The stratigraphic position of the ammonite bearing limestone bank of the Márvány-bánya quarry (Zirc, Bakony Mts, Hungary) and the age of the Borzavár Limestone Formation

István Főzy, Budapest and **Nico N. M. Janssen**, Utrecht

With 5 figures

FŐZY, I. & JANSSEN, N. N. M. (2006): The stratigraphic position of the ammonite bearing limestone bank of the Márvány-bánya quarry (Zirc, Bakony Mts, Hungary) and the age of the Borzavár Limestone Formation. – N. Jb. Geol. Paläont. Mh., **2006**: 41 –46; Stuttgart.

Abstract: One of the richest Cretaceous cephalopod assemblages in Hungary was collected from a limestone lens in Márvány-bánya ("Marble quarry") near Zirc. The lens was nearly completely removed by collecting but its age has not been satisfactorily established. We re-examined the available material that contains about 40 taxa of Late Hauterivian ammonites and nine species of Late Hauterivian and late Early Barremian belemnites. Some of the ammonites are rare, poorly known and/or recorded from Hungary for the first time. The crinoidal, brachiopod-rich Borzavár Limestone, cropping out in a nearby quarry, is very likely Early Hauterivian in age. Thus it represents an older formation situated below the fossil rich bed(s) of the Márvány-bánya.

Zusammenfassung: Eine der reichsten Cephalopoden-Vergesellschaftungen Ungarns wurde aus einer Kalkstein-Linse in Márvány-bánya („Marmorbruch") bei Zirc zusammengetragen. Die Schicht war durch Sammlertätigkeit völlig entfernt worden, doch war ihr Alter nicht zufriedenstellend geklärt. Wir haben das verfügbare Material erneut untersucht. Es enthält etwa 40 Ammoniten-Taxa aus dem oberen Hauterivium und 9 Belemniten-Taxa aus dem Ober-Hauterivium und dem späten Unter-Barremium. Einige der Ammoniten sind selten, ungenügend bekannt und/oder werden zum ersten Male aus Ungarn erwähnt. Der Kalkstein aus Borzavár, der Crinoiden und Brachiopoden enthält und in einem Steinbruch in der Nähe ansteht, besitzt höchstwahrscheinlich ein Unter-Hauterivium-Alter. Er stammt somit aus einer Formation im Liegenden der fossilienreichen Schicht von Márvány-bánya.

Key words: Hauterivian, Barremian, ammonite, belemnite, stratigraphy, Hungary

1. Introduction

The so-called Márvány-bánya ("Marble Quarry") is a small, abandoned quarry at the foothill of Pintér-hegy, in the close vicinity of Zirc (GPS coordinates: X: 47° 16,061; Y: 17° 51,248) (Fig. 1.) This quarry yielded light, compact, Upper Jurassic limestones poor in megafossils. On the top of these rocks there was a brownish, fossiliferous limestone bank (or a lens?) with siltstone lenses and stromatolitic nodules. The extension of this bank was rather limited: its thickness was about 50 cm and its area extension was about 2-3 square meters. The beds discovered in 1932, yielded a very rich and well-preserved Early Cretaceous cephalopod assemblage. Because this period was thought to be a period of terrestrial bauxite deposition in the Bakony Mts. for a long time, the bank of marine origin attracted the interest of the early geologist. Because of its unique features and special importance, the Early Cretaceous slab was intensively collected, and finally nearly completely destroyed. Some of the ammonites were listed, and subsequently illustrated; finally the whole material was deposited in the Rákóczi-telep storehouse of the Hungarian Geological Survey. Nowadays the figured specimens can be found in the main collection of the Survey in Budapest, under the inventory numbers mentioned in the explications of the figures, whereas the bulk of the remaining fossil

material is still in Rákóczi-telep depository. Some additional specimens, and also the ammonite described here as *Jeanthieuloyites* sp. from the Borzavár quarry are deposited in the collection of the Hungarian Museum of Natural History in Budapest.

2. Previous studies

The small quarry of Márvány-bánya was already known and mentioned by TAEGER (1909), who believed that the excavated limestone is of Middle Jurassic age. The Upper Jurassic age of the limestone, and, more importantly, the presence of the Neocomian limestone bank above, was recognised and discovered by WEIN in 1932 during a field trip. WEIN published his observation as a part of his doctoral thesis in the Földtani Közlöny in 1934. NOSZKY, a colleague of WEIN, listed the rich ammonite material collected from the Cretaceous bank in the same volume (NOSZKY 1934). NOSZKY mapped the neighbourhood of the Márvány-bánya, collected and determined 27 ammonite taxa, and concluded that the bank is Hauterivian, "but not the deepest Hauterivian" in age. This more than 70 years old list of NOSZKY is still a good base for the re-evaluation of the fauna: making minor corrections on the list and "dusting" the old generic names, we get a more or less typical Late Hauterivian fauna.

In the early sixties, FÜLÖP gave a detailed description of the locality and briefly described the fauna in his monograph on the Lower Cretaceous of the Bakony Mts. (FÜLÖP 1964). He – possibly with the help of I. NAGY – determined and listed 51 (!) ammonite taxa (essentially from the NOSZKY collection) and figured some representative ammonites (including crioceratids, ptychoceratids, a desmoceratid, a hamulinid, and a pulchelliid) on four plates. FÜLÖP concluded that the fossiliferous bank is Lower Barremian in age. Later NAGY, former co-worker of FÜLÖP, did also a short palaeontological contribution on the ammonite fauna of the bank (NAGY 1981). He figured two plates of stratigraphically less important forms. Without giving long discussion he quoted the fauna also as a Barremian one.

More recently, MISZLIVECZ studied the site and the fauna. In a short note in 1985, she figured some fragmentary long ranging forms. Subsequently, in relation to her PhD studies, a further collection was carried out in 1986, which provided mainly poorly preserved fragmentary specimens only but stated the nearly complete disappearance of the rest of the former limestone bank. MISZLIVECZ summarised her results in her unpublished thesis (1990). She described Early and Late Hauterivian as well as Early and Late Barremian ammonites and concluded that the age of the fauna is Early Barremian.

Besides the large number of ammonites, a few dozens of belemnite fragments were also collected from the Márvány-bánya. Already NOSZKY (1934) listed *Duvalia dilatata* BL.; later FÜLÖP reported and figured (1964, pl. 29, fig. 5) *Duvalia lata* (BL.), and NAGY mentioned (1981: 74) *Duvalia dilatata* (BL.).

The Márvány-bánya fauna yielded not only cephalopods, but brachiopods and bivalves as well. A recent revision of the latter group (SZENTE 2003) suggests that the fauna – containing seven genera – is rather diverse.

During the past decades, much was done related to Early Cretaceous biostratigraphy and distribution of Mediterranean ammonites. Therefore and because of the inconsistency of the former results, a re-evaluation of one of the superb Early Cretaceous cephalopod assemblage seems topical. The present paper is not a complete palaeontological revision of the large cephalopod fauna of the Márvány-bánya – only some of the stratigraphically most important taxa are discussed. All of the figured cephalopods came form the old collections of NOSZKY and FÜLÖP. I. F. is responsible for the ammonite studies, whereas N. J. studied the belemnites.

3. The ammonite fauna of the "cephalopod limestone bank" of the Marble Quarry

After the revision of the Márvány-bánya ammonite fauna, collected by the numerous palaeontologists and by their co-workers, the list of the nodular Early Cretaceous limestone bank is given below. The asterisk (*) in front of the names indicates if the taxon is new for the Hungarian fauna, or if it is figured here under its proper taxonomic name for the first time.

P h y l l o c e r a t i n a
Phylloceras tethys (D'ORBIGNY, 1841), (figured by FÜLÖP 1964, pl. 26, fig. 6)
Phylloceras serum (OPPEL, 1865), (figured by FÜLÖP 1964, pl. 26, fig. 2 as *P. tethys*)
Phyllopachyceras infundibulum (D'ORBIGNY, 1841), (Fig. 3.B)
Phyllopachyceras winkleri (UHLIG, 1882), (Fig. 2.A, B)
Holcophylloceras ponticuli (ROUSSEAU, 1842), (figured by FÜLÖP 1964, pl. 26, fig. 5, and by NAGY 1981, pl. 1, fig. 1 as *P*. (*H*.) aff. *aptiense*)
Ptychophylloceras sp., (Fig. 4.D)
Phylloceras spp.

