsii** (O.) aff. rectelobatus, C. (C.) cf. **extinctus** (Pl. 6, Fig. 12), C. (Polyplectites) rozyczki (Pl. 6, Figs 8-9), C. (P.) cf. rozyczki (Pl. 6, Figs 22-23), C. (P.) aff. **zlatarskii** (Pl. 6, Fig. 13-14), C. (P.) (Pl. 6, Fig. 11), C. (P.) **minutus** sp. nov. (Pl. 6, Fig. 5-7), C. (P.) sp. 1 aff. dorni (Pl. 6, Figs 15-16), C. (P.) sp. aff. dorni (Pl. 6, Fig. 10), **Benatinites** (Lugariceras) lugaresis (Pl. 6, Figs 18-21), Parkinsonia (P) cf. **schoenbachii, Parkinsonia** (Gonolkites) cf. subplanulata, **Pseudodimorphinites** aff. pinguis (Pl. 14, Fig. 11), Ps. sp. 1 (Pl. 14, Fig. 15), **Planisphinctes** (P) cf. torensis (Pl. 9, Fig. 2), **Procerites** (P) tinotolobus (Pl. 10, Fig. 6), P. (Siemiradzkia) lenthayensis (Pl. 10, Fig. 3), P. (S.) sp. and **Zigzagiceras** (Z.) cf. torensis (Pl. 10, Figs 4-5). The zone is characterized by numerous phylloceratid taxa; **Adabofoloceras** is abundant in the Benatina section (A. sp., A. abdabofolenae azynse (Pl. 1, Figs 7-10), A. cf. abichi (Pl. 1, Figs 3), A. cf. plicatum (Pl. 1, Figs 4-5), whereas **Calliphylloceras disputabile** and **Holophylloceras zigno-
The Asphinctites recinctus Subzone of the Aurigerus Zone was recognized in the Dolný Mlyn section on the basis of specimens of Asphinctites (A.) recinctus (Pl. 14, Fig. 14) and Polysphinctites polysphinctus (Pl. 14, Fig. 6) collected from bed 3 (Text-fig. 2). Single specimens of Oxycerites cf. seebachi (Pl. 5, Fig. 6) and Cadomites (Polyplectites) minutus sp. nov. (Pl. 6, Figs 3-4) were collected from the same level.

Vršatec, condensed Bed 7 (Zigzag - Aurigerus Zones)

The upper part of the Lower Bathonian of the Vršatec section (bed 7, see Text-fig. 3) yielded Ebrayiceras pseudoanceps (Pl. 14, Fig. 13) associated with numerous phylloceratids (Pl. 1, Fig. 11), Nannolytoceras tripartition, Lytoceras adelae (Pl. 3, Fig. 8), L. aff. adelae, L. eudelssianum adeloiades, L. sp. 1 (Pl. 3, Fig. 1), Lissoceras ventriplanum (Pl. 5, Fig. 1-2, Pl. 6, Fig. 1, Text-fig. 9A-C), L. compressus sp. nov. (Pl. 4, Figs 1-2), Oxycerites yeovilensis (Pl. 4, Figs 3-4), Bullatimorphites (B.) sp. (Pl. 7, Fig. 5), B. (Sphaeroptychius) sp., Parkinsonia (Gonolkites) gyrumbilica (Pl. 14, Figs 1-2), Zigzagiceras (Procerozigzag) postpollubrum (Pl. 12, Fig. 1), Procerites (P.) fowleri (Pl. 9, Fig. 1), P. (P.) cf. imitator, P. (P.) cf. fullonica, Procerites (P.) clausisprocerum (Pl. 12, Fig. 2), Choffatia (C.) sp. 1 (Pl. 15, Fig. 1), C. (C.) sp. 2 (Pl. 15, Fig. 2) and C. (Subgrossouvria) sp. The presence of Ebrayiceras, P. (G.) gyrumbilica and Z. (P.) postpollubrum indicates the upper part of the Zigzag Zone, Morphoceras (M.) macrocerus Subzone, although the large Procerites and the early Bullatimorphites are more typical of the overlying Aurigerus Zone and the Middle Bathonian Procerites (P.) progracilis Zone. The Bullatimorphites resembles B. (B.) latecentratus or B. (B.) sofarius, the former being the oldest representative of the subgenus (Aurigerus Zone to the lower part of the Progracilis Zone), the latter being restricted to the lower part of the Progracilis Zone. Bullatimorphites (B.) ymir, another similar species, has the same stratigraphical range as B. (B.) sofarius. The above-mentioned Choffatia are of particular interest because they belong to the oldest members of this taxon so far known (see the chapter on systematic descriptions).
Middle and Late Bathonian

No ammonites indicative of the Procerites (P.) progracilis, Tulites (T.) subcontractus and Morristiceras (M.) mornisi Zones have been found.

It is probable that the uppermost Middle Bathonian or lower Upper Bathonian is present in the Udol section (Text-fig. 5). Bed 4 yielded Bullatimorphites (Sphaeroptychius) cf. lucasi (Pl. 7, Figs 2-4), which, according to Mangold & Gygi (1997) ranges from the Cadomites (C.) bremen Zone to the Hecticoceras (Prohecticoceras) retrocostatum Zone. Bullatimorphites (Kheraiceras) cf. hannoveranus (Pl. 7, Fig. 1) from bed 5, lying directly below the hardground (boundary between the Bositra microfacies and the Globuligerina microfacies) indicates the Bullatimorphites (Kheraiceras) hannoveranus Subzone of the Retrocostatum Zone.

The succeeding bed 6 is already of Early Oxfordian age (Text-fig. 5).

A few large, badly preserved, evolute specimens of Procerites close to the morphological group of P. (P.) quercinus, and one very evolute, corroded specimen, belonging probably to Homoeoplanulites (Parachoffatia) sp., from the lower part of the Kamenica section could also be indicative of the early Late Bathonian (Text-fig. 6).

Early Callovian

The only locality where the Early Callovian has been identified so far is the Jarabina section (for the description see Rakús 1990, p. 76). The specimen of Bullatimorphites (Kheraiceras) reported by Rakús (1990) and figured here belongs to the group of B. (K.) bullatus (Pl. 7, Fig. 6). The same author also described another B. (K.) bullatus from the Ukrainian part of the Pieniny Klippen Belt (Rakús 1990, p. 80, pl. 4, fig. 3), but its coiling, with an almost occluded umbilicus and a very large penultimate whorl, shows rather a morphology closer to that of the Late Bathonian B. (K.) hannoveranus.

