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Paleoenvironmental Distribution of Some Middle Triassic Ammonoid Genera in the Balaton Highland (Hungary)

ATTILA VÖRÖS*)

4 Text-Figures, 1 Table and 2 Plates

Hungary
Balaton
Triassic
Ammonoidea
Paleoenvironment

Contents

Zusammenhänge zwischen Umweltbedingungen und Verteilung einiger mitteltriadischer Ammonitengattungen aus dem Balaton-Hochland (Ungarn)

Zusammenfassung

Große Ammonitenfaunen (an die zehntausend Stück), die den Zeitraum von oberem Anisium bis unterem Ladinium (*Trinodosus*- bis *Reitzi*-Zone) umfassen, wurden von verschiedenen Profilen des Balatonhochlands gesammelt. Die Populationen werden von "sphärokonischen" Formen (Ptychiten und Arcestiden) dominiert. Das bedeutet, daß sich zu dieser Zeit das gesamte Gebiet unter mäßig tiefen, pelagischen Bedingungen befunden hat. Die verschiedenen topographischen Elemente des vertikal gegliederten Schelfs (Pelagische Plateaus und Becken) werden durch Populationen unterschiedlicher Zusammensetzung charakterisiert. Die "Coronaten" (stark ornamentierte Ceratitiden) treten durchwegs tiefer in den Becken als auf den pelagischen Plattformen auf, wogegen die "Sphärokonischen" (Arcestiden und Ptychitiden) sich umgekehrt verhalten. In dieser Studie wird die Verteilung von Ammoniten des höheren Anteils der *Reitzi*- und der *Avisianum*-Subzone auf die verschiedenen Umweltbedingungen untersucht. Der stratigraphische Umfang ist an sieben Profilen und einigen anderen Lokalitäten des Balatonhochlands vertreten und bot eine extrem reiche Ammonitenfauna (2000 Exemplare aus 19 Gattungen). Neun Gattungen zeigen definitive umweltbedingte Verbreitung. *Hungarites*, *Longobardites* und *Latemarites* scheinen auf die Gebiete rings um die Plattformen beschränkt zu sein; die Gattungen *Parakellnerites* und *Aplococeras* zeigen ähnliche Verbreitung. *Proarcestes*, *Halilucites* und *Ticinites* sind in den Becken häufig und kommen in den Peri-Plattform-Gebieten niemals vor. Bemerkenswerterweise besteht bei vielen Ammoniten keine Beziehung zwischen der Schalenmorphologie und dem Paläoenvironment. Beispielsweise dominieren in den Peri-Plattform-Gebieten die involuten, abgeflachten und glatten *Hungarites* und *Longobardites*, obwohld diese Morphotypen traditionell für pelagische Formen des tieferen Wassers gehalten werden. Andrerseits treten die evoluten, stark berippten Gattungen *Ticinites* und *Halilucites* hauptsächlich in den Beckenserien auf.

Abstract

Large ammonoid faunas (nearly ten thousand specimens) have been collected from several sections of the Balaton Highland, encompassing the Late Anisian to Early Ladinian interval (*Trinodosus* and *Reitzi* Zones). The ammonoid assemblages are dominated by "sphaerocones" (Ptychitidae and Arcestidae); this clearly shows that in those times the whole territory was under moderately deep, pelagic influence. The different topographic elements of the vertically dissected pelagic shelf (pelagic plateaux and basins) are characterised by ammonoid assemblages of different compositions. The environmental distribution of special morphogroups of ammonoids shows that the proportion of "coronates" (strongly ornamented ceratitids) is consistently lower in the basins than in the pelagic plateaux, whereas "sphaerocones" (Ptychitidae + Arcestidae) show inverse relationship.

*) Author's address: Dr. ATTILA VÖRÖS, Hungarian Natural History Museum, Geological-Palaeontological Department, H 1088 Budapest, Múzeum körút 14–16, Hungary.
voros@paleo.nhmus.hu.

In the present paper the environmental distribution of ammonoid genera in the higher part of the *Reitzi* Zone (*Reitzi* and *Avisianum* Subzones) is studied. This stratigraphical interval is represented in seven sections and some other localities of the Balaton Highland and provided an extremely rich ammonoid fauna (over 2000 specimens, 19 genera). Nine genera have shown definite environmental distribution. *Hungarites*, *Longobardites* and *Latemarites* seem to be connected to the peri-platform areas. The genera *Parakellnerites* and *Aplococeras* show partly similar distribution. *Proarcestes*, *Halilucites* and *Ticinites* are frequent in the basin areas and never occur in the peri-platform areas. Remarkably, in many cases the shell morphology of the ammonoids does not show direct correlation with the palaeoenvironment. For example, the involute, compressed and smooth *Hungarites* and *Longobardites* are predominant in the peri-platform areas, though these morphotypes (smooth oxycones) were usually believed to be deeper-water forms. On the other hand, the evolute, strongly ribbed *Ticinites* and *Halilucites* were found mainly in the basinal sequences.

1. Introduction

The extinct Ammonoidea offer minute chance of uniformitarian approach to the palaeoenvironmental reconstruction. They are, however, the most frequently found fossils in marine Mesozoic strata, therefore palaeontologists have always tried to obtain some palaeoenvironmental information from these excellent "guide fossils".

Arrays of palaeoecological analyses, habitat reconstructions and scenarios for Carboniferous to Cretaceous ammonoid faunas have been published (e.g. ELMI & ALMÉRAS, 1984; MARCHAND et al., 1985; WESTERMANN, 1990; CECCA et al., 1994; WESTERMANN & TSUJITA, 1999) and the theoretical basis of these applications (from speculations to experiments) was also published in length (e.g. GÉCZY, 1959; REYMENT, 1973; EBEL, 1985; see a review in WESTERMANN, 1990 and HEWITT & WESTERMANN, 1997).