L y t o c e r a t i n a
Lytoceras subfimbriatum (D'ORBIGNY, 1841), (figured by FÜLÖP 1964, pl. 27, fig. 2 and by MISZLIVECZ 1985, pl. 1, fig. 1)
Lytoceras sp.
Protetragonites quadrisulcatus (D'ORBIGNY, 1841), (figured by FÜLÖP 1964, pl. 27, fig. 1, and by NAGY 1981, pl. 1, fig. 4)

A m m o n i t i n a
Haploceratidae:
Neolissoceras grasianum (D'ORBIGNY, 1841), (Figs. 3.D, 5.E)

Desmoceratidae:
(*) *Abrytusites neumayri* (HAUG, 1889), (Fig. 4.A), (another specimen figured by FÜLÖP 1964, pl. 29, fig. 6, as *V. crassidorsata*)
(*) *Abrytusites thieuloyi* VAŠIČEK, 1986
(*) *Abrytusites julianyi* (HONNORAT-BASTIDE, 1890)
Abrytusites sp.
(*) *Plesiospitidiscus subdificilis* (KARAKASCH, 1907), (Fig. 2.F)
Plesiospitidiscus sp.

Silesitidae:
(*) *Silesites* sp. (Fig. 2.J)

Pulchelliidae:
Discoidella cf. *favrei* (OOSTER, 1860), (Figs. 2.I, 4.C, refigured after FÜLÖP 1964, pl. 29, figs. 3-4 as *Nicklesia* cfr. *pulchella*)
(*) *Discoidella couratieri* VERMEULEN, 1995, (Fig. 5.D)

A n c y l o c e r a t i n a
Bochianitidae:
(*) *Pseudomoutoniceras annulare* (D'ORBIGNY, 1842), (Fig. 3.A)

Ancyloceratidae:
Crioceratites duvali LEVEILLE, 1837

(*) *Crioceratites krenkeli* SARKAR, 1955, (Fig. 3.F)
Crioceratites spp.
Crioceratites munieri SARASIN & SCHÖNDELMAYER, 1902
Emericiceras emerici (LEVEILLE, 1837)
Pseudothurmannia spp.
(*) *Paraspinoceras pulcherrimum* (D'ORBIGNY, 1840), (Fig. 3.C, figured by FÜLÖP 1964, pl. 28, fig. 2, as *Heteroceras* sp.)
(*) *Paracostidiscus radians* BUSNARDO, 2003, (Fig. 4.E)
(*) *Hamulinites munieri* (NICKLES, 1894), (Fig. 3.E)
Ancyloceratidae spp.

Hamulinidae:
Hamulina astieriana (d'ORBIGNY, 1850), (a specimen, today not found, figured by FÜLÖP, 1964, pl. 28, fig. 3)
Hamulina spp.
(*) *Anahamulina* cf. *subundulata* (d'ORBIGNY, 1850), (Fig. 4.B)
Anahamulina sp.

Ptychoceratidae:
Ptychoceras meyrati (OOSTER, 1860), (Fig. 2.H, another almost complete specimen was figured by FÜLÖP 1964, pl.28, fig. 1)
Ptychoceras biassalense KARAKASCH, 1907 (Fig. 2.G, another specimen figured by FÜLÖP 1964, pl. 29, fig. 2)

Douvilleiceratidae:
(*) *Paraspiticeras percevali* (UHLIG, 1883) (Fig. 2.E)

4. Remarks on the ammonite fauna

Altogether more than 1300 ammonite specimens were collected from the limestone bank. Most of the fossils are fragments of moderately well preserved internal moulds with – at least partly – preserved shell. As can be seen from the list, the fauna is relatively diverse both on family and species levels. Although representatives of Phylloceratina and Lytoceratina form more then half (58 %) of the specimens, Ancyloceratidae and Desmoceratidae are also well represented (20 and 15 % respectively). The rest of the specimens (7 %) is composed of species belonging to Haploceratidae, Silesitidae, Pulchelliidae, Hamulinidae, and Ptychoceratidae. However, the bulk of the stratigraphically important species belong to these latter five families.

The faunal list above contains more taxa than the genuine list of NOSZKY because some of the lately described ammonites were unknown to him. On the other hand the list is shorter than the list of FÜLÖP whose assignment was based on a splitter attitude, which resulted the use of many – possibly too many – ammonite names.

P h y l l o c e r a t i n a
The fauna is rich in phylloceratids, *P. tethys, P. serum*, and *P. infundubulum*, which have a long range, but they are known from the Hauterivian onwards (REBOULET 1996, BUSNARDO et al. 2003). *H. ponticuli* is a basically Barremian species, but it appears already in the Late Hauterivian (CECCA et 1998). NOSZKY (1934) and FÜLÖP (1964) listed several other, relatively poorly known species like *P. rouyanum* (which is close to *P. infundibulum*, but has a less inflated whorl section), *P. stuckenbergi, P. eichwaldi, P. milaschewitschi*, and *P. morelianum*.

L y t o c e r a t i n a

The overwhelming majority of lytoceratids were determined as the "classical" species of *L. subfimbriatum* and *P. quadrisulcatus*. Besides these common taxa NOSZKY listed *L.* cfr. *Raricinctum*, and FÜLÖP some additional less known species, like *L. vogdti, L. subsequens*, and *Leptotetragonites*. These names and forms still require a revision.

Protetragonites crebrisulcatus, generally regarded as a Barremian species, was figured from Márvány-bánya by NAGY (1981, pl. 1, fig. 3). This ammonite represents possibly an early silesitid, as discussed below.

Costidiscus nodosocostatus was traditionally ranged into Lytoceratina. It was listed by NOSZKY (1934) and later also by FÜLÖP (1964) and MISZLIVECZ (1990). The genus is typical of the Early (but not earliest) Barremian, therefore its incidental presence is of special importance. However, during the revision it became clear that specimens labelled as *Costidiscus* were misidentified. They belong to the recently described Late Hauterivian genus *Paracostidiscus* (see also the remarks on Ancyloceratidae).

A m m o n i t i n a

Haploceratidae:

Neolissoceras grasianum is a characteristic, easily identifiable ammonite which was listed by NOSZKY (1934) as *Lissoceras Grasianum*. It is a flat, smooth ammonite showing a typical oblique umbilical wall. The species is common in the Berriasian but it became extinct in the Late Hauterivian around the Sayni Zone (REBOULET 1996) or even higher, but still in the uppermost Hauterivian. A close ally is *Neolissoceras subgrasianum* which was reported by DRUSHCHITS (1960) from the Barremian. The latter age was probably a misinterpretation.

Desmoceratidae:

The fauna is rich in desmoceratids. Numerous different species were listed by NOSZKY (1934) and subsequently by FÜLÖP (1964) under several generic names like *Desmoceras*, *Barremites*, and *Valdedorsella*. All of these genera, plus *Abrytusites*, *Melchiorites*, and *Plesiospitidiscus*, are closely related and sometimes difficult to separate. In many cases their only significant difference lies in the whorl section, whereas the inner whorls of many forms are indistinguishable. In many cases, even the higher categories are uncertain. E.g., *Plesiospitidiscus* was usually placed within Desmoceratidae (WRIGHT et al. 1996), but some authors emphasise that it has holcodiscid features (HOEDEMAEKER 1995, CECCA et al. 1998). Whereas the type species of *Abrytusites* (*A. neumayri*) is from the latest Hauterivian, it seems that *Abrytusites* could be a useful name for those Hauterivian taxa which are morphologically very close to the (possibly Aptian) *Valdedorsella*. From this point of view, the use of the Late Hauterivian genus *Pseudovaldedorsella* (introduced by CECCA et al. 1998) seems to be unnecessary. *Barremites* (used basically for the Barremian group of *B. difficilis* and its close allies) also traces back to the Late Hauterivian.

In general, many of the Márvány-bánya desmoceratids are very close to those forms which were described and figured from the latest Hauterivian of the Apennines by CECCA et al. (1998). The whole group needs a revision, but this is far beyond the scope of this study.

Silesitidae:

This family in most cases unites very few genera with very few species. *Silesites* was traditionally used mainly for two species: for the Lower (but not lowermost) Barremian *S. vulpes* (COQUAND) and for the Upper Barremian – Aptian *S. seranonis* (D'ORBIGNY). On the other hand there are further, not very well-known, almost "forgotten" species in the old

literature (e.g., KARAKASCH 1907). Recently, AVRAM (1987) created a new (Barremian) genus, *Patruliusiceras*, within this family, which contains numerous closely allied species.

