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The Anisian/Ladinian boundary in the Vászoly section (Balaton Highland, Hungary)

By

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Abstract: The Anisian/Ladinian boundary was drawn by ammonoid biostratigraphy in a Middle Triassic key section at Vászoly (Balaton Highland, Hungary). Two ammonoid biozones, the Avisianum Zone and the Reitzi Zone were recognized. The authors' opinion is expressed in detail, supporting the use of the zones above, and arguing for their significance, as the Anisian/Ladinian boundary should be defined between them. Contribution was made to brachiopod biostratigraphy.

INTRODUCTION

Stratigraphers have an old debt in Hungary: to provide new and modern data to the Anisian/Ladinian boundary problem in the classic Balaton Highland region. The Vászoly section seems to have key importance in this respect.

The fossiliferous outcrops on the Öreg Hill near Vászoly were discovered by I. SZABÓ, and the first detailed collection made by the Hungarian Geological Survey (HGS) was led also by him. In 1982 I. SZABÓ produced an interim manuscript report for the HGS describing the section, providing the faunal list and ammonoid stratigraphy of the trench P-11/a, but he suggested to draw the Anisian/Ladinian boundary much higher in the sequence.

Recently the renewal of geological mapping in the Balaton Highland put the questions of Triassic stratigraphy in the lime-light. The large-scale mapping made by T. BUDAI (HGS) in the Vászoly area cast doubt on the suggested position of the Anisian/Ladinian boundary. The Vászoly section was sampled by S. KOVÁCS for conodont investigation and the material proved to be of great importance concerning the Anisian/Ladinian boundary question. His results combined with the earlier ammonoid data of I. SZABÓ are under publication (KOVÁCS et al., in press).

In order to make a new collection of macrofauna the HGS reopened the trench P-11/a. In the frame of the "Dezső Laczkó Fossil Hunting Camp" the Paleontological Department of the Hungarian Natural History Museum carried out the collection in 1988, with the eager assistance of Budapest University's students and professors. The present paper is devoted to show the biostratigraphic results derived from the study of fossils obtained in this way.

DESCRIPTION OF THE VÁSZOLY SECTION

The investigated section is located between Vászoly and Pécsely villages and the Lake Balaton, on the gentle eastern slope of the Öreg Hill (Fig. 1). The artificial excavation exposes a sequence of about 6 m in thickness, belonging to the Dörgicse Formation (somewhat equivalent of the formerly used "Buchenstein Beds") overlying the Anisian Megyehegy Dolomite Formation. The trench of about 10 m in length, 3 m in width and 2-3 m in depth runs in NE-SW direction. The outcropping beds are dipping southwestward at an angle of 30-40°. The beds are most intact at the bottom and on the lower part of the NW wall of the excavation, elsewhere (primarily in the SW end of the trench) they are disturbed (Fig. 2).