The Triassic is rather less advanced in this respect. Apart from the traditional view that the "leiostracan" ammonoids (*Ptychites*, *Monophyllites*, *Arcestes*) were deep-water elements, hardly any detailed contribution has been given to ammonoid palaeoecology until the recent paper by WANG & WESTERMANN (1993). This excellent study summarised the autecology (morphotypes, habitats, siphuncle and septal strength) and synecology (communities and death assemblages) of Triassic ammonoids on the example of Chinese faunas. Applying the ideas and results of WANG & WESTERMANN (1993) the bathymetric evaluation of some Middle Triassic ammonoid fauna of the Balaton Highland was done and published in a previous article (VÖRÖS, 1996).

In the mentioned paper I focused on the environmental distribution of special morphogroups of ammonoids. The results showed that the proportion of "coronates" (strongly ornamented ceratitids) is consistently lower in the basins than in the pelagic plateaux, whereas "sphaerocones" (Ptychitidae + Arcestidae) show inverse relationship. During the studied interval, the proportion of "coronates" decreases, whereas the proportion of "sphaerocones" increases in time in the whole territory. This relationship was used to estimate water depth and changes in bathymetry. The majority of ceratitid ammonoids were taken as a single morphogroup ("coronates") because, at that time, further paleoenvironmental differentiation was not recognised within this group.

In the last years, new sections in "peri-platform" areas have been collected. The detailed study of the ammonoid fauna of these layers deposited in the neighbourhood of contemporaneously active platforms and the re-evaluation of some earlier data have shown that the distribution of some genera is in close correlation with the inferred palaeoenvironment. These relationships are best documented in the higher part of the *Reitzi* Zone (*Reitzi* and *Avisianum* Subzones).

The present study was supported by the grants No. 7631 and No. 26278 of the Hungarian National Research Fund (OTKA).

2. Material

In the last fifteen years, in the course of the detailed geological mapping of the Balaton Highland, significant, detailed, bed-by-bed collections have been made supported by the Hungarian Geological Institute, the Hungarian Natural History Museum and the National Scientific Research Fund. The collecting and field work, led by the present author, was done mainly

STAGES	SUBSTAGES	ZONES	SUBZONES
LADINIAN	LONGOBARDIAN	REGOLEDANUS	
		ARCHELAUS	
		GREDLERI	
		CURIONII	
		SECEDENSIS	
	FASSANIAN	REITZI	Avisianum
			Reitzi
			Liepoldti
			Felsoeoersensis
ANISIAN	ILLYRIAN	TRINODOSUS	Pseudohungaricum
			Camunum
			Trinodosus
			Binodosus
	PELSONIAN	BALATONICUS	Zoldianus
			Balatonicus

Table 1.
Position of the investigated environments in the stratigraphical column.

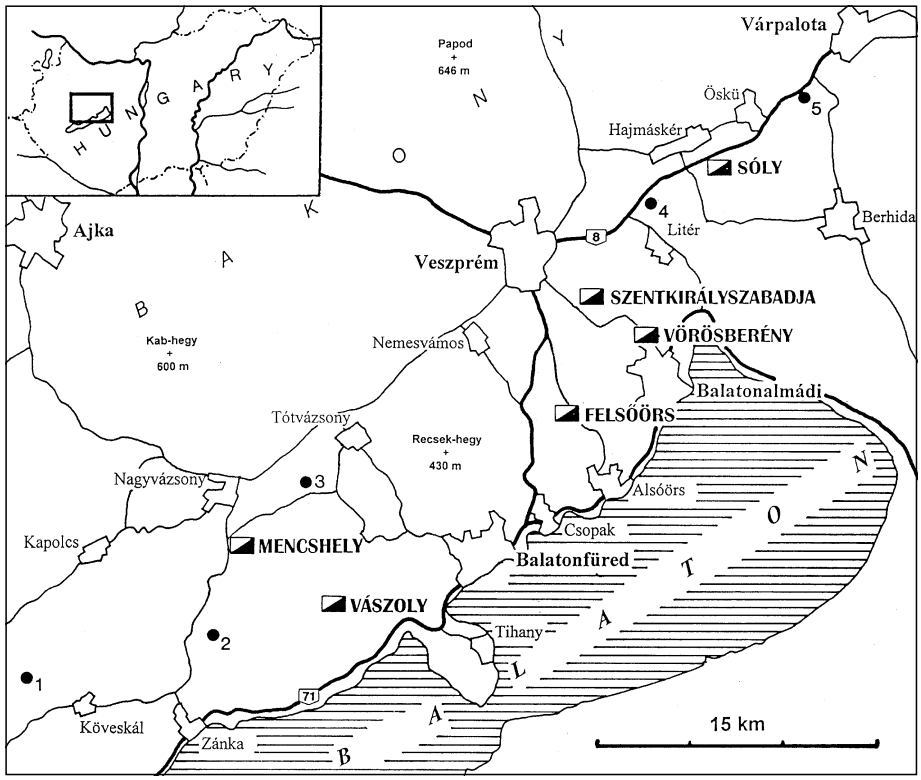


Table 1.
Locality map showing the studied occurrences of the upper part of the *Reitzi* Zone (Ladinian) in the Balaton Highland (after VÖRÖS, 1998, modified).
Divided squares: sections collected in detail; dots: other occurrences.
1. Szentbékkálla, 2. Szentjakabfa, 3. Barnag, 4. Litér, 5. Öskü.

by T. BUDAI, L. DOSZTÁLY, and I. SZABÓ, with occasional help by G. CSILLAG, I. FÖZY, A. GALÁCZ, J. PÁLFY & P. VINCZE. The collections were focused on the ammonoids of prime importance in biostratigraphy but rich assemblages of brachiopods, bivalves and gastropods were also found. Besides, some important groups of microfossils (Conodonta, Radiolaria, Ostracoda) were studied as well. The detailed evaluation of all these fossil groups contributed to the stratigraphical scheme and the palaeogeographical picture of the area. The Middle Triassic palaeogeography (sedimentation and palaeotectonics) of the Balaton Highland was recently dealt by BUDAI & VÖRÖS (1992, 1993) and BUDAI & HAAS (1995). Paleoenvironmental evaluation of different fossil groups was given by PÁLFY (1986, 1991), MONOSTORI (1995) and VÖRÖS (1996), whereas a complex palaeogeographical picture was outlined in the paper by VÖRÖS et al. (1998).