FÜLÖP (1964) was the first who recognised the presence of *Silesites* in the Márvány-bánya fauna. Later, MISZCLIVIECZ (1990) determined the silesitids from the quarry as *S. vulpes*, which has a special biostratigraphical implication, because it was the zonal index of the Early Barremian for a long time. Therefore, its presence was a key for the biostratigraphic position of the limestone bank. Indeed the smooth Márvány-bánya silesitids can be distinguished easily from *S. vulpes*, which bears a weak or stronger ribbing. They represent a new form, or a taxon related to some of the forms (like *S. typus*) described and figured by KARAKASCH (1907), and may represent the earliest known species of the family. They also resemble certain lytoceratids (namely *Protetragonites*) but the new forms have different suture lines and also a different style of constrictions (slightly sigmoid).

Pulchelliidae:
This is also a biostratigraphically very important family, since the majority of the species and genera are exclusively Barremian in age. On the other hand, there is no doubt that the oldest forms (*Discoidella* spp.) appear already in the latest Hauterivian (e.g., VERMEULEN 2002). In the case of the Márvány-bánya fauna, pulchelliids were recognised by the early workers correctly on family level, but misidentified on generic and, more importantly, on specific level.

A single specimen of *Discoidella* cf. *favrei* (OOSTER) was already recognised in the Bersek-hegy section (FŐZY & FOGARASI 2002: 307), while *Discoidella couratieri* VERMEULEN is new for the Hungarian fauna.

A n c y l o c e r a t i n a
Bochianitidae:
FÜLÖP (1964) listed three specimens belonging to this group ("Bochianitinae sp."), but since the labels and the fossils were separated and later mixed, it is unknown to which ammonites they were referred. During the revision, a single piece of an extremely uncoiled Ancyloceratina was determined as *Pseudomoutoniceras annulare* (D'ORBIGNY). This is a poorly known Late Hauterivian ammonite, only found in fragments, and possibly identical with "*Ancyloceras cinctum* D'ORBIGNY" figured by OOSTER (1860, pl. 51, figs. 1-3). THOMEL (1964) discussed the species in detail which was previously not described from Hungary. Some of the specimens listed above as Ancyloceratidae spp. are very close to the forms figured by OOSTER (1860) as *Ancyloceras Seringei* ASTIER, and *Ancyloceras jourdani* ASTIER, and recently by BUSNARDO et al. (2003) as *Hamulina pictetiformis* nov. sp.

Ancyloceratidae:
The fauna is very rich in fragments of specimens that belong to this family. Since ancyloceratids and especially *Crioceratites* and related forms change a lot throughout their ontogeny, it is impossible to determine many of the fragments on species level. Despite of this, some characteristic species were recognised. In general we can say that the majority of the Márvány-bánya criocone ammonites are characterised by compressed (oval to high oval) cross-sections typical of the Hauterivian forms. Ancyloceratids with subcircular whorl-sections (which is a feature of Barremian forms in general terms) play a subordinate role in the composition of the fauna.

For a long time it was believed that the relatively diverse and well-preserved crioceratid fauna of the Márvány-bánya provides a key in the understanding the age of the fauna. Indeed, many other, occasionally rare elements provide more help than *Crioceratites* and *Pseudothurmannia* species, which are difficult to determine and evaluate. *Paraspinoceras*

pulcherrimum (D'ORBIGNY) is a little known ammonite, recorded for the first time by NOSZKY (1934) under the generic name of *Hamulina*. THOMEL (1964) reported the rare *Acrioceras (Paraspinoceras) pulcherrimum* (D'ORBIGNY) from south-east of France with a maximum frequency around the Hauterivian/Barremian boundary beds. Subsequently, VAŠIČEK & MICHALIK (1988) described carefully these species as characteristic elements of the Pseudothurmannia Beds from the Hauterivian/Barremian boundary in the Western Carpathians.

Paracostidiscus radians BUSNARDO is also a rare faunal element, which caused again many misunderstandings throughout the early researches. Both the genus and the species were introduced in 2003; they were described from the classical section of Veveyse de Châtel (Switzerland) from Late Hauterivian beds. The Hungarian specimens are the first report of this species out of the type section. They were identified by NOSZKY, FÜLÖP and MISZLIVECZ as *Costidiscus*, and therefore they were used as prove of the Barremian age. Indeed, it is a Late Hauterivian ammonite (BUSNARDO et al. 2003) which shows striking similarities to the true *Costidiscus,* which is in fact a Barremian form. *P. radians* was described from Veveyse together with the minute leptoceratid *Hamulinites munieri* (NICKLES, 1894) from the same stratigraphic level. This species, or a very close form, was also found at Márvány-bánya. The taxonomy and stratigraphy of the small-sized Late Hauterivian – Barremian heteromorph ammonites is still problematic. VAŠIČEK & WIEDMANN (1993) regarded *H. munieri* as a synonym of *Hamulinites parvulus* (UHLIG), which is – according to these authors – a "cosmopolitan and mainly Lower Barremian species". In this paper the points of view of CECCA et al. (1998) and BUSNARDO et al (2003) are accepted; therefore *munieri* and *parvulus* are treated as separate species with a possibly different stratigraphic distribution. On the other hand *H. munieri* is very close to *Hamulinites varusensis* (D'ORBIGNY, 1850) which is a possible synonym of NICKLES' species.

Hamulinidae:
Middle or big sized fragments, straight limbs and hooks with ribbing and with, or without tubercles were ranged into this family. The whole group is typical of the Barremian, but as it was proved in many cases, the first representatives appear already in the Late Hauterivian. Only *Hamulina astieriana* and *Hamulina* cf. *subundulata* were identified on species level.

Ptychoceratidae:
Traditionally, this family comprises only two genera (*Ptychoceras* and *Euptychoceras*) but since there are no obvious differences, the latter can be regarded as a synonym of *Ptychoceras*. Numerous straight, incomplete limbs and knee-like curved part of these three-armed ammonites were found and determined as *Ptychoceras meyrati* (OOSTER). Fragments of the juvenile and middle limbs show strong affinities to the incomplete young specimens of *Euptychoceras borzai* VAŠIČEK, 1998 (VAŠIČEK 1998, pl. 2, figs. 1-2) and to the almost complete specimen of FÜLÖP (1964, pl. 28, fig. 1). These ammonites have no blunt swellings on the adult limb, but only a fine to strong ribbing. As a consequence, the fragmentary specimen of VAŠIČEK (1964, pl. 2, fig. 4), described also as *E. borzai*, presumably belongs to the *biassalense/inostranzewi* group.

Douvilleiceratidae:
According to WRIGHT et al. (1996), the family comprises Barremian – Middle Albian ammonites, but the first representatives (*Paraspiticeras*) appear already in the latest Hauterivian (e.g., CECCA et al. 1998). *Paraspiticeras* is never common but always present in the Mediterranean assemblages (e.g., COMPANY et al. 1995). It unites some classical, although poorly known species. Some large fragments were recorded also from the Gerecse Mts. (FŐZY

& FOGARASI 2002). The *Paraspiticeras* specimens in the Márvány-bánya were already recognised by NOSZKY (1934), who listed them as "*Aspidoceras* cfr. *Guerinianum* ORB." and "*Aspidoceras (Pachydiscus?)* cfr. *Percevali* UHLIG."

5. The belemnite fauna of the „cephalopod limestone bank" of the Márvány-bánya

During recent studies all the available belemnite material collected from the quarry was revised. Similarly to the ammonites, the labels belonging to the belemnite specimens yielded no precise information on the beds where the fossils were derived. In most cases only the locality (Márvány-bánya) was indicated. Exceptionally, "bed no. 4" was written on some of the labels. The final faunal composition of the Márvány-bánya belemnite material is the following:

Mesohibolitidae:
"*Mesohibolites*" cf. *gladiiformis* UHLIG, 1883, (Fig. 5.A) – One rather large ortholineate Mesohibolitidae lacking the apical part. The alveolus is centrally placed and the slit appears to be "*Mesohibolites*"-like.
"Mesohibolites" gr. *garshini* (STOYANOVA-VERGILOVA, 1965 in TOPCHISHVILI et al. 2002, pl. 9, fig. 4.), (Fig. 5.H) – One ventrally corroded specimen. Group of rather short, apically depressed, alveolar part rounded belemnites. It might belong to the genus *Curtohibolites*.
Hibolithes sp. – Most probably four incomplete specimens (from bed 4) of *Hibolithes* gr. *subfusiformis* (RASPAIL, 1829).
Pseudobelus brevis PAQUIER, 1900, (Fig. 5.B, C) – One specimen with well defined eight-shaped sagittal cut, and well-defined lateral lines. Onset of alveolus and alveolar groove is present. This specimen is typical of the Late Hauterivian but is unknown to occur in sediments younger than the Late Hauterivian Balearis Zone.
Hibolithes sp. – One elongated half fragment of an immature specimen, and one thicker fragment of what is most probably *Hibolithes* gr. *subfusiformis* (RASPAIL, 1829).
Mesohibolitidae spp. – Dozens of small corroded, very poorly preserved, fragmentary specimens from a seemingly glauconitic rock.
Mucrohibolites? sp. – A fairly fragmented and compressed specimen.