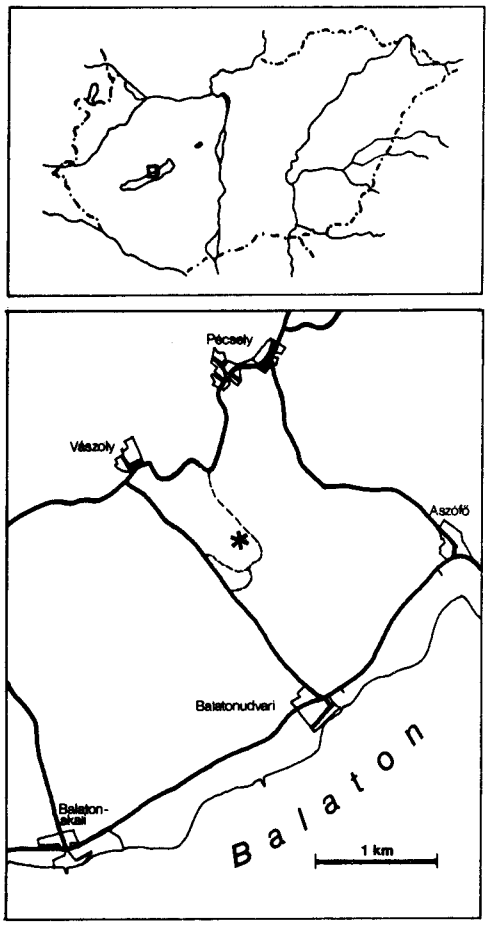

Fig. 1
Locality map showing the position of the Vászoly section

During the collection the bed numbers used by I. SZABÓ were largely followed to avoid confusion, except for our interpretation for Bed 16/A. A concise lithologic description of the section is given below.

Bed 1 - brownish crinoidal limestone (underlain by greenish-yellow dolomite, belonging to the Megyehegy Formation)
2/A - light yellow tuffaceous calcareous sandstone
2 - brownish crinoidal limestone
3/A - tuffaceous, calcareous sandstone, rich in ammonites and brachiopods
3 - bluish-grey compact dolomite, silicified in the upper part, containing a few, poorly preserved ammonites
4 - dolomitic, silicified greenish-brownish limestone with poorly preserved ammonites and brachiopods and a thin Daonella shell-bed intercalation
5 - fossiliferous biodetrital limestone, very rich in ammonites and brachiopods
6 - brownish biodetrital limestone, rich in brachiopods
7 - greenish-grey marl
8 - yellowish tuff with rare ammonites
9 - greenish-yellow tuffaceous sand with marly lenses and relatively rare ammonites
10 - red tuffaceous sand with thin limestone intercalations
11 - purplish tuffaceous clay
12 - yellowish clay with numerous limestone nodules containing a very rich ammonite fauna and few brachiopods
13 - brownish-grey tuffaceous, sandy clay
14 - yellowish clay with numerous limestone nodules rich in often fragmentary ammonites
15 - olive-green tuffaceous clay with marly limestone nodules containing rare ammonites
16/A - blocks of yellowish, somewhat nodular, bedded limestone containing a very rich ammonite fauna
16 - well-bedded, pale grey or reddish, compact, slightly silicified micritic limestone

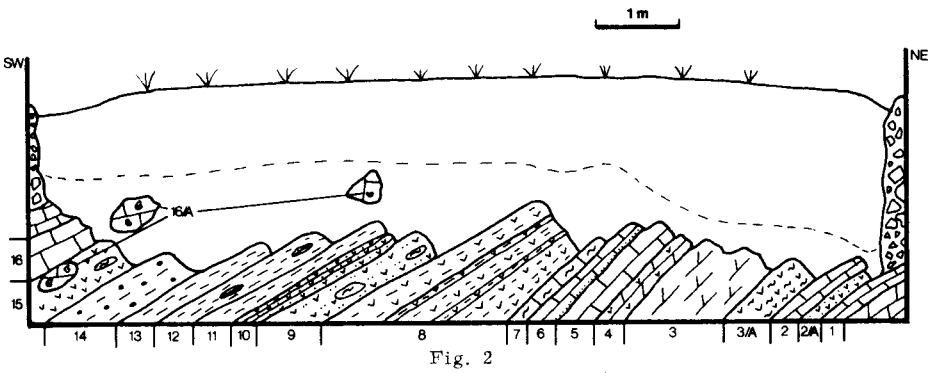

Fig. 2
Geological section of the trench P-11/a, Vászoly

The sequence in the upper part of the section is somewhat controversial, since Bed 16/A is represented by isolated blocks, mostly floating in the highest soft tuffaceous layer. However, its underlying position just below the Bed 16 seems to be evident.