PALAEOENVIRONMENT AND PALAEOBIOGEOGRAPHY

The quantitative data on the relative abundance of ammonite taxa suggest ecological stability of the Late Bajocian and Early Bajocian environments. Phyllocerasina and Lytoceratina dominate throughout the period (Text-fig. 8). Lytoceratina constitute 37% of the whole assemblage in the Parkinsoni Zone and 35% in the Zigzag Zone. In common with the Phylloceratina they represent more than 50% of the fauna (and more than 60% in bed 7 of the Vršatec section). In general, their distribution is mainly environmentally controlled. Such a high percentage of pelagic groups indicates a moderate to deep-water open-marine environment. Nannolytoceras, the most abundant of all the taxa present, was probably an inhabitant of a moderate depth environment (Westermann 1990). Among Phylloceratina, the genera Phylloceras and Calliphylloceras are considered as inhabitants of deeper-water oceanic environments (Westermann 1990). They prevail (12:1) over the relatively shallower-water Holophylloceras in both the Parkinsoni and the Zigzag
zones. On the other hand the ratio is inverted in bed 7 of the Vršatec section (4:5); however, the reliability of these data is open to question in view of the condensation associated with the fauna.

The position of the Czorsztyn Ridge near the European continental margin during the Middle Jurassic is assumed by many authors (e.g. Csontos & Vörös 2004). Recent palaeomagnetic data obtained from the Ukrainian part of the Pieniny Klippen Belt (Lewandowski & al. 2005) indicate a palaeolatitude of 41.5° ± 5°. The whole Late Bajocian to Early Bathonian fauna shows an intermediate character between the Mediterranean and Sub-Mediterranean Provinces. Among the Ammonitina, the palaeobiogeographically widespread genera Cadomites, Parkinsonia, Planisphinctes, Procerites and Morphoceras prevail. However, on closer inspection, it is seen that there are clear differences between the associations of the Parkinsonia Zone and the Zigzag Zone. The high abundance of Parkinsonia in the Parkinsonia Zone is associated with around 50% of Phylloceratina and Lytoceratina (Text-fig. 8). Here, Parkinsonia is the most abundant ammonite taxon, constituting around 25% of the whole fauna. In contrast, it becomes very rare (<1%) in the Zigzag Zone, where the Zigzagicerasinae and Cadomitinae are the most common. Although this reduction could be locally influenced by some other factors, it certainly also reflects the natural decline of the Parkinsoniinae during the Early Bathonian.

The surprisingly high percentage of the Cadomitinae (>15%) in the Zigzag Zone is caused by an unusual richness of the normally very rare taxon Benatinites (Pl. 6, Fig. 17). It is associated with rare, extremely small sized Lugariceras (only four specimens, Pl. 6, Fig. 18-21), interpreted as its microconch counterpart (Schögl & al. in press). In this context, it is also interesting to note a relatively high diversity of the microconch Polyplectites in the Zigzag Zone, represented by numerous small to minute species (Pl. 6). Because of the generally bad state of preservation, they could only partly be described to species level. Similarly various Polyplectites assemblages have been reported from Iran (e.g. Seyed Emami & al. 1985).

The Early Bathonian fauna comprises ammonites of Arabian origin, namely Micromphalites (M.) aff. pusatiferus (Pl. 5, Fig. 8). Their palaeobiogeographical distribution follows an assumed migration corridor along the former South-European margin, linking the Arabian and Sinai Peninsula, NW African shelf (Morocco), the Iberian area and going as far as to the Czorsztyn Ridge (Pieniny Klippen Belt). The presence of this taxon is of considerable interest because it constitutes the northernmost Early Bathonian occurrence of the family Clydoniceratidae in the Western Tethys (Enay & al. 2001; Schögl & Rakós 2004).

CONCLUSIONS

The Late Bajocian Parkinsoni Zone, the Early Bathonian Zigzag and Aurigerus Zones and the Late Bathonian Retrocostatum Zone could be recognized on the basis of ammonite faunas at several localities in the Czorsztyn Unit, Pieniny Klippen Belt. The Upper Bajocian biostratigraphy is based on the common occurrence of the Parkinsoniinae, whereas that of the Early Bathonian is based mainly on the occurrence of the Morphoceratidae, enabling correlation with both the NW European Province and the Sub-Mediterranean Province.

The fauna is obviously intermediate in character. The composition of the Late Bajocian and Early Bathonian ammonite faunas shows several important features. The typical Mediterranean groups, such as the Phylloceratina and Lytoceratina, predominate in both intervals. They are associated with a high percentage of Parkinsoniinae, Morphoceratidae and Zigzagicerasinae (mainly Planisphinctes), taxa that are normally scarce or absent in the Mediterranean Province, but abundant in the Sub-Mediterranean and NW-European Provinces. These features indicate the strong affinity of the fauna to that of the Sub-Mediterranean Province.

The ammonite fauna of the Late Bajocian Parkinsoni Zone of the study area shows the following characteristics:
1. Around 50% of the fauna is represented by Phylloceratina and Lytoceratina.
2. Abundance of Parkinsonia, common Cadomitinae and rare Oppeliidae (Text-fig. 8).

The typical features of the Early Bathonian ammonite faunal associations are as follows:
1. Around 50% of the fauna is represented by Phylloceratina and Lytoceratina.
2. Abundance of Cadomites, Morphoceras, Planisphinctes and Procerites, but scarcity of Parkinsonia, Zigzagiceras and Oppeliidae.
3. Presence of Microphalites, an ammonite taxon of Arabian origin

The Middle and Late Bathonian ammonites are scarce; the Ammonitina consist almost exclusively of Tulitidae (Kheniceras, Sphaeroptychius).

Three new species are proposed, Lytoceras joniaki, Lissoceras compressus and Cadomites (Polyplectites) minitus.
SYSTEMATIC DESCRIPTIONS

Because the complete list of the fauna comprises too many taxa, we decided to focus this chapter only on those which are new or rare; or possibly new, but the state of the material available is insufficient for their description. Except for the type material and the specimens already described by RAkos (1990), the entire material is housed in the Department of Geology and Paleontology, Comenius University in Bratislava (coll. SCHLOG). The holotypes, paratypes and the material of RAkus are housed in the Slovak National Museum in Bratislava (SNM Z).

Suborder Phylloceratina ARKELL, 1950
Family Phylloceratidae ZITTEL, 1884
Subfamily Phylloceratinae ZITTEL, 1884
Genus Adabofoloceras JOLY, 1977

Adabofoloceras sp. 1
(Text-fig. 12D, PI. 1, Figs 1-2)

MATERIAL: Five more or less fragmentary internal moulds.

<table>
<thead>
<tr>
<th>D</th>
<th>H</th>
<th>E</th>
<th>O</th>
<th>0D(%)</th>
<th>E/H</th>
</tr>
</thead>
<tbody>
<tr>
<td>61.6</td>
<td>37</td>
<td>23.6</td>
<td>4</td>
<td>6.5</td>
<td>0.6</td>
</tr>
</tbody>
</table>

DESCRIPTION: Involute form with a very narrow umbilicus and a high-oval whorl section (Text-fig.12D). The maximum whorl width is near mid-flank. The flanks are only slightly convex, almost flat. The venter is regularly rounded. Strong, prorsiradiate ribs arise on the upper half of the flanks and become more pronounced along the siphonal line. There are 22 ribs per half-whorl at 43 mm diameter and 26 at 60 mm.