Duvaliidae:
Duvalia grasiana (DUVAL-JOUVE, 1841), (Fig. 5.K, L) – One specimen with a typical morphology, with slightly swollen middle part of the rostrum)
Duvalia gr. *grasiana* (DUVAL-JOUVE, 1841), (Fig. 5.M, N, O, P) – One alveolar fragment and one almost complete specimen (from bed 4). The specimens are different from the typical morphology of *D. grasiana* but are either slender variations of the same species or (sexual) dimorphs.
Duvalia dilatata (DE BLAINVILLE, 1827) (Fig. 5.G, J) – Three very compressed specimens.

The belemnite taxa from Márvány-bánya suggest slightly different age than ammonites do. E.g., *Hibolithes* gr. *subfusiformis* has a long range, spanning from the latest Valanginian to the earliest Barremian. *Pseudobelus* gr. *brevis* and *Duvalia dilatata* are typical Late Hauterivian forms, but they appear already in the Early Hauterivian. "*Mesohibolites*" cf. *gladiiformis, Duvalia grasiana,* and *D.* gr. *grasiana* are characteristic elements of the Early, but not the earliest, and Middle Barremian faunas.

The numerous corroded, glauconitic fragments (Mesohibolitidae) are derived from even younger deposits; they represent the fauna of the Tata Limestone Formation – traditionally regarded as Aptian – which was the covering of the cephalopod limestone bank in the Márvány-bánya quarry. The observation of the Aptian (or even younger?) belemnites

from the quarry fits well with the results of SZIVES (2001) who listed numerous ammonites including *Holcophylloceras guettardi* (RASPAIL, 1831), *Tetragonites duvalianus* (D'ORBIGNY, 1840), *Melchiorites melchioris* (TIETZE, 1872), *Valdedorsella getulina* (COQUAND, 1880), *Silesitoides* n. sp., *Ptychoceras laeve* MATHERON, 1842, *Cheloniceras (Ch.) cornuelianum* (d'ORBIGNY, 1841), and *Acanthohoplites abichi* (SEUNES, 1887) from the same locality. Theses ammonites were preserved as phosphatized and glauconitized internal moulds, their infilling is very different to those of the "cephalopod limestone bank". More information on the age of the Tata Limestone Formation was given by SZIVES (1999) and SZIVES & MONKS (2002). Even today, the blocks of the Aptian Tata Limestone can be observed all around the Márvány-bánya quarry.

6. The age of the fossiliferous bank

As it has been shown above, the age of the cephalopod bearing limestone bank in the Márvány-bánya quarry was a question of debate for a long time in the Hungarian geology. NOSZKY (1934) argued that it is Hauterivian in age, while FÜLÖP (1964) suggested an Early Barremian age. MISZLIVESZ (1990) recognised five Hauterivian ammonite zones and one Barremian ammonite zone, and supposed also the presence of the Upper Barremian.

The position of the boundary between the Hauterivian and Barremian stages has suffered certain modifications during the past decades. In this paper, the authors follow the latest recommendations by HOEDEMAEKER et al. (2003), drawing the boundary at the base of the Hugii Zone.

As it is shown, the age of the cephalopod bearing limestone bank in the quarry can be approached by means of ammonites, as well as the belemnite fauna. Since most of the phylloceratids and lytoceratids have a long range within the Early Cretaceous, they are relatively less important from a stratigraphical point of view. The rest of the fauna, namely representatives of the Ammonitina and Ancyloceratina, are more informative. *Neolissoceras grasianum*, represented by numerous specimens, is an important ammonite, definitely not younger than Late Hauterivian. According to their labels, they were possibly found in the oldest(?), 4th bed of the bank. *N. grasianum* always disappears in the latest Hauterivian assemblages. The recognised pulchellids (*Discoidella* spp.) are typical elements of the latest Hauterivian, but *D. favrei* became extinct only at the end of the lowermost Barremian (possibly in the Hugii Zone of this stage). Some ammonites, including *Paraspinoceras pulcherrimum* and *Hamulinites munieri* were always reported just below and around the Hauterivian/Barremian boundary beds. *Pseudomoutoniceras annulare* and *Abrytusites neumayri* are possibly restricted to the Late Hauterivian. Some of the Márvány-bánya forms, like *Paraspiticeras*, are typical Barremian ones, but their first representatives appear already in the Late Hauterivian.

It is concluded here, that many of the Márvány-bánya ammonites are exclusively Late Hauterivian in age, while the rest of the forms are known from the Late Hauterivian and from the Barremian as well. Characteristic Early Barremian ammonites, like many pulchelliids, and holcodiscids, are virtually absent from the fauna. Thus, the ammonite-based age of the Márvány-bánya limestone bank is Late Hauterivian. On the other hand, some of the belemnite findings ("*Mesohibolites*" cf. *gladiiformis, Duvalia grasiana,* and *D.* gr. *grasiana*) indicate also Early Barremian sediments to be present, i.e. post-Nicklesi Zone age. This slight discrepancy can be explained either by our lack of knowledge on the exact distribution of cephalopods, or by the lack of the true Early Barremian ammonites from the (?) uppermost part of the former limestone bank.

7. The age of Borzavár Limestone Formation – a related problem

A few kilometres north (GPS parameters: X: 47° 16,655, Y: 17° 50,655, Z: 445) of the Márvány-bánya quarry, along the road from Zirc to Borzavár, there are several small abandoned quarries, where reddish limestones (Borzavár Limestone Formation) and the Aptian Tata Limestone Formation crop out (Fig. 1).

The Borzavár limestone is rich in fossils, especially in crinoids (SIEWERTS-DORECK 1961), echinoids and brachiopods (mainly pygopids). At the beginning of the research, the outcropping 10-12 meters of the limestone were thought to have a Tithonian age (KOCH 1875). Later FÜLÖP (1964) suggested a Valanginian-Hauterivian age. The latest lithostratigraphic chart (CSÁSZÁR 2000) implies that the few meters thick, coarse-grained limestone succession represents the whole Valanginian and the Hauterivian, and a part of the Barremian as well. Ammonites are scarce and very poorly preserved. FÜLÖP (1964) listed *Phylloceras* sp., *Lytoceras* sp., a single specimen of *Crioceratites* sp., and *Neolissoceras grasianum*. In addition to these ammonites, a specimen of *Jeanthieuloyites* sp. was recently collected (Fig. 4.D). Although this specimen is eroded, the characteristic style of ribbing, the constrictions and even the faint ventral band is visible. Similar forms were documented from the Gerecse Mts. (FŐZY & FOGARASI 2002). In the Gerecse Mts. this genus is common throughout the Late Valanginian – Early Hauterivian deposits. The genus *Jeanthieuloyites* include numerous species, around the *rossfeldensis-quinquestraitus* group which are highly variable and were difficult to separate, even on the base of the representative fossil material of the Gerecse Mts. The poorly preserved fragment from the Borzavár-road-quarry was not identified on species level, but it shows strong similarity to the specimens of Bersek-hegy (Gerecse Mts.).

As a conclusion, we can say, that the coarse grained crinoidal Borzavár limestone, which we interpret as a rapidly deposited formation, represents a rather short time interval around the Late Valanginian and/or within the Early Hauterivian. It is likely that it represents the underlying succession of the cephalopod limestone bank of the Márvány-bánya quarry.

8. Conclusions

The revision of the ammonite and belemnite fauna of the Márvány-bánya limestone bank revealed, that the mayor part of the 50-cm thick fossiliferous, nodular limestone was deposited in the Late Hauterivian. Some belemnites indicate, that possibly the uppermost part is Early (but not the earliest) Barremian in age. The ammonites of the bank are moderately well preserved internal moulds, with partly preserved shells in most cases. Generally both sides are preserved. No preferential dissolution of upper halves of specimens (a common mode of preservation in Jurassic deposits) was observed. Some of the fragments are eroded. The position of the cephalopods in the limestone was chaotic. Phosphatized and glauconitized nodules, up to 10 cm in diameter, were common (MISZLIVECZ & POLGÁRI 1987). All these features suggest a highly energetic and pelagic palaeoenvironment. The cephalopod rich association can be regarded as a kind of moderately condensed lag deposit, which was formed possibly on a topographic high.