DISTRIBUTION OF THE FAUNA

In the Vászoly section 18 beds were collected and studied thoroughly, of which 7 did not yield any identifiable fossils, but the others proved to be richly fossiliferous. Ammonites are usually preserved as internal moulds, while the brachiopods often bear shell remnants. The total number of specimens (including even the indeterminable fragments) is 1726, consisting mainly of ammonoids (821 specimens) and brachiopods (516 specimens). The bulk of the bivalves is originated from a thin Daonella shell-bed. The distribution of the major megafaunal groups is shown in Fig. 3.

50 taxa were separated, 35 of them were identified at species level. Nautiloids are represented by 1, ammonoids by 22 and brachiopods by 12 species. The vertical distribution of species and specimen number data is given in Table 1.

The complete faunal list is the following:

Palaeonucula sp.
Parallelodon ? sp.
Posidonia ? sp.
Daonella sp.
Pteria ? sp.
Mysidioptera ? sp.
Michelinoceres cf. campanile (Mojsisovics, 1869)
Michelinoceras sp.
Norites dieneri Arthaber, 1903 ?
Paraceratites ? subnodosus (Mojsisovics, 1882) (Plate I: 3)
Beyrichites sp.
Longobardites cf. zsigmondyi (Böckh, 1872)
Longobardites sp.
Hungarites mojsisovicsi (Roth, 1872) (Plate I: 4, Plate II: 2)
Hungarites cf. lenis (Hauer, 1896) (Plate I: 6)
Hungarites bocsarensis Arthaber, 1903 (Plate II: 1)
Hungarites sp., aff. bocsarensis Arthaber, 1903
Hungarites sp. A
Hungarites sp. indet.
Hungarites ? boeckhi Hauer, 1896 (Plate I: 5)
Parakellnerites cf. meriani Rieber, 1973 (Plate II: 3)
Parakellnerites cf. frauenfelderi Rieber, 1975