REMARKS: The taxon is very close to A. adabofolense COLLIGNON (1958, pl. 12, fig. 63), but differs in having a more compressed whorl, slightly different whorl section, and also in ornamentation, which is largely restricted to the ventrolateral margin and venter. A. adabofolense ayense JOLY has a different whorl section and the maximum whorl width is closer to the ventrolateral margin. From a morphological point of view, this character places Adabofolocerus sp. 1 between A. adabofolense and A. adabofolense ayense, a taxon of the Zigzag Zone in France (Text-fig. 12A-C, see also JOLY 2000).

Stratigraphical and geographical distribution: Late Bajocian, Parkinsoni Zone, Beňatina and Dolňý Mlyn, Slovakia

Suborder Lytoceratina HYATT, 1889
Superfamily Lytocerataceae NEUMAYR, 1875
Family Lytoceratidae, NEUMAYR, 1875
Subfamily Lytoceratinae NEUMAYR, 1875
Genus Lytoceras SUESS, 1865

Lytoceras joniaki sp.nov.
(Text-fig. 12E, Pl. 2, Figs 1-4, 9)

1958. Dinolytoceras zhivagoi sp. n. (pars); BEZNOsov, p. 86, pl. 23, fig. 1, 2 only.
1990. Lytoceras adelae (d’OrBIGNY, 1844); RAkos, p. 88, pl. 3, fig. 2, text-fig. 6e
1994. Lytoceras polyanchomenum GEMMELLARO; GALACZ, p. 139, pl. 1, fig. 2

MATERIAL: Three almost complete adult specimens, nine fragments of internal moulds.

HOLOTYPE: Pl. 2, Fig. 3-4, Text-fig. 12E (Slovak National Museum, SNM Z 24 166)
PARATYPE: Pl. 2, Fig. 1 (SNM Z 20 676), Pl. 2, Fig. 9 (SNM Z 24 167)

LOCUS TYPICUS: Beňatina, Pieniny Klippen Belt, East Slovakia

STRATUM TYPICUM: Czorsztyn Limestone Formation (Zigzag Zone)

DERIVATIO NOMINIS: After Dr. PETER JONIAK, an enthusiastic young Slovak palaeontologist

DIAGNOSIS: Relatively small lytoceratid with circular whorl section, fine ornamentation on body chamber and numerous pronounced constrictions. Suture line typically lytoceratid and very complicated. Peristome probably simple with deep peristomal constriction.

DESCRIPTION: All the material is more or less deformed and thus not measurable. The holotype and paratypes are adult or almost adult, and the final diameter can be estimated at around 85 mm. The whorl section is circular or subcircular throughout ontogeny. There are six or more relatively wide, shallow constrictions per whorl. Except for the constrictions, the internal mould of the phragmocone is smooth; the ornamentation appears at the beginning of the adult body chamber. It consists of numerous bifurcate ribs that arise on the umbilical wall. They are concave near the umbilical edge and then become stronger and prorsiradial. The point of bifurca-
tion is situated just above the umbilical edge. The innermost whorls are not preserved. Partially preserved peristomes on the paratype specimens show a deep peristomal constriction.

REMARKS: Some of the specimens described were previously assigned to the species *L. polyanchomenum* GEMMELLARO (SCHLOGL 2002), which is considered here to be morphologically closest to the new species. The revision of GEMMELLARO’s original material (GALÁCZ 2002) enables us to verify the former determination. The two specimens which served as originals for GEMMELLARO’s drawings are relatively small *Lytoceras* with a compressed oval whorl section throughout ontogeny, flat flanks on the body chamber, fine costulation and a very simple suture line. *L. joniaki* differs in its circular whorl section, more numerous and more pronounced constrictions, bifurcate ribs and complicated lytoceratid suture line.

Two specimens of *D. zhivagoi*, described and figured by BEZNOSOV (1958, pl. 23, figs 1, 2) differ from the type specimen of the species in their general morphology and ornamentation (BEZNOSOV 1958, pl. 22, fig. 1), which are reminiscent of those of *L. joniaki*. They are probably con-specific. The holotype of *D. zhivagoi*, in contrast, bears more robust ribbing and there are rib-like elevations in the middle of each constriction.

STRATIGRAPHICAL AND GEOGRAPHICAL DISTRIBUTION: Early Bathonian, Zigzag Zone, Befatina and Vršatec, Slovakia; and probably also Early Bathonian of the Mecsek Mts., Hungary, and Late Bajocian of the Caucasus.

Order Ammonitina HYATT, 1889
Family Haploceratidae ZITTEL, 1884
Genus *Lissoceras* BAYLE, 1879

*Lissoceras compressus* sp. nov.
(Pl. 4, Figs 1-2, Text-fig. 9D)

---

A-C. *Lissoceras ventriplanum* WENDT, 1963. A. section. B. suture line, D = 83 mm. C. slightly corroded suture line at D = 91 mm. Vršatec, bed 7, Zigzag Zone or *Auligerus* Zone. D. *Lissoceras compressus* sp. nov., holotype suture line at H = 42 mm (SNM Z 24169), Vršatec, bed 7, Zigzag Zone or *Auligerus* Zone. Scale 10 mm
MATERIAL: An internal mould of an adult specimen, still partially covered with recrystallized shell

PL. 4, Figs 1-2
SNM Z 24 169  13.4  6.2  4  3.05  22.7  0.65

HOLOTYPE: Pl. 4, Figs 1-2 (Slovak National Museum, SNM Z 24 169)

LOCUS TYPICUS: Vršatec, Pieniny Klippen Belt, West Slovakia

STRATUM TYPICUM: Czorszyn Limestone Formation (Early Bathonian, Zigzag Zone or Aurigerus Zone)

DERIVATIO NOMINIS: After the laterally compressed whorl section, compressus (Lat.) = laterally flattened

DIAGNOSIS: Large Lissoceras with compressed whorl section, narrow and highly arched venter and typical lissoceratid suture line.

DESCRIPTION: The taxon is characterized by its large size (at least 150 mm). The whorl section is high-oval, with the maximum whorl width near one-third of the whorl height. The umbilical wall is low, almost vertical or very steep with a regularly rounded edge. The flanks are only slightly convex; the venter is narrow and highly arched. The shell is totally smooth. The type of aperture is unknown, but is probably simple. The suture line is relatively well divided, similar to that of L. psilodiscus (Schloenbach) (see e.g. Galácz 1980, text-fig. 45), but only a part of S1, S2 and L1 can be seen (Text-fig. 9D).

REMARKS: There are two similarly large Early Bathonian Lissoceras; L. ventriplanum Wendt and L. magnum Galácz. The holotype of Lissoceras ventriplanum (Wendt 1963, pl. 17, fig. 4) from the Bathonian of Sicily is incomplete; the adult size of this taxon can reach at least 140 mm (estimated from a deformed specimen collected from the same bed as L. compressus in the Vršatec section, see also Sandoval 1986). It differs in considerably broader whorls and in the trapezoidal whorl section of the adult body chamber. Lissoceras magnum (Galácz 1980, pl. 12) differs mainly in the broader whorl section. The suture lines of the three above-mentioned species show the same disposition and complexity (for the suture line of L. ventriplanum, see Text-fig. 9B-C). The systematic position of other contemporaneous species, such as L. monachum (Gemmellaro) and L. ferrifer (Zittel) has already been discussed by Galácz (1980, p. 59), Sandoval (1986, p. 442) and more recently by Pavía (2002). Unfortunately, the type material of these taxa is badly preserved or juvenile. This is particularly the case with L. monachum, the holotype of which is a poorly preserved juvenile specimen, closely comparable with the inner whorls of L. magnum or L. ventriplanum. As already noted by Pavía (2002, p. 202), without a new type material the taxonomic position of these taxa is difficult to clear up.