The preservation of the cephalopod-rich limestone bank in the Márvány-bánya quarry is exceptional, but not exclusive. FÜLÖP (1964) reported similar ammonite fauna from the neighbouring Rendkő and Hárskút sections. In these localities the succession is more marly and the fossils are not so well preserved.

On a wider geographical scale the ammonite association of the Márvány-bánya quarry clearly reflects Mediterranean affinities, which is typical of the Bakony Mts. and the whole

Transdanubian Central Range of Hungary. Many of the listed ammonites are poorly known and some of them are new for the Hungarian Early Cretaceous ammonite associations. The composition of the fauna shows strong affinities to the Pseudothurmannia Beds of the Western Carpathians (VAŠIČEK & MICHALIK 1988), to the fauna collected from the "Guide-bed of the Faraoni-level" from the Umbria-Marche Apennines (CECCA et al. 1998), and to those assemblages that are known from the latest Hauterivian of the Subbetics of Southern Spain (HOEDEMAEKER 1995, COMPANY et al. 2003).

Acknowledgements

The authors are particularly indebted to MIGUEL COMPANY (University of Granada) and ZDENEK VAŠIČEK (Technical University of Ostrava) for consulting on certain specimens and for providing literature. PETER RAWSON (University College London) is especially thanked for his constructive comments, suggestions and also for the linguistic corrections. OTTILIA SZIVES and JÓZSEF PÁLFY (Hungarian Natural History Museum, Budapest) are also thanked for their useful advice. ISTVÁN SZENTE (Eötvös L. University, Budapest) is thanked for offering access to the Borzavár quarry specimen. The study was sponsored by the Hungarian Scientific Research Found (OTKA) project No: 34208.

References

AVRAM, E. (1987): *Patruliusiceras*, a new genus of the family Silesitidae HYATT, 1900 (Ammonitina). – Dari Seama Inst. Geol. Geofiz., **74** (3): 69-86.

DUVAL-JOUVE, J. (1841): Bélemnites des terraines crétacées inférieures des environs de Castellane (Basses-Alpes), considérées géologiquement et zoologiquement, avec la description de ces terrains. – Acad. Sci. Nat. Paris, p. 1-80.

BLAINVILLE, H. & DUCRATOY, M. de (1827): Mémoire sur les bélemnites, considérées zoologiquement et géologiquement. – 136 pp.; Paris & Strasbourg (Levrault).

BUSNARDO, R., CHAROLLAIS, J., WEIDMANN, M., & CLAVEL, B. (2003): La Crétacé inférieur de la Veveyse de Châtel (Ultrahelvétique de Préalpes externes; canton de Fribourg, Suisse). – Rev. Paléobiol., **22**: 1-174.

CECCA, F., FARAONI, P. & MARINI, A. (1998): Latest Hauterivian (Early Cretaceous) ammonites from Umbria-Marche Appenines (Central Italy). – Palaeontogr. Ital., **85**: 61-110.

COMPANY, M., SANDOVAL, J. & TAVERA, M. (1995): Lower Barremian ammonite biostratigraphy in the Subbetic Domain (Betic Cordillera, southern Spain). – Cretaceous Research, **16**: 243-256.

– (2003): Ammonite biostratigraphy of the uppermost Hauterivian in the Betic Cordillera, (SE Spain). – Géobios, **36**: 685-694.

COQUAND, H. (1880): Etudes supplementaires sur la paleontologie Algerienne. – Bull. Acad. Hippone, **15**: 1-449.

CSÁSZÁR, G. (2000): Magyarország litosztratigráfiai alapegységei. (Basic Litostratigraphic Units of Hungary.) (wall-chart). – Budapest (MÁFI).

DRUSCSIC, V. V. & KUDRJAVCEV, M. P. (1960): Atlasz nyizsnyemelovoj fauni Szevernovo Kavkaza i Krima. – Goszudarsztvennoje Naucsno-Tehny. Izd. Nyeft, 701 pp.; Moszkva.

FŐZY I. & FOGARASI, A. (2002): The Lower Cretaceous biostratigraphy of the Bersek Hill (Gerecse Mts., Transdanubian Range) on the basis of the ammonite fauna and nannofossil flora. – Földt. Közl., **133** (4-5): 293-325. (in Hungarian with English abstract)

FÜLÖP, J. (1964): Unterkreide-Bildungen (Berrias-Apt) des Bakony-Gebirges. – Geol. Hung., Ser. Geol., **13**: 1-194.

HAUER, F. v. (1862): Über die Petrefacten der Kreideformation des Bakonyer Waldes. – Sber. k. Akad. Wiss., math.-naturwiss. Cl., **44**: 631-659.

HAUG, E. (1889): Beitrag zur Kenntnis der oberneokomen Ammonitenfauna der Pauzalpe bei Corvara (Südtyrol). – Beitr. Paläont. Geol. Österr.-Ungarn Orients**,** **7**: 193-231.

HOEDEMAEKER, P. J. (1995): Ammonite distribution the Hauterivian-Barremian boundary along the Rio Argos (Caravaca, SE Spain). – Géol. Alp., **20**: 219-277.

HOEDEMAEKER, P. J., REBOULET, S., AGUIRRE-URRETA, M., ALSEN, P. AOUTEN, M., ATROPS, F., BARRAGAN R., COMPANY, M., GONZALES, C., KLEIN, J., LUKENEDRE, A., PLOCH, I., RAISOSSADAT, N., RAWSON, P., ROPOLO, P., VAŠICEK, Z., VERMEULEN, J., & WIPPICH, M. (2003): Report on the 1st International Workshop of the IUGS Lower Cretaceous Ammonite Working Group, the Kilian Group (Lyon, 11 September 2002). – Cretaceous Research, **24**: 89-94.

KARAKASCH, N. I. (1907): Le crétacé inférieur de la Crimée et sa faune. – Trav. Soc. Imp. Nat. St.-Pétersburg, **32** (5): 1-482.

KOCH, A. (1875): A Bakony éjszaknyugati részének másodkori képletei – Földt. Közl., **5** (5): 104-126.

HONNORAT-BASTIDE, E. (1890): Formes nouvelles d'ammonites de bélemnites et de *Crioceras*. – C. R. 18ième Congrès A. F. A. S., Paris, p. 462-466.

LEVEILLE, CH. (1837): Description des quelques nouvelles coquilles fossiles de département des Basses-Alpes. – Mém. Soc. Geol. France, sér. 1, **2**: 313-315.

MATHERON, P. (1842): Cathalogue methodique et descriptif des corps organises fossiles du Département des Bouches-du-Rhoneet lieux circonvoisins. – 269 pp.; Marseille.

MISZLIVECZ, E. (1985): Studies on the lower Cretaceous Cephalopod-Bearing beds of the "Marble-Quarry" at Zirc (Transdanubian Central Range). – Ann. Univ. Sci. Budapest., Sect. Geol., **25**: 153-159.

– (1990): Bakony alsó-kréta képződmények rétegtani és fácies elemzése, különös tekintettel a zirci Márványbánya szelvényére. – PhD thesis, ELTE Őslénytani Tanszék, 67 pp.

MISZLIVECZ, E. & POLGÁRI, M. (1987): Fe-P-bearing calcareous concretions from Zirc "Marble Quarry". – Ann. Univ. Sci. Budapest., Sect. Geol., **29**: 27-30.

NAGY, I. Z. (1981): Unterkretazische Cephalopoden aus der "Marmorgrube" bei Zirc (Bakony-Gebirge, Ungarn). – Ann. His. Nat. Mus. Nat. Hung., **73**: 69-77.

NICKLES, R. (1894): Contributions à la paléontologie du Sud-Est de l'Espagne. – Paléontologie, Mém., **4**.

NOSZKY, J. (1934): Adatok az északi Bakony kréta képződményeinek ismeretéhez. (Beiträge zur Kenntnis der kretazischen Bildungen des nördlichen Bakony). – Földt. Közl., **64** (4-6): 99-136.

ORBIGNY, A. DE (1840-42): Paléontologie française. Terrains crétacés. I. Céphalopodes. – 662 pp. ; Paris (Masson).

– (1850): Prodrome de Paléontologie stratigraphique universelle des animaux et rayonnés, **2,** 428 pp.; Paris (Masson).

OOSTER, W. A. (1857-1863): Catalogue des Céphalopodes fossiles des Alpes suisses. Parties I-V et partie VI supplémentaire (1863). – Zürich & Genève.

PAQUIER, V. (1900): Recherches géologiques dans le Diois et les Baronnies orientales. – Ann. Univ. Grenoble, **12**: 373-516, 551-806.