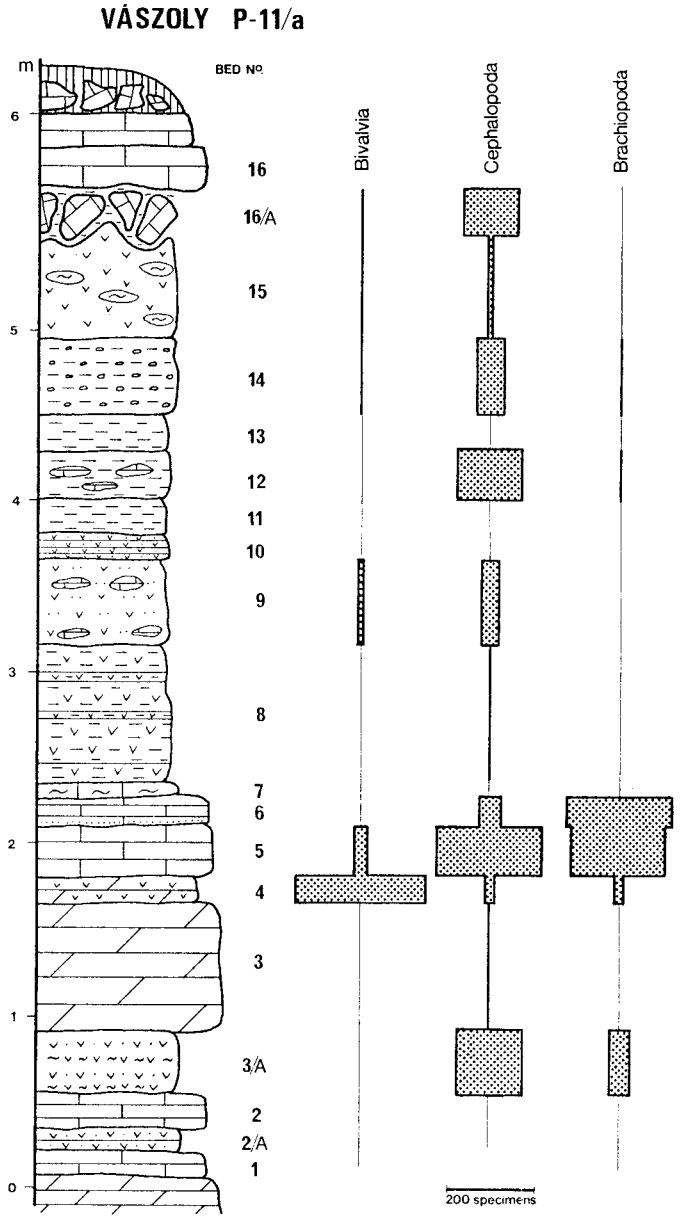

Fig. 3
Vertical distribution of the major megafaunal groups found in the Vászoly section

Parakellnerites cf. boeckhi (Roth, 1871)
Parakellnerites cf. hungaricus (Mojsisovics, 1880)
Parakellnerites sp., aff. felsoeoersensis (Stürzenbaum, 1875)
Parakellnerites sp.
Parakellnerites ? sp.
Stoppaniceras cf. variabilis Rieber, 1973 (Plate I: 1, 2)
Stoppaniceras ? sp.
Nevadites ? cf. hantkeni (Mojsisovics, 1882) (Plate III: 2)
Nevadites ? cf. ecarinatus (Hauer, 1896) (Plate III: 1)
Xenoprotrachyceras reitzi (Böckh, 1872) (Plate III: 5)
Xenoprotrachyceras cholnokyi (Frech, 1903) (Plate III: 3, 4)
Ptychites sp.
Flexoptychites flexuosus (Mojsisovics, 1882)
Flexoptychites acutus (Mojsisovics, 1882)
Flexoptychites cf. angustoumbilicatus (Böckh, 1872)
Flexoptychites cf. gibbus (Benecke, 1856)
Flexoptychites sp.
"Atractites" sp.
Discohelix? sp.
Norella refractifrons (Bittner, 1890) (Plate IV: 2)
Norella sp., aff rosaliae (Salomon, 1895) (Plate IV: 1)
Volirhynchia vivida (Bittner, 1890)
Volirhynchia productifrons (Bittner, 1898)
Trigonirhynchella ? sp., aff. delecta (Bittner, 1982)
Decurtella sp.
Mentzelia mentzeli (Dunker, 1851)
Mentzelia mentzeli baconica (Bittner, 1890) (Plate IV: 3)
Mentzelia sp., aff. ampla (Bittner, 1890) (Plate IV: 7)
Mentzelia sp. indet.
Koeveskallina ? pannonica (Bittner, 1890) (Plate IV: 4)
Koeveskallina sp. indet.
Pexidella cf. sturi (Böckh, 1872)
Schwagerispira speciosa (Bittner, 1890) (Plate IV: 6)
Coenothyris ? sp., aff. vulgaris (Schlotheim, 1820)
Angustothyris ? sp., aff. suspecta (Bittner, 1902) (Plate IV: 5)

BIOSTRATIGRAPHIC EVALUATION

Taking the number of specimens and species, as well as the stratigraphic value of the macrofossil groups known from the Vászoly section into account, the ammonoids and - secondarily - the brachiopods could be used for biostratigraphic studies.

Ammonoid biostratigraphy

The distribution of ammonoids is scattered within the Vászoly section. Richly fossiliferous and barren beds alternate, seemingly not related to the lithologic alternation of carbonate and tuffaceous layers. In general, the section contains a satisfactory quantity of ammonites to found its biostratigraphic succession.

The biostratigraphic study of the Vászoly section was intended to draw the Anisian/Ladinian boundary. First our own view should be demonstrated on the widely disputed Upper Anisian - Lower Ladinian biostratigraphic units.