STRATIGRAPHICAL AND GEOGRAPHICAL DISTRIBUTION: Zigzag Zone or Aurigerus Zone, Vršatec, bed 7, Slovakia

Oecotraustes (O.) aff. costiger Buckman, 1905
(Pl. 3, Figs 5, 9-10)

MATERIAL: Two fragmentary and partly deformed specimens

PL. 3, Fig. 5 31 11.4 7 22.6

DESCRIPTION: A relatively strongly ornamented Oecotraustes with a compressed whorl section, almost flat flanks and a fastigate venter. The umbilical wall is low and steep, with a rounded umbilical edge. The ribs are densely spaced, falcate and attenuated in the middle of the flanks. The ribs on the inner half of the whorls are weaker and prorsiradiate, but are rursiradiate and sometimes bifurcate on the upper half. On the ventrolateral margin they are sharply curved adorally, each one being surmounted by a small tubercle. The venter is keeled.

REMARKS: We agree with the opinion (Stephanov 1966) that O. (O.) costiger occupies a somewhat special place within the genus. Its type of ribbing, with a feeble spiral groove, suggests its close affinity to the subgenus Puroecotraustes. Apart from some small morphological details, both the type specimen and the material of Stephanov (1966, pl. 1, figs 5-7) differ from our material in the lower stratigraphical position, which was confirmed to be Late Bajocian (Parkinsont Zone, Bomfordi Subzone). Our material is associated with taxa typical of the Early Bathonian Zigzag Zone
TRIBUTION: Early Bathonian, Zigzag Zone, Béfatina, Slovakia

Superfamily Stephanocerataceae Neumayr, 1875
Family Stephanoceratidae Neumayr, 1875
Subfamily Cadomitinae Westermann, 1956
Genus Cadomites Munier-Chalmas, 1892
Subgenus Polyplectites Mascke, 1907

Cadomites (Polyplectites) sp. 1 aff. domi (Roche 1939) (Pl. 6, Figs 15-16, Text-fig. 12G)

MATERIAL: One fragment of an internal mould of an adult specimen with body chamber

<table>
<thead>
<tr>
<th>D</th>
<th>H</th>
<th>E</th>
<th>O</th>
<th>O/D(%)</th>
<th>E/H</th>
</tr>
</thead>
<tbody>
<tr>
<td>45.2</td>
<td>14.6</td>
<td>21.6</td>
<td>19</td>
<td>42</td>
<td>1.48</td>
</tr>
</tbody>
</table>

DESCRIPTION: A medium-sized, moderately evolute Polyplectites with a depressed oval whorl section (Text-fig. 12G). The venter is broad and regularly arched. Numerous short, slightly prorsiradiate ribs arise near the umbilical line and branch below mid-flank into two to five fine secondary ribs. The number of secondaries per primary rib decreases towards the aperture. The peristome is not preserved. The body chamber occupies two-thirds of the last whorl.

REMARKS: It is close to C. (P.) domi (Roche) but the furcation point is lower on the flanks, the venter is more arched and the secondary ribs are more numerous. Another similar taxon, C. (P.) bajocensis (Grossouvre 1930, pl. 40, fig. 8), is smaller and more involute, with concave ribs.

STRATIGRAPHICAL AND GEOGRAPHICAL DISTRIBUTION: Early Bathonian, Zigzag Zone, Vršatec, Slovakia

Cadomites (Polyplectites) minutus sp. nov. (Pl. 6, Figs 3-7, Text-fig. 10A-B, 12H)

MATERIAL: Internal moulds of two adult specimens with peristomes

<table>
<thead>
<tr>
<th>D</th>
<th>H</th>
<th>E</th>
<th>O</th>
<th>O/D(%)</th>
<th>E/H</th>
</tr>
</thead>
<tbody>
<tr>
<td>17.3</td>
<td>5.6</td>
<td>8</td>
<td>7.8</td>
<td>45.1</td>
<td>1.43</td>
</tr>
<tr>
<td>17.8</td>
<td>5.5</td>
<td>7.4</td>
<td>7.3</td>
<td>41</td>
<td>1.4</td>
</tr>
</tbody>
</table>

HOLOTYPE: Pl. 6, Figs 3-4, Text-fig. 10A, 12H (SNM Z 24 170)

PARATYPE: Pl. 6, Figs 5-7, Text-fig. 10B (SNM Z 24 171)

LOCUS TYPICUS: Dolný Mlyn, Pieniny Klippen Belt, West Slovakia

STRATUM TYPICUM: Czorsztyn Limestone Formation (Early Bathonian, Zigzag and Aurigeni Zones)

DERIVATIO NOMINIS: The name is derived from the diminutive size of the taxon

DIAGNOSIS: Polyplectites characterized by its diminutive size, broad trapezoidal whorl section, dense primary and secondary ribbing, and peristome bearing lateral lap-pets

DESCRIPTION: A diminutive Polyplectites with relatively evolute coiling, broad trapezoidal whorl section and dense, prorsiradiate, slightly irregular primary ribs. These
terminate in small tubercles and branch into four to six secondary ribs. There is one pronounced, narrow constriction on the last whorl. The body chamber occupies 270° of the last whorl. The peristome bears long and narrow lateral lappets.

REMARKS: The taxon is characterized by its very small size. The only similarly-sized taxon is \( C. \) \((P)\) gracilis WESTERMANN (1954, pl. 32, fig. 5) from Calvados in France, but this shows a different morphology, especially concerning the more involute coiling, the whorl section and the denser ornamentation. The ammonite figured by SCHRAIER (1989, pl. 1, fig. 8) from Sengenthal, Germany, is almost identical, but it is nearly twice the size and shows regular primary ribbing, in contrast to the slightly irregular primary ribbing in our specimens. Moreover the German specimen is stratigraphically older, having been collected from the Late Bajocian \( Parkinoni \) Zone.