RASPAIL, F. V. (1829): Histoire naturelle des bélemnites, accompagnée de la description et de la classification des espèces, que M. Emeric de Castellane a recueillies dans les Basses-Alpes de Provence. – Ann. Sci. Observ., **1**: 271-331.

– (1831): Ammonites des Basses Alpes et des Cevennes. – Ann. Sci. Observ., **3**: 1-115.

REBOULET, S. (1996): L'évolution des ammonites du Valanginien – Hauterivien inférieur du bassin vocontien et de la plate-forme provençale (Sud-Est de la France): relations avec la stratigraphie séquentielle et implications biostratigraphiques. – Doc. Lab. Géol. Lyon, **137**: 1-371.

SARKAR, S. S. (1955): Révision des Ammonites déroulées du Crétacé inférieur du Sud-Est de la France. – Mém. Soc. Géol. France, nouv. sér., **34 (72)**: 1-176.

SEUNES, J. (1887): Notes sur quelques ammonites du Gault. – Bull. Soc. Géol. France, **3**: 557-571.

SIEWERTS-DORECK, H. (1961): Neokom crinoideák a Bakonyhegységből. – MÁFI Évk., **49** (3): 735-737.

STOYNOVA-VERGILOVA, M., (1965): Nouvelles espéces des bélemnites du Crétace inférieur de Bulgarie. – Trav. Géol. Bulgar., Sér. Paléont., **7**: 151-177.

SZENTE, I. (2003): Late Jurassic and Early Cretaceous bivalve assemblages from Transdanubia (Hungary). – Földt. Közl., **133** (4): 477-499.
SZIVES, O. (1999): Ammonite biostratigraphy of the Tata Limestone Formation (Aptian - Lower Albian), Hungary. – Acta Geol. Hung., **42** (2): 401-411.
– (2001): A Tatai Mészkő Formáció bázisrétegében található ammonitesz-fauna őslénytani vizsgálata (Ammonites of the base horizon of the Tata Limestone Formation /Aptian, Hungary). – PhD Thesis, ELTE Dept. of Paleontology, 104 pp.
SZIVES, O. & MONKS, N. (2002): Heteromorphs of the Tata Limestone Formation (Aptian-Lower Albian), Hungary. – Palaeontology, **45**: 1137-1149.
TOPCHISHVILI, M., KELEPTRISHVILI, S. & KVANTALIANI, I.. (2002): Yurskie i Melovye belemnitidy Gruzii. – Trudy AN Gruzii geologicheskie institut im. A.I. Dzhanelidze (n.s.), **118**: 1-302; Tbilisi.
TAEGER, H. (1909): Adatok az északi Bakony földtani viszonyaihoz (Beiträge zur Geologie des nördlichen Bakony). – MÁFI Évi Jel., p. 58-59.
THOMEL, G. (1964): Contribution á la connaissance des céphalopodes Crétacés du Sud-Est de la France: note sur les ammonites déroulées du Crétacé inférieur Vocontien. – Mém. Soc. Géol. France, nouv. sér., **101**: 1-80.
TIETZE, E. (1872): Geologische und paläontologische Mittheilungen aus dem südlichen Theil des Banater Gebirgsstockes. – Jb. k.-k. Geol. Reichsanst., **22**: 1-108.
UHLIG, V. (1882): Zur Kenntnis der Cephalopoden der Rossfeldschichten. – Jb. k.-k. Geol. Reichsanst., **32**: 373-396.
– (1883): Die Cephalopoden der Wernsdorfer Schichten. – Denkschr. k.-k. Akad. Wiss. Wien, math.-naturwiss. Kl., **46**: 127-290.
VAŠIČEK, Z. & MICHALIK, J. (1986): The Lower Cretaceous ammonites of the Manin unit (Mt. Butkov, West Carpathians). – Geol. Carpath., **37** (4): 449-481.
– (1988): Some Heteromorphic ammonites from Polomec (Hauterivian – Barremian, Central Western Carpathians, Czechoslovakia). – Geol. Zborn., Geol. Carpath., **39** (6): 655-674.
VAŠIČEK, Z. & WIEDMANN, J. (1993): The Leptoceratoidinae: small heteromorph ammonites from the Barremian. – Palaeontology, **37**: 203-239.
VERMEULEN, J. (1995): Nouvelle tripartition de la famille des Pulchelliidae (Ammonoidea) illustrée par la description de trois espèces des Alpes de Haute-Provence. – Riviera Scientifique, **12**: 65-80.
– (2002): Étude stratigraphique et paléontologique de la famille des Pulchelliidae (Ammonoidea, Ammonitina, Endemoceratacae). – Géol. Alp., Mém. H. S., **42:** 333, 57.
WEIN, G. (1934): Zirc környékének titon rétegei. (Tithonschichten der Umgebung von Zirc). – Földt. Közl., **64** (4-6): 81-99.
WRIGHT, C. W., CALLOMON, J. H. & HOWARTH, M. K. (1996): Cretaceous Ammonoidea. – Treatise on Invertebrate palaeontology, Part L, Mollusca 4, revised. – 361 pp.; Boulder & Lawrence (Geol. Soc. America & Univ. Kansas).

Manuscript received: April 29th, 2005.
Revised version accepted by the Stuttgart editor: October 26th, 2005.

Addresses of the authors:

FŐZY, I., Hungarian Natural History Museum, Pf.137, 1431 Budapest, Hungary;
e-mail: fozy@paleo.nhmus.hu
JANSSEN, N. M. M., Geertekerkhof 14bis, 3511 XC Utrecht, The Netherlands;
e-mail: Klein@naturalis.nl

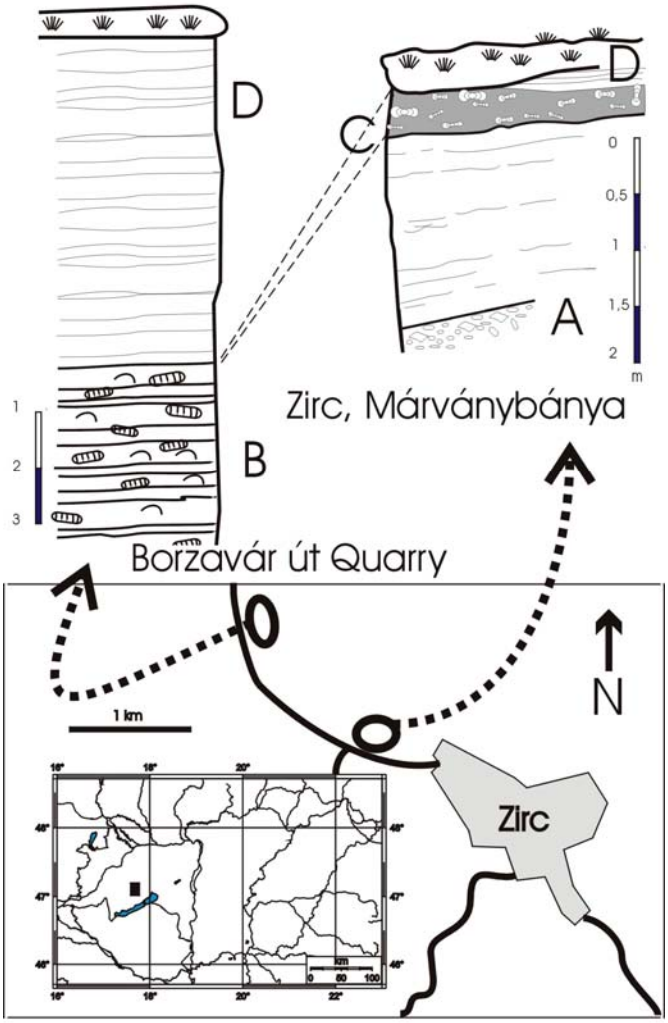

Fig. 1. Correlation of the succession in the Zirc Márvány-bánya (to the right) and Borzavár út quarry (to the left) successions. **A** – Kimmeridgian and Tithonian nodular limestone (Szentiványhegyi Limestone Formation), **B** – possibly Early Hauterivian crinoidal limestone (Borzavár Limestone Formation), **C** – Ammonite-rich limestone bank (?lens) in the Márvány-bánya quarry, **D** – Aptian crinoidal limestone (Tata Limestone Formation).