KRYSTYN (1983) introduced the "Parakellnerites Zone" for the uppermost Anisian and the "Nevadites Zone" for the lowermost Ladinian. Unfortunately, this was accepted on the workshop meeting of the IGCP-4 project, and the IUGS Subcommission on Triassic Stratigraphy (see ZAPFE 1983). Nevertheless, from nomenclatorial point of view, we cannot

accept these names for the two biozones mentioned above, instead we suggest to retain the use of the Avisianum Zone and the Reitzi Zone, according to the following ideas.

The Anisian/Ladinian sections of the Southern Alps were investigated in detail (RIEBER 1973, BRACK and RIEBER 1986). There an independent biozone occurs regularly above the Trinodosus Zone. RIEBER (1973) distinguished and named this one as "Polymorphus Zone", correlating it with ASSERETO's (1969) Avisianum Zone. Later on, KRYSTYN (1983) referred to the same interval designating his "Parakellnerites Zone". These three names are synonymous, of them the Avisianum Zone has the priority, so its further use is supported.

The modern redefinition of the Reitzi Zone was done by BRACK and RIEBER (1986). They listed the "Ceratites" ellipticus species group and the "reitzi" group (including reitzi, conspicuus, perauritus, ecarinatus, etc.) assigned to Nevadites by them, as characteristic forms of this zone. So the Reitzi Zone is equivalent to the informal "Nevadites Zone", above the Avisianum (="Polymorphus") Zone and below the Curionii Zone. Since such a modern and detailed study was not yet published on Balaton Highland sections, BRACK's and RIEBER's opinion was accepted concerning the fossil content, time span and the position of the Reitzi Zone within the zonation. It must be mentioned however, that we are inclined to assign the species reitzi and conspicuus to the genus Xenoprotrachyceras, erected by WANG (1983).

The other question is the setting of the Anisian/Ladinian boundary. BRACK and RIEBER (1986) drew this boundary above the Reitzi Zone, at the base of the Curinoii Zone characterized by the occurrence of "true" trachyceratids, bearing trachyceratid suture-line. This is the method introduced earlier in North America for practical reasons (see TOZER 1981, SILBERLING and NICHOLS 1982). In ideal case evolutionary events are used for delimitation of zones in the biostratigraphy. However, it is not a proper way to extend this principle to chronostratigraphy, so to the delimitation of stages. The occurrence of a higher taxonomic group is not a necessary criterion for drawing the boundary of a higher chronostratigraphic unit. (In this case the occurrence of the Trachyceratáceae superfamily would mean the base of Ladinian, sensu BRACK and RIEBER). According to the principles of stratigraphy, a stage must be based on stratotype, its lower boundary must be drawn at the base of its lowermost chronozone/biozone per definitionem. The Ladinian has no designated stratotype section, but the type area is in the Southern Alps, where the lowermost formation is the "Buchenstein Beds" (BITTNER 1892), and the lowermost biozone is the Reitzi Zone (MOJSISOVICS 1882), according to the original definitions. There is no reason for its modification. Consequently the zonation suggested and used by the present authors for the Upper Anisian/Lower Ladinian is the following:

Curionii Zone	Lower Ladinian
Reitzi Zone	
Avisianum Zone	Upper Anisian
Trinodosus Zone	

The Vászoly section can be divided into four parts, according to the vertical distribution of ammonoid species (Fig. 4).

Part A includes Beds 3/A-5. It is characterized by the presence of Stoppaniceras variabilis, which is accompanied by Longobardites zsigmondyi and Paraceratites ? subnodosus in the Beds 4-5. This assemblage reminds the "trinodosus-faunas" as well, but by the occurrence of species of Stoppaniceras it must be referred to the Avisianum Zone, according to RIEBER's (1973) data.

Part B begins with Bed 5 (thus overlapping with Part A) by the occurrence of species of Parakellnerites. Beds 5 and 6 are characterized by P. frauenfelderi and P. sp., aff. felsoeoersensis, accompanied by Norites dieneri. Other species of Parakellnerites persist through the upper beds of the section.