STRATIGRAPHICAL AND GEOGRAPHICAL DISTRIBUTION: Early Bathonian, Zigzag Zone, Vrsatec, and Aurigenus Zone, Dolný Mlyn, Slovakia

Genus Benatinites SCHLÖGL & al., in press
Subgenus Luganiconas SCHLÖGL & al., in press
Benatinites (Luganiconas) lugarensis SCHLÖGL & al., in press
(Pl. 6, Figs 18-21 Text-fig. 11)

MATERIAL: Four internal casts of adult specimens, one of them complete with aperture

<table>
<thead>
<tr>
<th>D</th>
<th>H</th>
<th>E</th>
<th>O</th>
<th>O/D(%)</th>
<th>E/H</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.5</td>
<td>3.6</td>
<td>5.7</td>
<td>45.6</td>
<td>1.39</td>
<td></td>
</tr>
<tr>
<td>11.2</td>
<td>3.4</td>
<td>4.7</td>
<td>49.75</td>
<td>1.38</td>
<td></td>
</tr>
</tbody>
</table>

DESCRIPTION: A minute and evolutely coiled ammonite with a subquadrate whorl section. The maximum whorl width is situated at mid-flank. The primary ribs are radiate or slightly concave and almost all of the same thickness. They end in small tubercles from which one or two secondary ribs branch. These are interrupted mid-ventrally throughout ontogeny. Near the ventral line, the secondaries terminate in small tubercles. The adult body chamber occupies around 240° of the last whorl. The aperture bears small lateral lappets and a ventral visor-like collar.

REMARKS: Benatinites (Luganiconas) represents probably the microconch counterpart of Benatinites (Benatinites). Both taxa are described and discussed in detail by SCHLÖGL & al. (in press).

STRATIGRAPHICAL AND GEOGRAPHICAL DISTRIBUTION: Early Bathonian, Zigzag Zone, Beňatinava and Vrsatec sections, Slovakia. Zigzag Zone of northeastern Morocco, Zigzag Zone, Macrescens Subzone of Subbetic (Spain).

Family Perisphinctidae STEINMAN, 1890
Subfamily Leptosphinctinae ARKELL, 1950
Genus Vermisphinctes BUCKMAN, 1920
Subgenus Prosismphinctes BUCKMAN, 1920
Vermisphinctes (Prosismphinctes) aff. meseres BUCKMAN, 1927 non 1923
(Pl. 8, Figs 1-2 Text-fig. 12K)

MATERIAL: Five more or less complete specimens with at least partially preserved body chamber, two of them still with recrystallized shell.

DESCRIPTION: A large and evolute form with a broad and shallow umbilicus. The whorl section of the phragmocone is depressed-oval with the maximum width in the middle of the whorl height, the flanks are convex. The venter is large and moderately arched. The whorl section changes at the end of the phragmocone, where it is almost circular, but becomes high-oval with slightly convex flanks and a highly arched venter on the body chamber. The umbilical wall is relatively high and steep with a rounded umbilical edge. The ornamentation consists of long radiate to slightly prosiradiate primary ribs which bifurcate at approximately two-thirds of the whorl height. The secondary ribs are prosiradiate and cross the venter without interruption. The number of primary ribs per whorl increases from 40 to 44 in the last four ornamented whorls. There are two prosiradiate constrictions parallel to the ribbing per whorl. These weaken on the body chamber. The ornamentation attenuates about a half-

Fig. 11. Benatinites (Luganiconas) lugarensis (SCHLÖGL & al. in press), Beňatinava, Zigzag Zone. Scale 10 mm
whorl before the end of the phragmocone. The body chamber is totally smooth. Due to the preservation of the recrystallized shell the suture-line is not visible.

REMARKS: The phragmocone morphology of this large perispinctid ammonite is closely comparable with that of *P. meseres* (BUCKMAN 1927, non 1923), differing only in the type of ribbing, which is more prorsiradiate in BUCKMAN’s specimen. The body chamber is not preserved, thus making impossible comparison of the adult whorl section of these two ammonites. As has been already stated by GALÁCY (1980, p. 110), the second specimen figured by BUCKMAN under the name *P. meseres* (BUCKMAN 1927, fig. 446A-B) differs from the holotype...
Although our specimen generally resembles the strongly ornamented Middle Bathonian and Callovian forms such as C. (S.) rakotondrana­zavai (see Sandoval 1983, non Collignon 1958), C. (S.) gudjinsirensis (Waagen), C. (C.) transitoria Spath and C. (C.) soorkaensis Spath, it differs from these in its very evolute coiling and in the robust and distant ribbing beginning on the innermost whorls. The specimen was collected from bed 7 of the Vršatec section. This bed yielded a condensed ammonite association comprising taxa from the upper Zigzag and Aurigerus Zones. The specimen described here thus ranks among the earliest representatives of the genus.

STRATIGRAPHICAL AND GEOGRAPHICAL DISTRIBUTION: Zigzag Zone or Aurigerus Zone, Vršatec section, bed 7, Slovakia.

MATERIAL: One incomplete internal cast representing a complete phragmocone

DESCRIPTION: Similar coiling and whorl section as the previous species. The umbilical wall is low and steep. The ornamentation consists of dense radiate primary ribs that appear on the rounded umbilical edge and bifurcate between the middle and two-thirds of the whorl height. The secondaries are strong and slightly prorsiradiate. The constrictions are relatively shallow and also prorsiradiate, but their total number is not known due to the bad preservation of the specimen.

REMARKS: the specimen shows the same morphology as many other Middle and Late Bathonian species [e.g. C. (C.) subbakeriae (d'Orbigny)] or C. (S.) cerealis Arkell[, from which it differs in its older stratigraphical position. Innocenti (1976, pl. 5, fig. 1; pl. 10, fig. 2) figured two medium-sized Subgrossouvritheria from the Asphinctites tenuiiplicatus Zone of the late Early Bathonian from the vicinity of Castellane (France). The inner whorls bear dense prorsiradiate primaries, which become more widely spaced in the outer whorls. The venter is large and rounded. Based on the very similar coiling, whorl section and ornamentation, they could probably belong to the same morpho-group, possibly representing the microconch counterpart of our taxon.

STRATIGRAPHICAL AND GEOGRAPHICAL DISTRIBUTION: Zigzag Zone or Aurigerus Zone, Vršatec section, bed 7, Slovakia.

(Buckman 1923, fig. 446) in having more widely spaced and sharper ribbing, greater size and more robust whorls (thus probably not conspecific).

V' (P) martiasi (d'Orbigny) is more densely ribbed, the constrictions are more numerous and the whorl section is more compressed. V' (P) limnicicetus Buckman bears stronger and more widely spaced ribs on both the phragmocone and body chamber.

STRATIGRAPHICAL AND GEOGRAPHICAL DISTRIBUTION: Late Bajocian, probably lower part of the Parkinsoni Zone, Vršatec and Beňatina sections, Slovakia.

Subfamily Grossouvrinae Spath, 1931
Genus Choffatia Siemiradzki, 1898
Subgenus Choffatia Siemiradzki, 1898

Choffatia (C.) sp. 1
(PI. 15, Fig. 1, Text-fig. 12M)

MATERIAL: One incomplete internal cast with part of the body chamber

DESCRIPTION: An evolute ammonite with an oval, slightly depressed whorl section. The maximum whorl width is near mid-flank. The umbilical wall is steep and low, with a rounded edge. The whorls bear pronounced primary and secondary ribs with one shallow and wide constriction per half-whorl. Slightly rursiradiate primary ribs arise on the umbilical edge. They are finer and more densely spaced on the innermost preserved whorl but soon become strong and distant. They branch near two-thirds of the whorl height. Numerous intercalatory ribs are also present. All the secondary ribs on the last preserved whorl are of similar thickness.