By the detailed sampling of nine important sections, encompassing the Middle Anisian to Lower Ladinian interval, nearly ten thousand ammonoid specimens have been found. The most important localities and sections have been described and their ammonoid faunas have been listed elsewhere (VÖRÖS, 1998). The biostratigraphical study of the sections and their faunas gave results of wide interest (VÖRÖS, 1987, 1993, 1998), VÖRÖS et al. (1996) and the following stratigraphical subdivision was developed (Table 1).

In the present paper the upper part of the *Reitzi* Zone (framed in Table 1) was studied in detail. Two ammonoid subzones take a short part of the geologic time, but too long if we consider the possibly rapid local changes in the composition of faunas. Consequently, the selected interval certainly contains several "faunas" taken in strict sense. However, due to the facies variations recorded in the Balaton area, any further splitting of the selected interval would have resulted in a scattered mosaic of data with no chance of detailed comparison. Therefore, the selection of two ammonoid subzones as studied interval is a compromise between the theoretical requirements and the local conditions. Nevertheless, this short interval seemed to be appropriate for the palaeecological comparison because the ranges of ammonoid genera are shorter than a biozone, sometimes only a subzone.

This stratigraphic interval was crossed at five points of the Balaton Highland (Text-Fig. 1) and seven sections were collected bed-by-bed for ammonoids: Mencshely (Cser-tetö I., Cser-tetö II.), Vászoly (P-11/a, P-2), Felsöörs, Szentkirályszabadja, Sóly (Ör-hegy). In the Vörösberény section the upper part of the *Reitzi* Zone was crossed but detailed collection was not carried out. Some other localities also yielded ammonoids from the upper part of the *Reitzi* Zone (Text-Fig. 1). The ammonoid fauna collected from the *Reitzi and Avisianum* subzones consists of 2264 specimens representing 47 taxa (19 genera).

The stratigraphy and the fauna of the sections are described in VÖRÖS (1998). The faunal lists of the most important sections with specimen numbers (in parentheses) are given below.

❍ **Mencshely**
Cser-tetö I. and II.

Norites dieneri (5)
Longobardites zsigmondyi (5)
Hungarites emiliae (7)
Hungarites mojsisovicsi (17)
Hungarites lenis (3)
Hungarites sp., aff. *bocsarensis* B (2)
Hungarites sp., aff. *bocsarensis* C (1)
Hungarites ? *arthaberi* (95)
Halilucites cf. *costosus* (2)
Halilucites sp. (2)
Kellnerites cf. *bosnensis* (1)
Kellnerites angustecarinatus (1)
Kellnerites sp., aff. *angustecarinatus* (6)
Parakellnerites rothpletzi (4)
Parakellnerites hungaricus (10)
Aplococeras avisianum (13)
Reitziites reitzi (21)
Reitziites cholnokyi (9)
Latemarites ? *conspicuus* (14)
Latemarites latemarensis (4)
Nevadites ? *ecarinatus* (6)
Ticinites cf. *hantkeni* (1)
"Stoppaniceras" ex gr. *ellipticum* (2)
Flexoptychites cf. *angustoumbilicatus* (27)
Flexoptychites cf. *flexosus* (66)
Flexoptychites cf. *acutus* (16)
Flexoptychites sp. (728)
Discoptychites sp. (30)
Epigymnites ecki (2)
Proarcestes sp. (30)

❍ **Vászoly P-11/a and P-2**

Norites dieneri (1)
Hungarites mojsisovicsi (6)
Hungarites lenis (1)
Hungarites bocsarensis (1)
Hungarites sp. (13)
ParakeIlnerites hungaricus (2)
ParakeIlnerites cf. *rothpletzi* (1)
Reitziites reitzi (6)
Reitziites cholnokyi (6)
Aplococeras sp. (1)
Halilucites cf. *costosus* (1)
Halilucites rusticus (1)
Nevadites ? *symmetricus* (1)
Ticinites crassus (1)
Ticinites ? *hantkeni* (1)
"Stoppaniceras" ex gr. *ellipticum* (4)
Flexoptychites angustoumbilicatus (14)
Flexoptychites flexosus (17)
Flexoptychites cf. *acutus* (9)
Flexoptychites sp. (70)
Proarcestes sp. (4)

❍ **Felsöörs**

Hungarites cf. *mojsisovicsi* (1)
Hungarites sp. (3)
Reitziites reitzi (2)
Halilucites cf. *arietitiformis* (1)
Halilucites cf. *costosus* (1)
Halilucites cf. *obliquus* (1)
Aplococeras sp. (1)
Ticinites cf. *crassus* (1)
Ticinites ? *hantkeni* (2)
Ticinites sp. (2)
Flexoptychites flexuosus (5)
Flexoptychites cf. *acutus* (2)
Flexoptychites angustoumbilicatus (12)
Flexoptychites sp. (65)
Proarcestes sp. (5)

❍ **Szentkirályszabadja**

Hungarites sp., aff. *bocsarensis* (2)
Hungarites ? *arthaberi* (3)
Hungarites ? sp. aff. *arthaberi* (1)
Hungarites sp. (20)
ParakeIlnerites sp. aff. *hungaricus* (1)
ParakeIlnerites ? sp. (13)
Reitziites reitzi (2)
Latemarites latemarensis (6)
Latemarites ? *conspicuus* (4)
Aplococeras ? sp. (1)
"Stoppaniceras" ex gr. *ellipticum* (1)
Discoptychites cf. *megalodiscus* (1)
Discoptychites sp. (14)
Flexoptychites angustoumbilicatus (3)
Flexoptychites flexuosus (13)
Flexoptychites sp. (99)