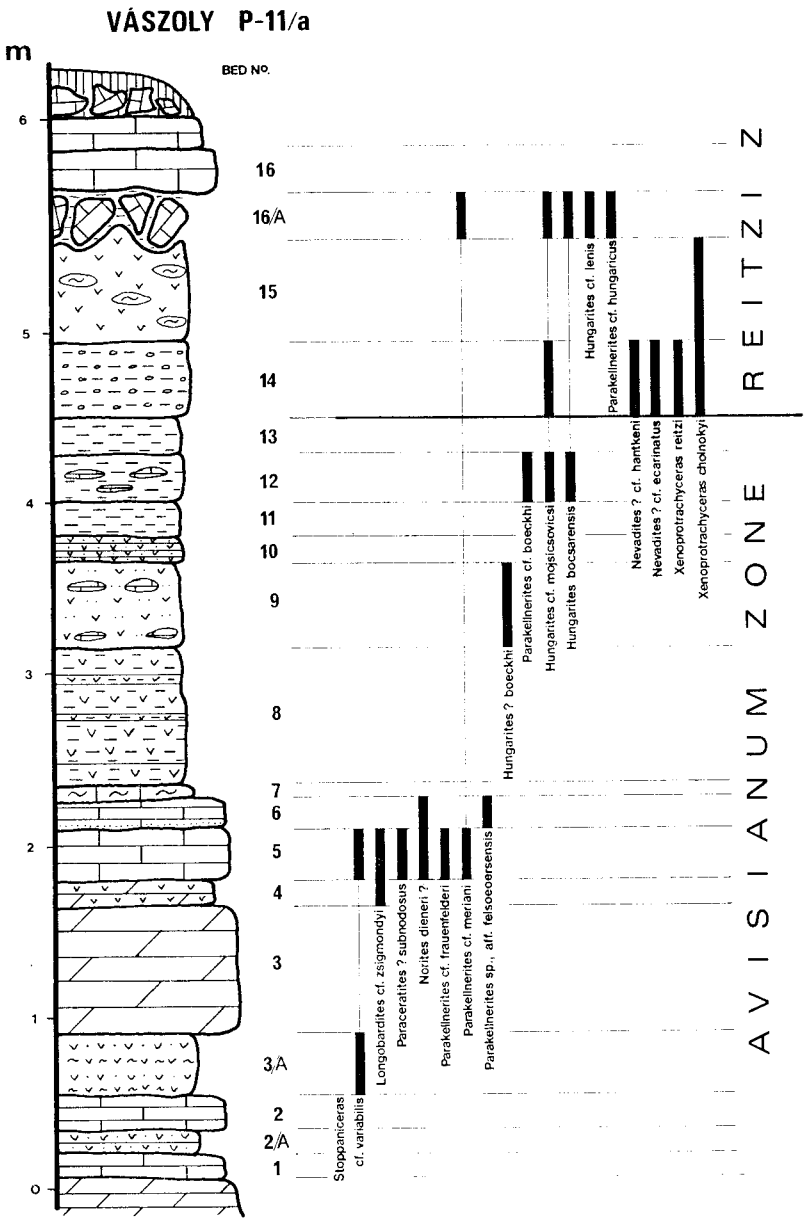

Fig. 4
Biostratigraphic subdivision of the Vászoly section based on the vertical distribution of distinctive ammonoid species

Table 1
The vertical distribution of the identified ammonoid and brachiopod species in the fossiliferous beds of Vászoly section