REMARKS: According to Mangold (1970), the first Subgrossouvritheria-Choffatia appear in the Middle or earliest Late Bathonian (Blanazense Zone), and they already show a morphology resembling that of their Callovian descendants. Up to now the earliest Choffatia have been documented from the upper part of the Zigzag Zone. Galác (1980) mentions (but without illustration) Choffatia (Subgrossouvritheria) sp. aff. rakotondrana­zavai (Collignon) from the Zigzag Zone of the Bakony Mts., Hungary; Warman & Arkell (1954) reported Choffatia aff. uriniacensis (Lissajous) among an ammonite association composed of Early Bathonian taxa from Monte Inici in Sicily. Sandoval (1983) described C. (S.) uriniacensis, from the late Early Bathonian and early Middle Bathonian deposits of the Betic Cordillera, Spain.
Family Morphoceratidae HYATT, 1900
Genus Pseudodimorphinites SEYED-EMAMI, 1989

**Pseudodimorphinites pinguis** (DE GROSSOUVRE, 1919) (PI. 14, Figs 7-10, Text-fig. 12I)

1919. *Morphoceras pingue* n. sp.; DE GROSSOUVRE, p. 391, pl. 14, fig. 7 a, b
1955. *Morphoceras pingue* DE GROSSOUVRE; ARKELL (1951-59), p. 135, text-fig. 49
1966. *Morphoceras (or Asphinctites) pingue* DE GROSSOUVRE; STURANI, p. 37, text-fig. 37
1970. *Asphinctites pinguis* (DE GROSSOUVRE); MANGOLD, p. 111, pl. 3, fig. 13-14
1972. *Asphinctites (Asphinctites) pinguis* (DE GROSSOUVRE); KRYSTYN, p. 264, pl. 8, fig. 3
1977. *Asphinctites pinguis* (DE GROSSOUVRE); LINARES & al., p. 259, pl. 1, fig. 2
1983. *Asphinctites (Asphinctites) pinguis* (DE GROSSOUVRE, 1919); SANDOVAL, p. 358, pl. 28, fig. 3, 5, text-fig. 112UV, 113I
1985. *Morphoceras pingue* GROSSOUVRE; ROSTOVTSEV, p. 161, pl. 44, fig. 5, 6
1987. *Asphinctites pinguis* (DE GROSSOUVRE); TORRENS, pl. 2, fig. 1-4
1991. *Pseudodimorphinites pinguis* (GROSSOUVRE); SEYED-EMAMI & al., p. 73, pl. 4, fig. 11
1994. *Asphinctites pinguis* (DE GROSSOUVRE); SANDOVAL, pl. 2, fig. 10
1999. *Asphinctites pinguis* (DE GROSSOUVRE, 1919); GALÁCZ, p. 159, pl. 2, fig. 4
1999. *Asphinctites sp. aff. pinguis* (DE GROSSOUVRE, 1919); GALÁCZ, p. 160, pl. 2, fig. 5

**MATERIAL:** Internal moulds of 30 incomplete specimens

<table>
<thead>
<tr>
<th>D</th>
<th>H</th>
<th>E</th>
<th>O</th>
<th>O/D(%)</th>
<th>E/H</th>
</tr>
</thead>
<tbody>
<tr>
<td>31.4</td>
<td>11.8</td>
<td>18.4</td>
<td>9.2</td>
<td>29.3</td>
<td>1.56</td>
</tr>
<tr>
<td>35</td>
<td>14.4</td>
<td>9.6</td>
<td>27.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26.3</td>
<td>10.7</td>
<td>14.8</td>
<td>8.7</td>
<td>33.1</td>
<td>1.38</td>
</tr>
<tr>
<td>25.6</td>
<td>10.1</td>
<td>8.7</td>
<td>37.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>11.2</td>
<td>9</td>
<td>31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24.5</td>
<td>9.8</td>
<td>13.7</td>
<td>8.1</td>
<td>33.1</td>
<td>1.4</td>
</tr>
</tbody>
</table>

**DESCRIPTION:** The species typically lacks the morphoceratid ontogenic stage (MANGOLD, 1997). Up to 35-38 mm diameter, it is regularly involutely coiled, with a relatively narrow and deep umbilicus; the coiling then becomes evolute and the umbilicus widens rapidly. The penultimate whorl is very broad, with markedly convex flanks and a broad, regularly arched venter. The umbilical wall is rounded. The rectiradiate primary ribs arise on the upper part of the umbilical wall. Generally they bifurcate, but simple ribs are also present. The point of division is situated in the lower half of the flanks. There are numerous intercalatory ribs, appearing between one third and two-thirds of the whorl height. The secondary ribs cross the venter without interruption or attenuation. Two or three strong, prorsiradiate constrictions are already present at a diameter of 12 mm, but information regarding the presence of contrictions at smaller diameters is not available since the earlier whorls are not preserved in the material studied. The body chamber occupies at least one whorl.

**REMARKS:** Although the more evolute coiling, as well as the uninterrupted secondary ribs, suggest its close affinity to the genus Asphinctites, we agree with MANGOLD (1970), who considered Pseudodimorphinites pinguis to be the oldest representative of the Pseudodimorphinites – Asphinctites evolutionary lineage.

**STRATIGRAPHICAL AND GEOGRAPHICAL DISTRIBUTION:** It already appears in the Morphoceras (M.) paraum Subzone, although similar ('homeomorph') forms were described from the Oxyconites yeovilensis Zone. It is known from the Parkinsonia (Gonolkites) conveys Zone of Cap Mondego in Portugal (MANGOLD 1970) and from the lower part of the Macrescens Subzone of the Beti in Spain (SANDOVAL 1983). STURANI (1966) and TORRENS (1987) figured similar forms from the Yeovilensis Subzone of the Bas Auran section, France. In the Western Carpathians, it occurs in the Early Bathonian, Zigzag Zone of the Beňatina section, Slovakia.

**Pseudodimorphinites aff. pinguis** (DE GROSSOUVRE, 1919) (PI. 14, Fig. 11, Text-fig. 12L)

**MATERIAL:** One internal mould, probably representing a complete phragmocone

<table>
<thead>
<tr>
<th>D</th>
<th>H</th>
<th>E</th>
<th>O</th>
<th>O/D(%)</th>
<th>E/H</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pl. 14, Fig. 11</td>
<td>41.1</td>
<td>14.1</td>
<td>21.6</td>
<td>9.4</td>
<td>22.9</td>
</tr>
</tbody>
</table>

**DESCRIPTION AND REMARKS:** Except some small differences in ornamentation, this specimen is identical with the preceding taxon. The main difference is in the type of the ribbing, which is much finer and more densely spaced. The primary ribs are simple or bifurcated. The point of bifurcation is situated in mid-flank. Intercalatory ribs are rare.