❍ **Sóly**

Norites dieneri (1)
Longobardites zsigmondyi (32)
Longobardites breguzzanus (18)
Hungarites mojsisovicsi (6)
Hungarites emiliae (40)
Hungarites sp. aff. *emiliae* (3)
Hungarites ? *arthaberi* (70)
Hungarites ? sp. aff. *arthaberi* A (14)
Hungarites ? sp. aff. *arthaberi* B (2)
Hungarites ? sp. aff. *arthaberi* C (4)
ParakeIlnerites cf. *hungaricus* (1)
ParakeIlnerites boeckhi (11)
ParakeIlnerites rothpletzi (15)
ParakeIlnerites loczyi (5)
ParakeIlnerites ? sp. (48)
Megaceratites ? *friccensis* (4)
Megaceratites ? sp. (12)
Reitziites cf. *reitzi* (2)
Latemarites latemarensis (51)
Latemarites ? *conspicuus* (23)
Latemarites ? sp. (51)
Aplococeras avisianum (6)
Aplococeras cf. *laczkoi* (1)
Detoniceras ? sp. (1)
Nevadites ? sp. (2)
Flexoptychites angustoumbilicatus (2)
Flexoptychites flexosus (12)
Flexoptychites sp. (88)
Discoptychites sp. (20)

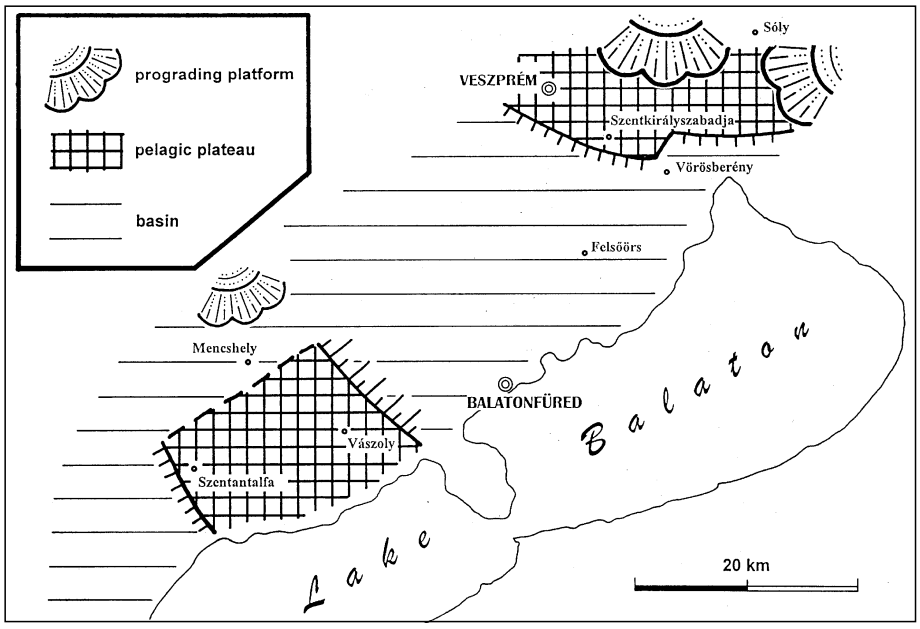
3. Palaeoenvironmental Model

The Middle Triassic palaeogeography and facies distribution of the Balaton Highland was outlined by BUDAI & VÖRÖS (1992), VÖRÖS (1996) and VÖRÖS et al. (1998). A slightly modified version of the mentioned palaeogeographic maps for the late *Reitzi* Zone (Early Ladinian) is shown in Text-Fig. 2. The sequences of the above mentioned five sections were deposited in five different palaeoenvironments. The palaeoenvironments were defined on the basis of the

- palaeotectonic position,
- sedimentological features and
- palaeoecological evaluation of different groups of fossils.

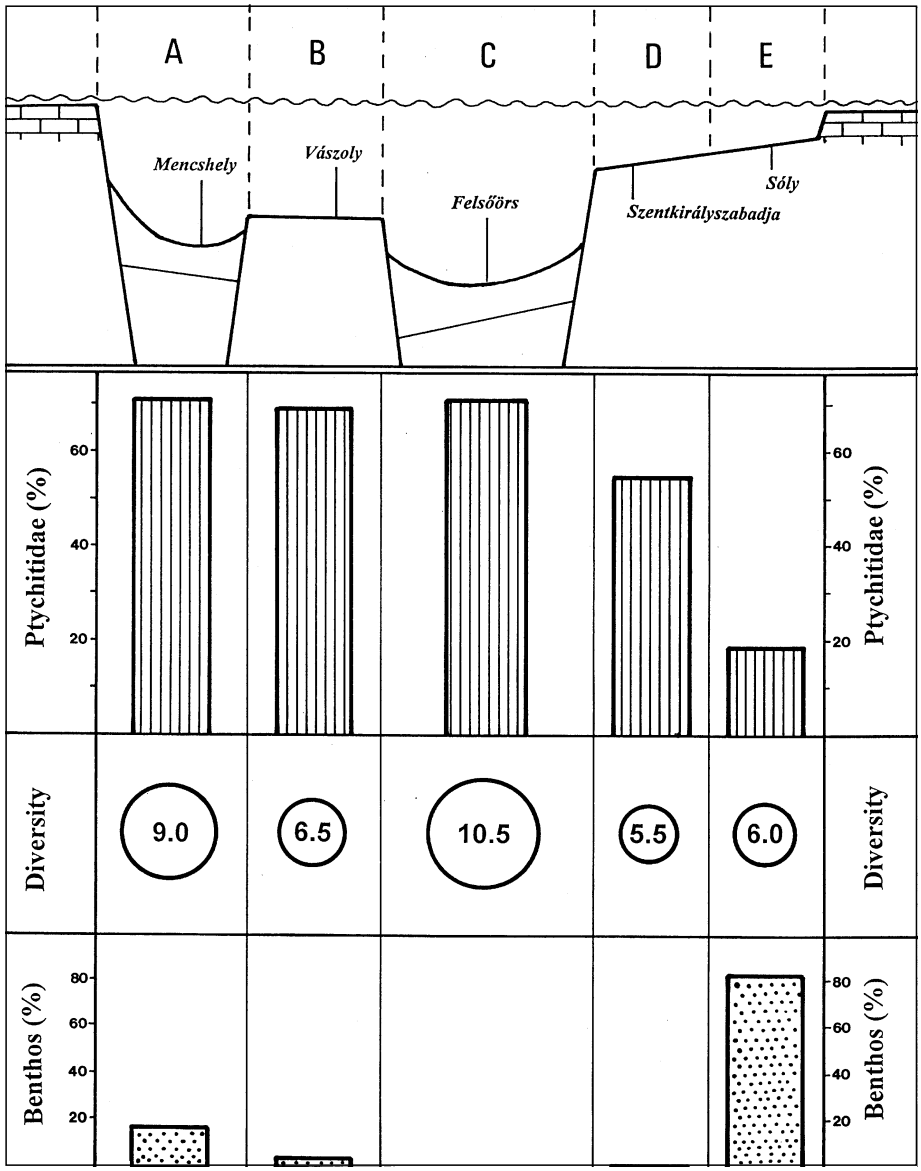
The palaeotectonic and sedimentologic criteria were surveyed in detail by BUDAI & VÖRÖS (1992, 1993) and VÖRÖS et al. (1998) for the studied sections; the main features will be summarised below.