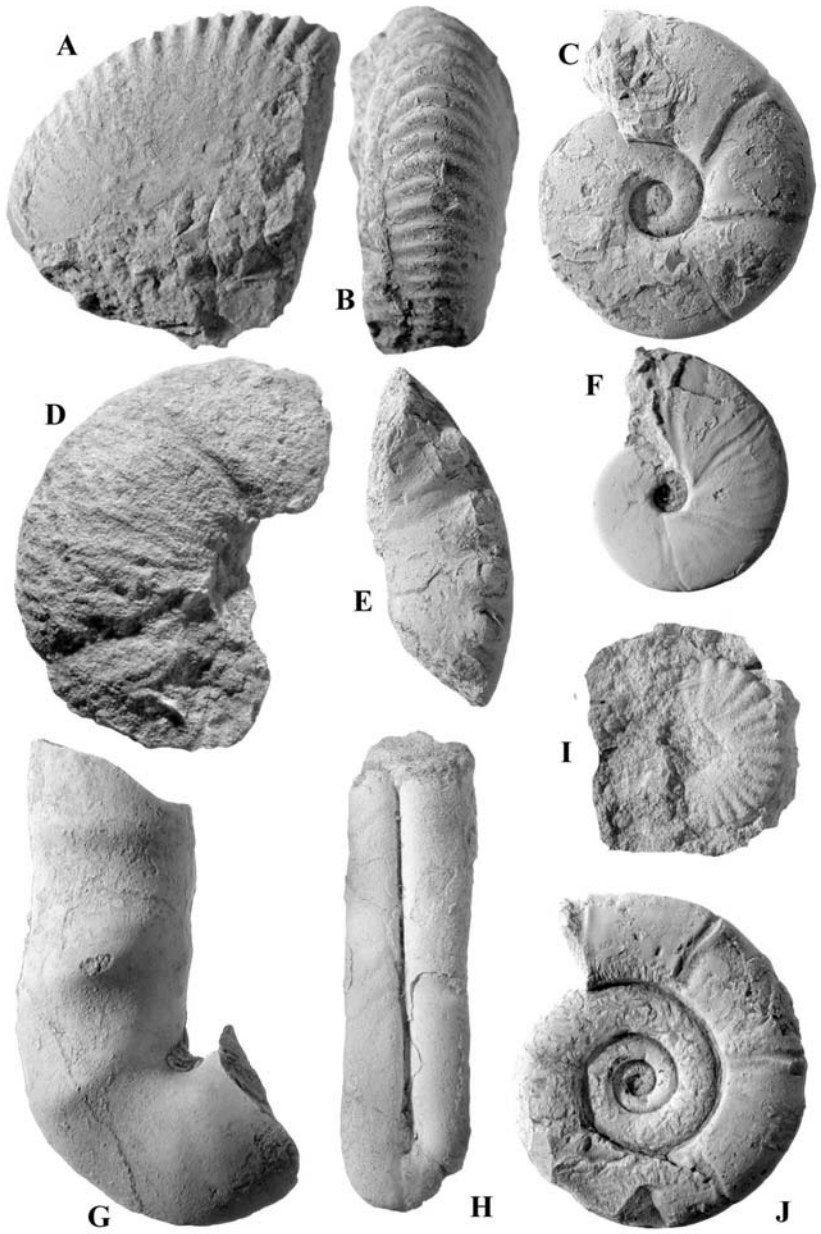

Fig. 2. Ammonites from Zirc, Márvány-bánya (Marble Quarry) and from the Borzavár út quarry. **A**, **B** – *Phyllopachyceras winkleri* (UHLIG, 1882), (no.: K15225), Zirc, Márvány-bánya. **C** – Desmoceratidae sp., (no.: K15226), Zirc, Márvány-bánya. **D** – *Jeanthieuloyites* sp., (no.: 2005.84), Borzavár út quarry. **E** – *Paraspiticeras* cf. *percevali* (UHLIG, 1883), (no.: K15227). **F** – *Plesiospitidiscus subdificilis* (KARAKASCH, 1907), (no.: K15228), Zirc, Márvány-bánya. **G** – *Ptychoceras biassalense* KARAKASCH, 1907, (no.: K15229), Zirc, Márvány-bánya. **H** – *Ptychoceras meyrati* OOSTER, 1860, (no.: K15230), Zirc, Márvány-bánya. **I** – *Discoidella* cf. *favrei* (OOSTER, 1860), (no.: K15231), figured by FÜLÖP (1964, pl. 29, fig. 3) as *Nicklesia* cfr. *pulchella* (ORB.), **J** – *Silesites* sp., (no.: K15232), Zirc, Márvány-bánya. – All figures in natural size.

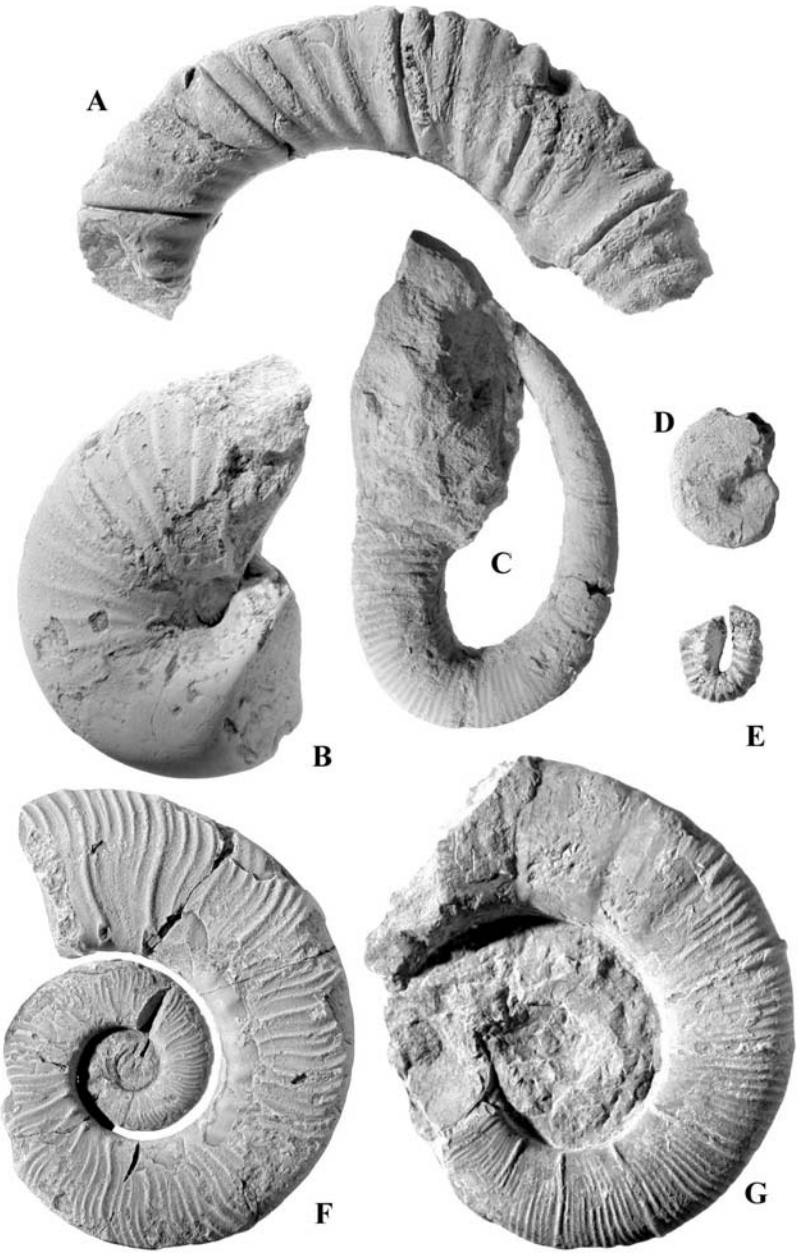

Fig. 3. Ammonites from Zirc, Márvány-bánya (Marble Quarry). **A** – *Pseudomoutoniceras annulare* (D'ORBIGNY, 1842), (no.: K15233). **B** – *Phyllopachyceras infundibulum* (D'ORBIGNY, 1841), (no.: K15234). **C** – *Paraspinoceras* cf. *pulcherrimum* (D'ORBIGNY, 1840), (no.: K15235). **D** – *Neolissoceras grasianum* (D'ORBIGNY, 1841), (no.: K15236). **E** – *Hamulinites munieri* (NICKLES, 1894), (no.: K15237). **F** – *Crioceratites krenkeli* (SARKAR, 1955), (no.: K15238). **G** – *Crioceratites duvali* (LÉVEILLE, 1837), (no.: K15239). – All figures in natural size