**STRATIGRAPHICAL AND GEOGRAPHICAL DISTRIBUTION:** Early Bathonian, Zigzag Zone, Beňatina section, Slovakia.
**MIDDLE JURASSIC AMMONITE FAUNA OF THE PIENINY KLIPPEN BELT, WESTERN CARPATHIANS**

---

**Pseudodimorphinites sp. 1**
(Pl. 14, Fig. 15)

MATERIAL: An internal mould of an adult specimen

<table>
<thead>
<tr>
<th>D</th>
<th>H</th>
<th>E</th>
<th>O</th>
<th>O/D(%)</th>
<th>E/H</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pl. 11, Fig. 15</td>
<td>44.3</td>
<td>10.4</td>
<td>24</td>
<td>54.2</td>
<td></td>
</tr>
</tbody>
</table>

DESCRIPTION: A relatively small *Pseudodimorphinites* with a subcircular whorl section, low and vertical umbilical wall and slightly convex flanks. The ornamentation consists of short radiate primary ribs, bifurcating on the inner half of the flanks. Some intercalary ribs are also present. The ribs pass over the venter without interruption. There is a pair of constrictions at the end of the phragmocone, the first of which is deeper and slightly wider. The body chamber is more than one whorl long.

REMARKS: *Pseudodimorphinites pinguis* differs from the described specimen in the markedly stouter whorls, the whorl section, unpaired constrictions and larger size. Other morphologically close specimens, but belonging to *Asphinctites*, were figured by Sturani (1966, pl. 10, fig. 2) and Torrens (1987, pl. 2, figs. 10-12) from the Bas Auran, France. However, there is a significant difference is in the type of ribbing, which is only bifurcate in our specimen, whereas the ribs branch more than twice in the French specimens. Moreover, these are stratigraphically younger, having been collected from the topmost Yeovilensis Subzone and Teniaplicatus Zone. *Apollonius* Hahn from the Recinctus Subzone is another similarly large taxon but with much finer ornamentation.

STRATIGRAPHICAL AND GEOGRAPHICAL DISTRIBUTION: Early Bathonian, Zigzag Zone, Beňatina section, Slovakia

---

Genus *Morphoceras* Douvillé, 1881
Subgenus *Morphoceras* Douvillé, 1881

*Morphoceras* (M) sp. aff. kostelecense Rakós, 1965
(Pl. 13, Figs 7-8, Text-fig. 12J)

MATERIAL: Two internal moulds of phragmocones with a part of the body chamber preserved

<table>
<thead>
<tr>
<th>D</th>
<th>H</th>
<th>E</th>
<th>O</th>
<th>O/D(%)</th>
<th>E/H</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pl. 13, Fig. 7</td>
<td>26</td>
<td>10</td>
<td>12.2</td>
<td>5.5</td>
<td>21.2</td>
</tr>
</tbody>
</table>

DESCRIPTION: Small sphaerocone ammonite with an extremely narrow umbilicus. Up to approximately 23 mm diameter, it is involute with an occluded umbilicus; the coil-}

ing then rapidly becomes evolute. The venter is broad and regularly rounded. The ornamentation consists of dense primary ribs, bifurcating at one-third of the whorl-height. Both the primary and secondary ribs are slightly prorsiradiate. They are interrupted in the middle of the venter, forming a thin smooth band. The secondary ribs alternate along the ventral line. There are three to four strong constrictions per whorl. These are only slightly prorsiradiate in the lower half of the flanks, but become much more curved adorally in the middle of the flanks. The body chamber is badly preserved. The suture line seems to be simpler than that of *M. (M) kostelecense* (see Rakós 1965).

REMARKS: The described form possesses several aspects in common with *M. (M) kostelecense* and *M. (M) ellipticum* San doval. The principal difference lies in the point of rib bifurcation, which is lowest in our specimens. The primary ribs of *M. (M) kostelecense* bifurcate between the middle and upper third of the flank, simple ribs are very rare. In contrast, *M. (M) ellipticum* is typified by a high number of simple ribs; bifurcate ribs being rare. The division point is situated near the middle of the flank. The inner whorls of both this and our taxon are fairly broad (depressed), but more slender than in *M. (M) kostelecense*. An elliptical shape is, according to Sandoval (1983), a typical feature of *M. (M) ellipticum*. Due to the incomplete preservation of the Carpathian material, the final shell shape cannot be examined. The taxon described here belongs to the early *Morphoceras* group, which are characterized by sphaerocone coiling and with an extremely narrow to almost completely occluded umbilicus (like in *D. dimorphus* (d'Orbigny)). The exact stratigraphic position of *M. kostelecense* is unknown (stated to be Early Bathonian). The Spanish taxon *M. ellipticum* is associated with ammonites proving the *Morphoceras* (M) dimorphiliformis Subzone of the Early Bathonian (equivalent of the Purum Subzone) (Sandoval 1983).

STRATIGRAPHICAL AND GEOGRAPHICAL DISTRIBUTION: Early Bathonian, Zigzag Zone, Beňatina section, Slovakia.

---

Acknowledgements

The study was carried out within the project VEGA 2/4095/4A: Geological structure and tectonic evolution of the Pieniny Klippen Belt. The work was also financed by Comenius University (Grant UK/133/2004 and UK/71/2003). We are also grateful to R. Enay and C. Parsons for their help and discussions as well as to N. Morton and A. Galacz who carefully reviewed the manuscript and made many comments which helped to improve the final version.
REFERENCES

— 1945. Geological research in the inner Klippen Belt, Western Carpathians. Prace Státnho Geologického Ústavu, 13, 1-176. [In Slovak]


BEZNOV, N. V. 1958. Jurassic ammonites of the northern Caucasus and the Crimea. Phylloceratina and Lytoceratina. Leningrad, 1-118. [In Russian]

BERKENMAJER, K. 1977. Jurassic and Cretaceous lithostratigraphic units of the Pieniny Klippen Belt, Carpathians, Poland. Studia Geologica Polonica, 45, 1-158.


Rakôs, M. 1965. Biostratigraphy of the Kostelec Klippe. Geologické Prace, Zprávy, 37, 163-177. [In Slovak]

— 1990. Ammonites and stratigraphy of the base of CzoRSzyn Limestone in the Pieniny Klippen Belt in Slovakia and in Ukrainian Carpathians. Keňovnická Zemňňko Plyn a Nafty, 9b, 73-108. [In Slovak]


— 1986. Middle Jurassic Haploceratidae (Ammonitina) from the Subbetic Zone (South Spain). Geobios, 19 (4), 435-463.


Wierzbowski, A. 1994. Late Middle Jurassic to earliest Cretaceous stratigraphy and microfacies of the CzoRSzyn Succession in the Spisz area, Pieniny Klippen Belt, Poland. Acta Geologica Polonica, 44 (3-4), 223-249.


Manuscript submitted: 20th January 2005
Revised version accepted: 20th October 2005
PLATE 1

11 – *Calliphylloceras disputabile* (Zittel, 1869). Vršatec, bed 7, Zigzag Zone or *Aurigerus* Zone.