For the palaeoecological evaluation we can use numerous factors; three of these were considered of general use and significance:



Text-Fig. 2.
Palaeogeographic sketch of the Balaton Highland for the late *Reitzi* Zone (Early Ladinian).

Text-Fig. 3.
Variation of some palaeoecological factors according to different palaeoenvironments (the brick-wall pattern at the extreme left and right of the palaeoenvironmental model signifies active carbonate platforms).



– the amount of benthonic faunal elements by sections,
– the species diversity (using the method by WILLIAMS [1964]) of the ammonoid fauna and
– the proportion of "sphaerocon" elements (in our case, practically, the Ptychitidae) within the ammonoid fauna.

The variation of these factors along a palaeoenvironmental scheme is shown in Text-Fig. 3.

The palaeoenvironmental units shown in the model (Text-Fig. 3) are represented and exemplified by five sections.

● **Palaeoenvironment "A"**
Example: Mencshely

The two sections (Cser-tetö I. and II.) dug near Mencshely exposed similar sequences. The lowermost Ladinian "Reitzi tuff" is underlain by thick, limestones with marly interlayers (Felsöörs Limestone) of Pelsonian to Illyrian age, proving that the area was a relatively deep basin in Anisian times. The deeper part of the Lower Ladinian is a 4 m thick greyish tuffite with a few thin (8–10 cm) intercalations of yellow and grey cherty limestones passing upward into reddish-brown tuffaceous clay with calcareous nodules in the uppermost levels. These crinoidal limestone nodules yielded a very rich ammonoid fauna of the *Reitzi* Subzone. With decreasing amount of clay, thinner, then thicker beds of crinoidal limestones appear. The crinoidal limestone is extremely rich in benthonic fossils (mainly bivalves and gastropods); the mass occurrence of patelloid gastropods is especially remarkable. The evaluation of the ostracodes (MONOSTORI in VÖRÖS et al., 1998) showed that the fossil assemblage might originally have lived in nearby sublittoral areas and was redeposited into the basin. The uppermost part of the exposed sequence is a pink to white micritic limestone (*Avisianum* Subzone), followed by red, cherty limestones. The Ptychitidae have a high proportion (70 %) within the ammonoid fauna; the specific diversity is considerable (9.0).

Palaeoenvironmental Position

The sequence exposed at Mencshely was deposited in a relatively deep basin, which, intermittently, received redeposited material (sediment and shell debris) from neighbouring shallow areas (carbonate platform ?).

● **Palaeoenvironment "B"**
Example: Vászoly

Two of the numerous sections (P-11/a, P-2) dug on the Öreg-hegy near Vászoly were collected bed-by-bed. Here the Anisian Megyehegy Dolomite is overlain by around two metres of yellowish tuffite alternating with dolomite and limestone layers. Higher up, the tuffite becomes predominant and contains only a few calcareous nodules.

This tuffitic part of the sequence is terminated by yellowish to purplish, clayey beds with boulders of yellow, crinoidal limestone yielding very rich ammonoid fauna of the *Avisianum* Subzone. The uppermost member of the exposed sequence is the several metres thick, well-bedded, white, micritic, filamentous Vászoly Limestone with rare ammonoids and phosphatitic hardgrounds in some horizons.

The Ptychitidae have a high proportion (69 %) within the ammonoid fauna of the higher part of the *Reitzi* Zone; the specific diversity is rather low (6.5). Benthonic fossils occur only sporadically.

Palaeoenvironmental Position

The Vászoly sequence was deposited on an intra-basinal submarine high.

● **Palaeoenvironment "C"**
Example: Felsöörs

The classical Felsöörs section exposes the thick, greyish, nodular, cherty or platy and marly limestone layers of Pelsonian to Illyrian Felsöörs Limestone of basinal facies. These are followed by a rather thick (18 m), greyish-yellowish to greenish variegated tuffitic sequence with thin, ochre-yellow, cherty limestone interlayers of flaser bedding ("Reitzi tuff": lowermost Ladinian). With a gradual decrease of tuffite, yellow, nodular, then red, cherty bedded limestones become predominant. The Ptychitidae are dominant (70 %) in the ammonoid fauna of the higher part of the *Reitzi* Zone; the specific diversity is high (10.5). Benthonic fossils were not found at all.

Palaeoenvironmental Position

The Felsoörs sequence was deposited in a deep basin. A reasonable interpretation of the high diversity of the ammonoid fauna can be that the different species lived in different depth, i.e. they shared vertically the water column.