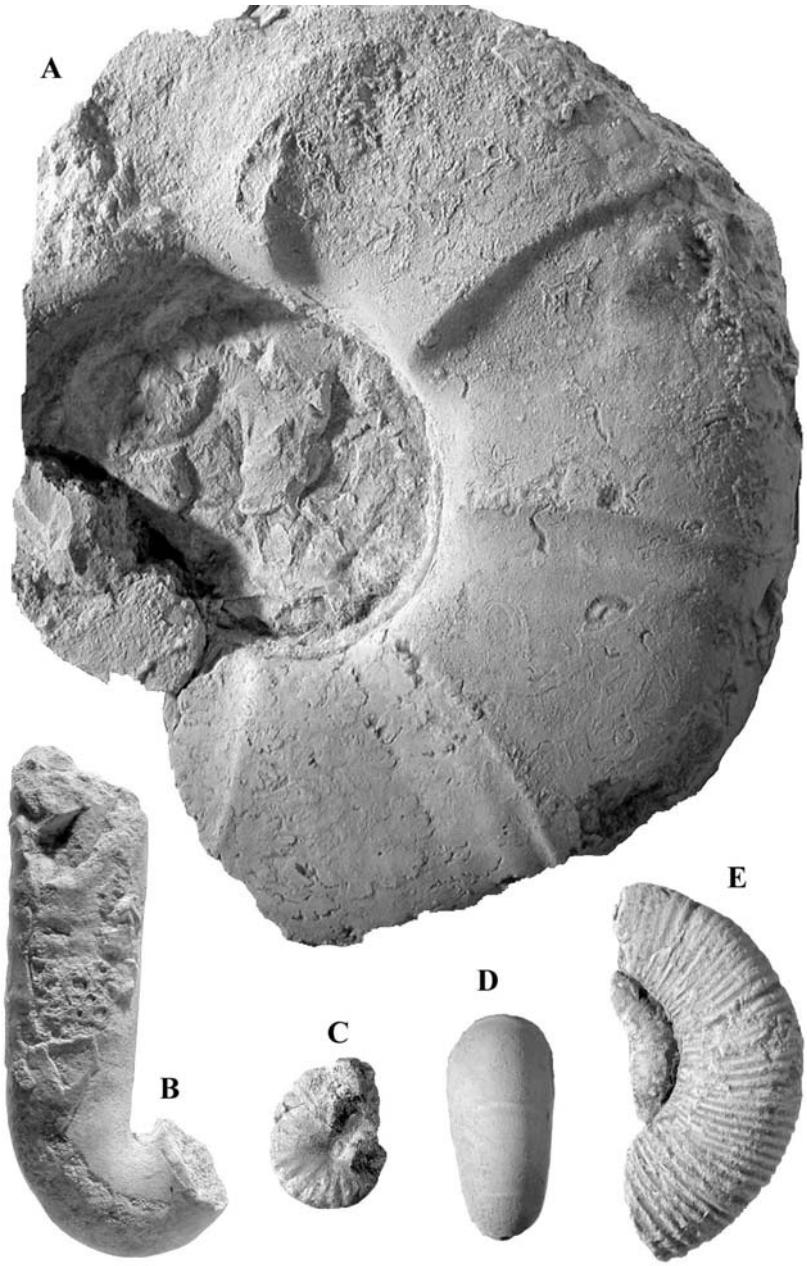

Fig. 4. Ammonites from Zirc, Márvány-bánya (Marble Quarry). **A** – *Abrytusites neumayri* (HAUG, 1889), (no.: K15240). **B** – *Anahamulina* cf. *subundulata* (d'ORBIGNY, 1850), (no.: K15241). **C** – *Discoidella* cf. *favrei* (OOSTER, 1860), (no.: K15242), figured by FÜLÖP (1964, pl. 29, fig. 4) as *Nicklesia* cfr. *pulchella* (ORB.). **D** – *Ptychophylloceras* sp., (no.: K15243). **E** – *Paracostidiscus radians* BUSNARDO, 2003), (no.: K15244). – All figures in natural size.

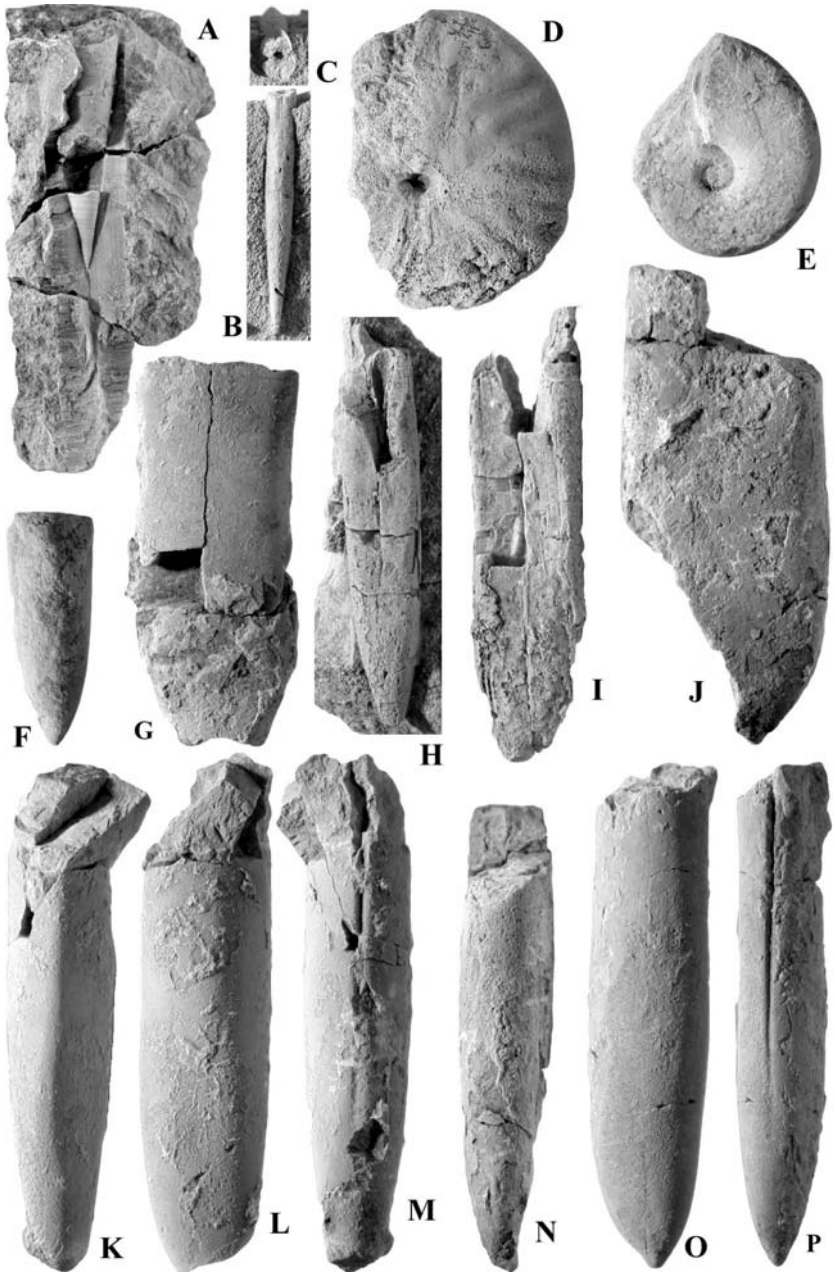

Fig. 5. Ammonites and belemnites from Zirc, Márvány-bánya (Marble Quarry). **A** – "*Mesohibolites*" cf. *gladiiformis* UHLIG, 1883, (no.: K15248), cross-section of a broken specimen. **B**, **C** – *Pseudobelus brevis* PAQUIER, 1900, (no.: K15249), dorsal view and cross-section. **D** – *Discoidella couratieri* VERMEULEN, 1995), (no.: K15247). **E** – *Neolissoceras grasianum* (D'ORBIGNY, 1841), (no.: K15246). **F** – *Neohibolites*? sp. (no.: K15250), lateral view of an apical fragment. **G** – *Duvalia dilatata* (DE BLAINVILLE, 1827), (no.: K15251), lateral view. **H** – "*Mesohibolites*" ex. gr. *garshini* STOYANOVA-VERGILOVA, 1965, (no.: K15254), lateral view of an eroded specimen. **I** – *Mucrohibolites?* sp., (no.: K15255), cross-section of an eroded specimen. **J**, **N** – *Duvalia dilatata* (DE BLAINVILLE, 1827), (no.: K15252), lateral and dorsal views. **K**, **L**, **M** – *Duvalia grasiana* (DUVAL-JOUVE, 1841), (no.: K15256), ventral, lateral and dorsal views. **O**, **P** – *Duvalia grasiana* (DUVAL-JOUVE, 1841), (no.: K15257), lateral and dorsal views. – All figures in natural size.