All figures are natural size
PLATE 2

1-4, 9 - *Lytoceras joniaki* sp. nov., Beňatina, Zigzag Zone. 1 – Paratype (SNM Z 20 676), specimen described and figured by RAKUS (1990, Pl. 3, Fig. 2). 2 – body chamber, SNM Z 24 168. 3 – Holotype, SNM Z 24 166. 4 – detail of suture line of the holotype. 9 – Paratype, SNM Z 24 167.


8 – *Nannolytoceras tripartitum* (RASPAIL, 1831). Beňatina, Zigzag Zone.

All figures are natural size
PLATE 3

1 – *Lytoceras* sp. 1. Vřesatec, bed 7, Zigzag Zone or *Aurigerus* Zone.


4 – *Siringoceras truellei* (d’ORBIGNY, 1845). Vřesatec, Parkinsoni Zone.


8 – *Lytoceras adelae* (d’ORBIGNY, 1844). Vřesatec, bed 7, Zigzag Zone or *Aurigerus* Zone.

All figures are natural size
PLATE 4

1-2 – *Lissoceras compressus* sp. nov. Holotype, SNM Z 24 169, Vršatec, bed 7, *Zigzag Zone* or *Aurigerus Zone*.

3-4 – *Oxycerites yeovilensis* ROLLIER, 1911. Vršatec, bed 7, *Zigzag Zone* or *Aurigerus Zone*.

All figures are natural size.
PLATE 5

1-2 – *Lissoceras ventriplanum* WENDT, 1963. Adult specimen with the one quarter of the last whorl removed, Vršatec, bed 7, Zigzag Zone or *Aurigerus* Zone.

3 – *Oppelia plewifer* (BUCKMAN, 1924). Dolný Mlyn, Parkinsoni Zone.

4 – *Oxycerites limosus* (BUCKMAN, 1925), Bešatina, Zigzag Zone.

5, 7 – *Oecotraustes* (*Oecotraustes*) sp. Bešatina, Zigzag Zone.


8 – *Micromphalites* (M.) aff. *pustuliferus* (DOUVILÉ, 1916). Bešatina, Zigzag Zone (specimen figured by SCHLOGL & RAKUS, 2004, fig. 4); × 1.5

Except fig. 8, all figures are natural size
PLATE 6

3-4 - *Cadomites* (*Polyplectites*) *minutus* sp. nov. Holotype, SNM Z 24 170, Dolný Mlyn, *Aurigerus Zone.* x 1.5
5-7 - *Cadomites* (*Polyplectites*) *minutus* sp. nov. Paratype, SNM Z 24 171, Vršatec, *Zigzag Zone.* x 1.5


20-21 - *Benainites* (*Lugmiceras*) *lugarenensis* SCHLÖGL & al., in press. Vršatec, *Zigzag Zone.* x 1.5

Except for figs 3-7, 11, 17-21, all are natural size
PLATE 7


5 – *Bullatimorphites* (*Bullatimorphites*) sp. Višatce, bed 7, *Zigzag* Zone or *Aurigerus* Zone.

6 – *Bullatimorphites* (*Kheraiceras*) ex gr. *bullatus* (D'Orbigny). Adult specimen with the terminal part of the body chamber missing. Jarabina quarry, Early Callovian (specimen figured by RAKOS, 1990, pl. 2, fig. 1, SNM Z 20 690).

All figures are natural size
PLATE 8

3 - *Vermisphinctes (?)* sp. Beňatina, Zigzag Zone.

Figures 2, 3 are natural size, figure 1 is × 0.5
PLATE 9

1 – *Procerites (Procerites) fowleri* ARKELL, 1958. Vršatec, bed 7, Zigzag Zone or Aurigerus Zone.


3-4 – *Planisphinctes (Planisphinctes) ex gr. tenuissimus* (SIEMIRADZKI, 1898). Beňatina, Zigzag Zone.

Figures 2-4 are natural size, figure 1 is x 0.66
PLATE 10


All figures are natural size
PLATE 11

1, 5 – Parkinsonia (Parkinsonia) parkinsoni (Sowerby, 1821). Benatina, Parkinsoni Zone.
2 – Zigzagiceras (Procerozigzag) crassizigzag (Buckman, 1892). Benatina, Zigzag Zone (specimen already figured by Rakös, 1990, pl. 1, fig. 1, SNM Z 20 682).
3-4 – Zigzagiceras (Zigzagiceras) ex gr. zigzag (d'Orbigny, 1845). Benatina, Zigzag Zone (specimen already figured by Rakös, 1990, pl. 1, fig. 2, SNM Z 20 677).

All figures are natural size
PLATE 12

1 - *Zigzagiceras (Procerozigzag)* postpollubrum WETZEL, 1937. Vršatec, bed 7, *Zigzag Zone* or *Aurigerus Zone*.

2 - *Procerites (Procrites) clausiprocerum* BUCKMAN, 1892. Vršatec, bed 7, *Zigzag Zone* or *Aurigerus Zone*.

All figures are natural size
PLATE 13

1 - *Parkinsonia (Durotrigensia) ex gr. dorsetensis* (Wright, 1856). Vršatec, Parkinsoni Zone.
2 - *Dimorphinites (Dimorphinites) dimorphus* (D’Orbigny, 1846). Dolný Mlyn, Parkinsoni Zone.
3 - *Morphoceras (Morphoceras)* sp. Vršatec, Zigzag Zone.
9 - *Parkinsonia (Parkinsonia) parkinsoni* (Sowerby, 1821). Vršatec, Parkinsoni Zone.

All figures are natural size
PLATE 14

1-2 – *Parkinsonia (Gonolkites) gyrumbilica* (QUENSTEDT, 1887). Vršatec, bed 7, Zigzag Zone or Aurigerus Zone.

3 – *Morphoceras (Morphoceras)* sp. Beňatina, Zigzag Zone.

4-5 – *Morphoceras (Morphoceras) multiforme* ARKELL, 1951. Dolný Mlyn, Zigzag Zone (specimen figured by RAKÚŠ, 1990, pl. 2, fig. 4-5).

6 – *Polsphinctites polysphinctus* BUCKMAN, 1922. Dolný Mlyn, Aurigerus Zone.

7-10 – *Pseudodimorphinites pinguis* (DE GROSSOUVRE, 1918). Beňatina, Zigzag Zone.


12 – *Ebrayiceras sulcatum* (ZIETEN, 1830). Dolný Mlyn, Zigzag Zone (specimen collected by M. HLOŠKA, described and figured by RAKÚŠ, 1990, pl. 2, fig. 2).

13 – *Ebrayiceras pseudoanceps* (EBRAY, 1864). Vršatec, bed 7, Zigzag Zone or Aurigerus Zone.

14 – *Asphinctites (Asphinctites) recinctus* BUCKMAN, 1924. Dolný Mlyn, Aurigerus Zone.

15 – *Pseudodimorphinites* sp. 1. Beňatina, Zigzag Zone.

All specimens are natural size.
PLATE 15

1 - Choffatia (C.) sp. 1. Vršatec, bed 7, Zigzag Zone or Aurigerus Zone.
2 - Choffatia (C.) sp. 2. Vršatec, bed 7, Zigzag Zone or Aurigerus Zone.

All specimens are natural size.