● **Palaeoenvironment "D"**
Example: Szentkirályszabadja

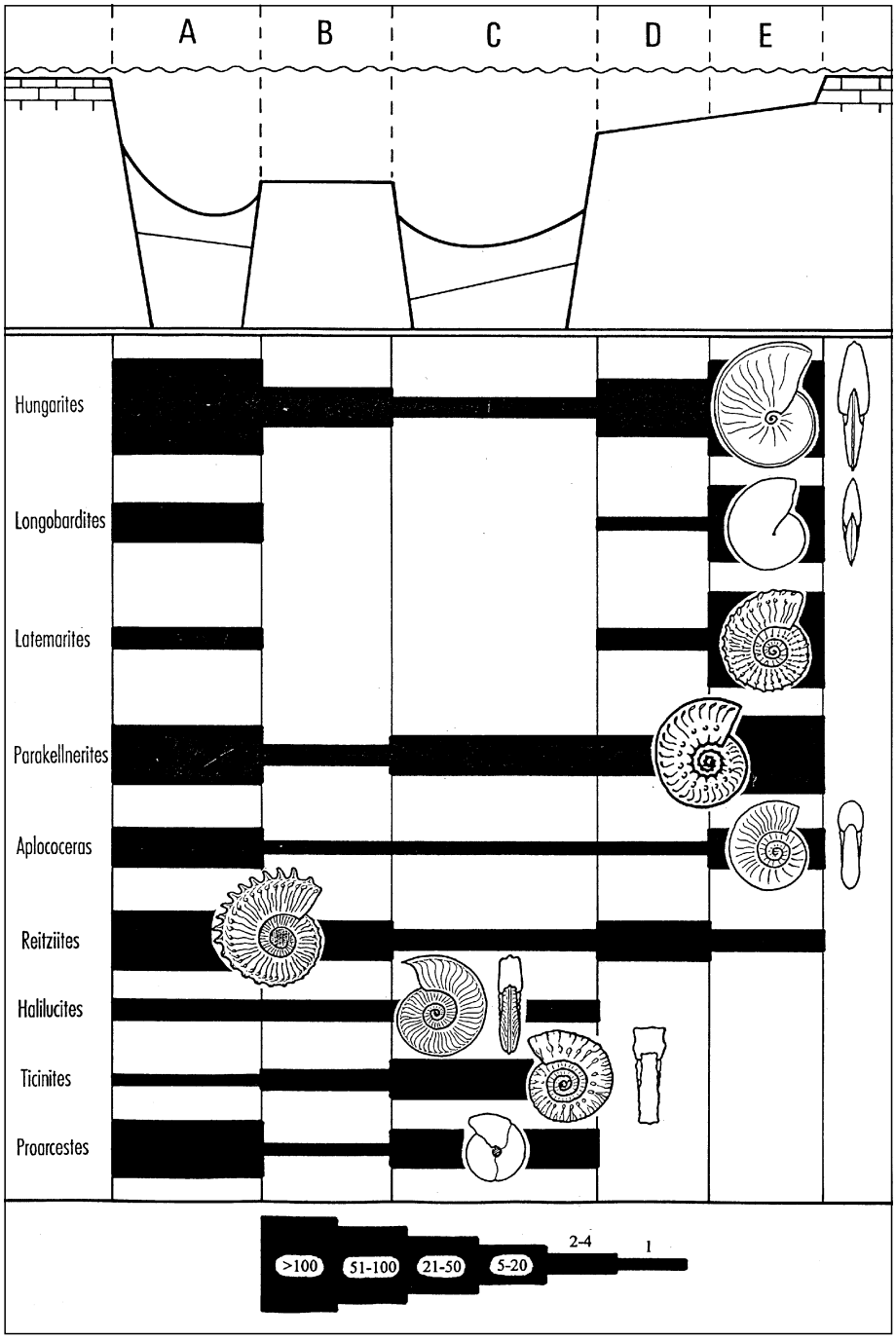
The Pelsonian Megyehegy Dolomite is overlain, with a sharp contact, by yellow or grey, dolomitized ammonitic limestone layers of uppermost Illyrian age ("Lardaroceras beds"). Higher up, tuffaceous clay interlayers appear, followed by tuffaceous dolomites. After a few limestone layers of rich ammonoid fauna, the dolomitic and tuffitic character returns and the uppermost exposed beds are formed by massive dolomites.
The proportion of the Ptychitidae in the ammonoid fauna of the higher part of the Reitzi Zone is 69 %; the specific diversity is rather low (5.5). Benthonic fossils are rare.

Palaeoenvironmental Position

The sequence of Szentkirályszabadja was deposited at a submerged margin of a carbonate platform. The deeper and pelagic environment was not stabilised: the carbonate platform prograded again to the area in the Early Ladinian.

● **Palaeoenvironment "E"**
Example: Sóly

The irregular surface of the Anisian (?) Megyehegy Dolomite is overlain by a four metres thick sequence of alternating yellowish tuffaceous limestones and tuffaceous clays. Higher up, the colour of the rocks turns into brownish-violet, and, after a thicker tuffaceous clay, very fossiliferous, violet-red crinoidal limestone layers appear in 2–3 m thickness. Yellow tuffaceous limestones, overlain abruptly by a mass of jointed and vuggy dolomite, follow these. The whole sequence belongs to the higher part of the Reitzi Zone. The proportion of the Ptychitidae in the ammonoid fauna of the higher part of the Reitzi Zone is very low (18 %); the specific diversity is low (6.0). The benthonic fauna (Bivalves, Gastropods, Brachiopods) is rich and diverse.



Text-Fig. 4.
Frequency distribution of nine ammonoid genera in different palaeoenvironments.

Palaeoenvironmental Position

The Sóly sequence was deposited in the neighbourhood of an active carbonate platform. After the short pelagic episode on the submerged (or otherwise "drowned") platform, a new phase of platform progradation reached the area.

4. Conclusions

Nineteen ammonoid genera occurred in the studied stratigraphical interval (higher part of the *Reitzi* Zone). Many of these were not suitable for a comparative study because they were found only sporadically, represented by only a few specimens in single localities. Ptychitidae were not evaluated, because their amount was used above as an independent palaeoenvironmental criterion. The specimen number data of the remaining nine ammonoid genera, showing widespread occurrence and definite distribution, are presented in Text-Fig. 4.

When evaluating the frequency distribution diagram, one has to bear in mind that the fauna of palaeoenvironment "A" (represented by the Mencshely localities) is palaeoecologically "mixed": the autochthonous assemblage of the deeper basinal environment may be altered or substituted by an admixture of shells redeposited from a shallow environment (carbonate platform ?).

It is clear from the diagram that the genera *Hungarites*, *Longobardites* and *Latemarites* favoured the peri-platform environments: they are dominant in the palaeoenvironments "A" and "E", whereas they are missing or subordinate in the basins. The genera *ParakelInerites* and *Aplococeras* show rather similar, though less marked, distribution. Some representatives of this shallow-water or peri-platform ammonoid assemblage are shown on Plate 1.

The basinal areas (palaeoenvironments "A" and "C") are dominated by *Proarcestes* and *Ticinites*, which, on turn, were never found on the platform margins ("D" and "E"). It is worth mentioning here, that the genus *Ticinites* was described first from an intra-platform basin (Grenzbitumenzone) but its representatives were found in other, basinal sequences ("Buchenstein Beds") (BRACK & RIEBER, 1993). The genus *Halilucites* seems also to be restricted to the deeper environments. Some representatives of the basinal association are shown on Plate 2. *Reitziites* occurred in all palaeoenvironments; its distribution shows a slight hint toward the medium depths.

The recognition by BRACK & RIEBER (1993, p. 487) given as the following short remark:

> *"... Hungarites, ParakelInerites and Aplococeras lived preferentially in shallow waters ... whereas other ammonoid genera and species preferred deeper and/or open sea waters ... "*

is partly endorsed and significantly improved by the present study.

Remarkably, the distribution of the ammonoid genera does not reflect any clear relationship between their functional morphology and the environment. Ammonoids of very different shell morphology have been found in the particular palaeoenvironments. For example, among the genera characteristic for the peri-platform palaeoenvironment, *Latemarites* is evolute and strongly ornamented, whereas *Hungarites* and *Longobardites* are involute, strongly compressed and smooth. From among the ammonoids characterising the deeper basins, *Proarcestes* (involute, globose, smooth, with complex sutures) "fulfils the expectations" in terms of functional morphology, whereas the evolute, strongly ornamented *Ticinites* and *Halilucites* definitely does not.

The above data of distribution and the conclusions drawn from them should be taken as preliminary results. Further advance in the knowledge of the palaeoenvironmental distribution of Middle Triassic ammonoids can be made by the study of faunas collected from wider areas and more palaeoenvironments.

Plate 1

Representatives of the shallow water or peri-platform ammonoid assemblage.

Figs. 1–3: *Hungarites mojsisovicsi* (ROTH).
Avisianum Subzone, Sóly, Ör-hegy, Beds 6 and 9.

Fig. 4: *Longobardites zsigmondyi* (BÔCKH) in ventral (a) and lateral (b) views.
Avisianum Subzone, Sóly, Ör-hegy, Bed 6.

Fig. 5: *Parakellnerites boeckhi* (ROTH).
Avisianum Subzone, Sóly, Ör-hegy, Bed 6.

Fig. 6: *Parakellnerites loczyi* (ARTHABER).
Avisianum Subzone, Sóly, Ör-hegy, Bed 6.

Fig. 7: *Parakellnerites rothpletzi* (SALOMON).
Avisianum Subzone, Sóly, Ör-hegy, Bed 6.

Fig. 8: *Latemarites latemarensis* BRACK & RIEBER.
Mencshely, Cser-tetö I., Bed U-7.

Figs. 9–15: *Latemarites latemarensis* BRACK & RIEBER.
Avisianum Subzone, Sóly, Ör-hegy, Beds 6 and 7.

Figs. 16,17: *Latemarites conspicuus* (DIENER).
Avisianum Subzone, Sóly, Ör-hegy, Bed 7.

Fig. 18: *Aplococeras* cf. *avisianum* (MOJSISOVICS).
Avisianum Subzone, Sóly, Ör-hegy, Bed 6.

Fig. 19: *Aplococeras avisianum* (MOJSISOVICS).
Reitzi or *Avisianum* Subzone, Szentjakabfa, scree.

Fig. 20: *Aplococeras* cf. *laczkoi* (ARTHABER).
Avisianum Subzone, Sóly, Ör-hegy, Bed 6.

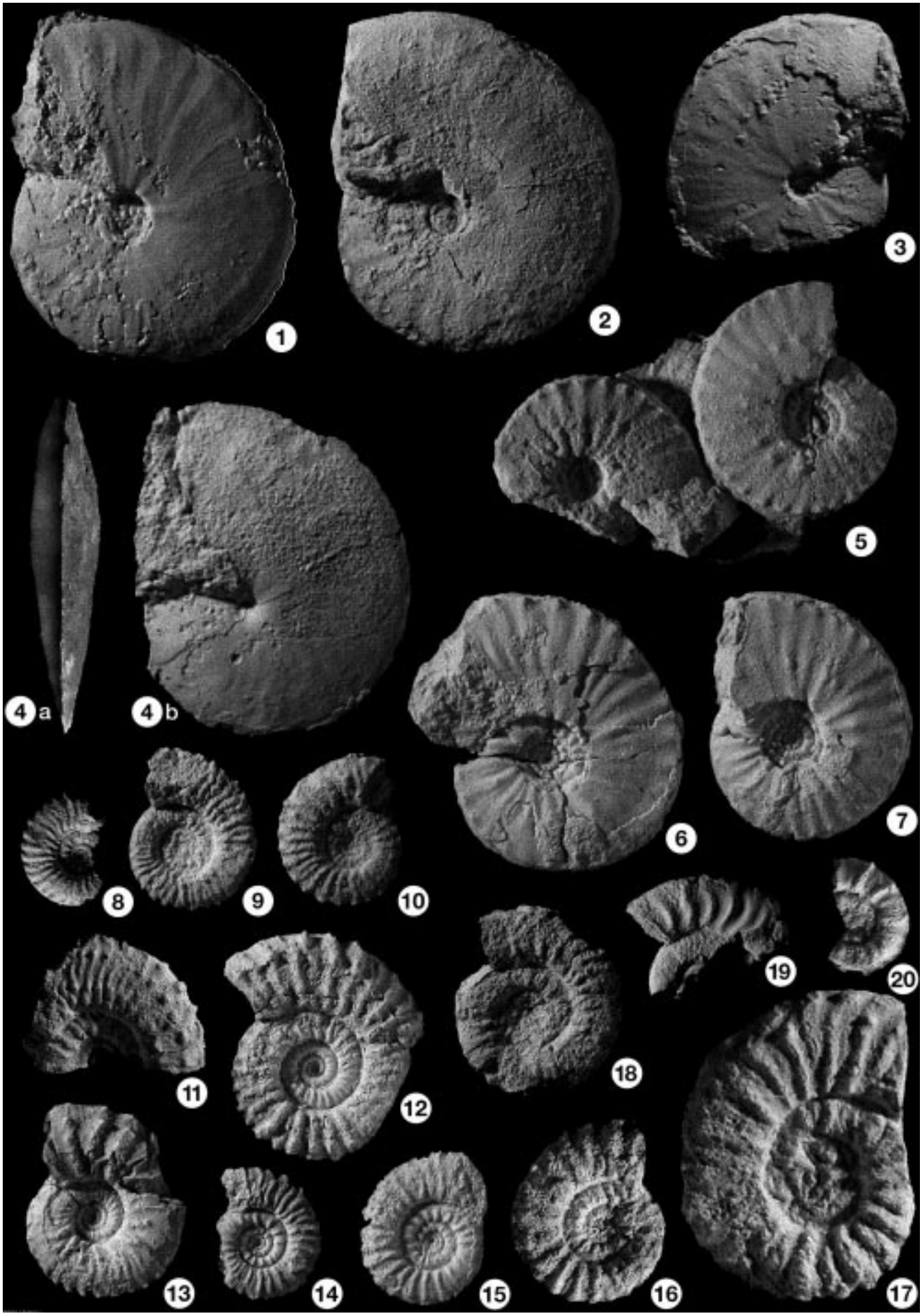

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Plate 2

Representatives of the deeper water ammonoid assemblage.

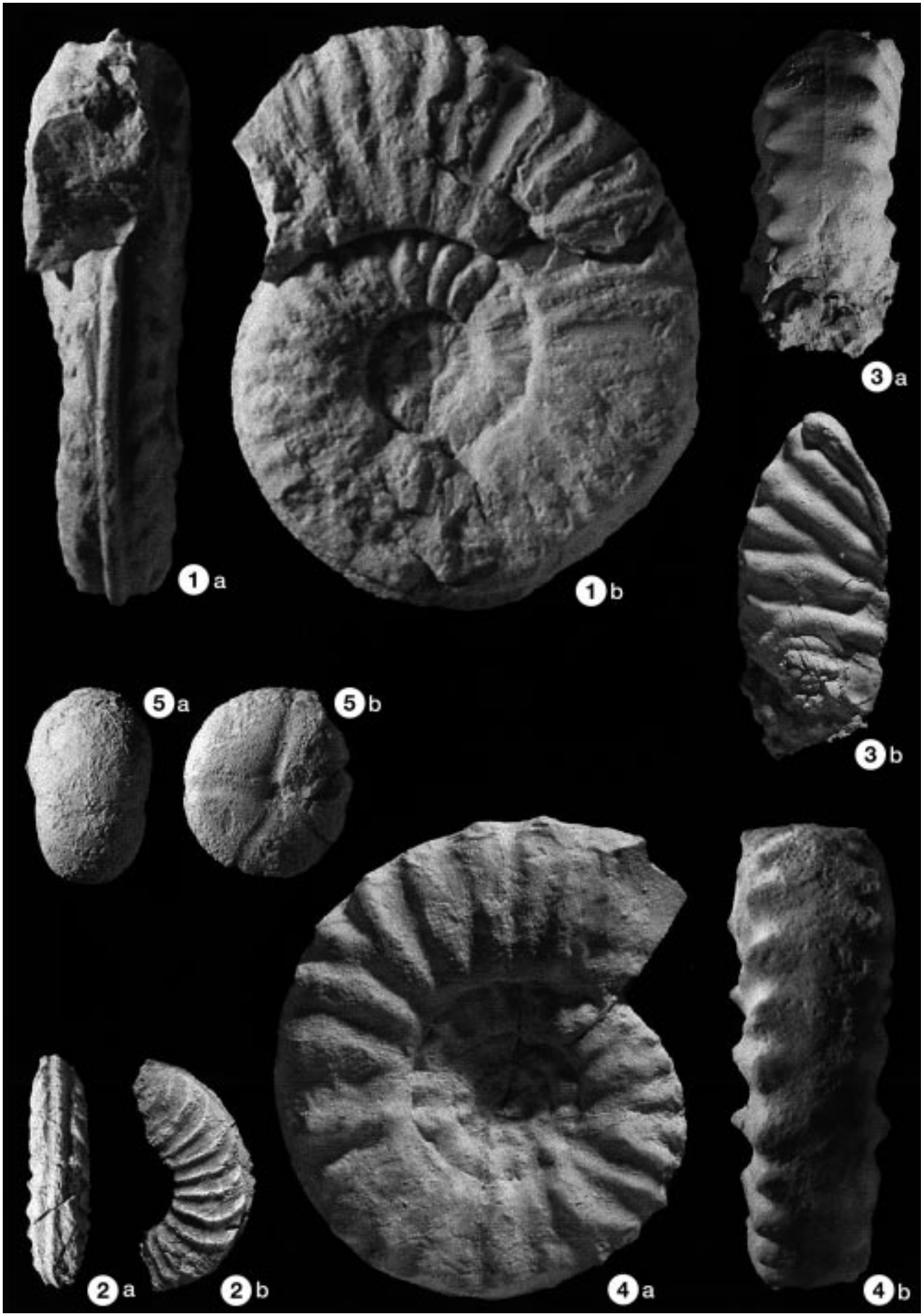
Fig. 1: *Halilucites rusticus* (HAUER) in ventral (a) and lateral (b) views.
Avisianum Subzone, or *Secedensis* Zone, Vászoly, P-11/a, Bed 16/A.

Fig. 2: *Halilucites* cf. *arietitiformis* (HAUER) in ventral (a) and lateral (b) views.
Avisianum Subzone (?), Felsöörs, Bed 111/B.

Fig. 3: *Ticinites* cf. *hantkeni* (MOJSISOVICS) in ventral (a) and lateral (b) views.
Avisianum Subzone (?), Felsöörs, Bed 111/J.

Fig. 4: *Ticinites crassus* (HAUER) in ventral (a) and lateral (b) views.
Avisianum Subzone, or *Secedensis* Zone, Vászoly, P-11/a, Bed 16/A.

Fig. 5: *Proarcestes* sp. in ventral (a) and lateral (b) views.
Avisianum Subzone, Mencshely, Cser-tetö I., Bed U-5.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