	3/A	3	4	5	6	8	9	12	14	15	16/A
Michelinoceras cf. campanile				12							
Norites dieneri ?				2	1						
Paraceratites ? subnodosus				4							
Longobardites cf. zsigmondyi			1	1							
Hungarites mojsisovicsi								2	1		3
Hungarites cf. lenis											1
Hungarites bocsarensis								1			1
Hungarites sp., aff. bocsarensis											1
Hungarites sp. A											1
Hungarites ? boeckhi							1				
Parakellnerites cf. mariani				6							1
Parakellnerites cf. frauenfelderi				11							
Parakellnerites cf. boeckhi								2			
Parakellnerites cf. hungaricus											1
Parakellnerites sp., aff. felsoeoersensis					2						
Stoppaniceras cf. variabilis	6			1							
Nevadites ? cf. hantkeni									1		
Nevadites ? cf. ecarinatus									1		
Xenoprotrachyceras reitzi									2		
Xenoprotrachyceras cholnokyi									3	2	
Flexoptychites flexuosus			2	11	3			4			14
Flexoptychites acutus								4	8		1
Flexoptychites cf. angustoumbilicatus				6	2				5		2
Flexoptychites cf. gibbus				7							
Norella refractifrons			1		1						
Norella sp., aff. rosaliae					7						
Volirhynchia vivida	4		1	11	1						
Volirhynchia productifrons				4							
Trigonirhynchella ? sp., aff. delecta			2	35	22			1	1		
Mentzelia mentzeli	18		4	43	90						
Mentzelia mentzeli baconica				22	28						

Table 1. (cont.)

	3/A	3	4	5	6	8	9	12	14	15	16/A
Mentzelia sp., aff. ampla	4			3	4						
Koeveskallina ? pannonica				39	35						
Pexidella cf. sturi				4	1						
Schwagerispira speciosa	3			6	3			1			
Coenothyris ? sp., aff. vulgaris			3	2							
Angustothyris ? sp., aff. suspecta	12			4	9						

Part C (Beds 9-12) is characterized by the occurrence of diverse Hungarites species (H. boeckhi, H. mojsisovicsi, H. bocsarensis). In Bed 12 Parakellnerites boeckhi joins the assemblage.

Part D begins with Bed 14, where Nevadites ? hantkeni and N. ecarinatus along with Xenoprotrachyceras reitzi and X. cholnokyi appear simultaneously. Although species of Hungarites known from the deeper part of the section are still present, this part must be assigned to the Reitzi Zone by the occurrence of the index species and other forms belonging to the "reitzi group", which characterize this zone. Thus the Anisian/Ladinian boundary can be drawn at the base of Bed 14. This "orthostratigraphic" boundary coincides almost perfectly with that established by conodont biostratigraphy (i.e. at the base of Bed 17: KOVÁCS et al. in press).

Brachiopod biostratigraphy

In the Vászoly section brachiopods represent the second richest fossil group after ammonoids. They are abundant in the lower, predominantly carbonatic part of the sequence (Beds 3/A, 4, 5, 6).

The composition of the fauna differs markedly from that of the Pelsonian brachiopod assemblages from other localities of the Balaton Highland (Köveskál, Aszófő and Felsőörs respectively), which were subject of the authors' previous study. The number of common species is only 3 in each case. Despite this fact all genera excluding Norella were found in the Pelsonian, but often represented by different species. The species of the genera Trigonirhynchella, Mentzelia, Koeveskallina, Schwagerispira and Angustothyris found in Pelsonian and Illyrian faunas are different, probably for rather evolutionary, than ecological reasons. Mentzelia mentzeli is a common form in both substages, but in Vászoly the subspecies M. mentzeli baconica was identified, which was originally described from Reifling Limestone of Illyrian age. The Schwagerispira genus is often represented by the species schwageri and mojsisovicsi in Pelsonian, which are replaced in the Vászoly section by speciosa, a characteristic form of the Illyrian Schreyeralm Limestone. This basinal limestone contains the type horizon for Norella refractifrons, another element of the Vászoly fauna. In brachiopod assemblages belonging to the Balatonicus Zone Koeveskallina koeveskalyensis and Angustothyris angustaeformis are widespread, while in Vászoly their probably younger counterparts, K. pannonica and A. sp., aff. suspecta were found. A spiriferid, Mentzelia sp., aff. ampla would fit into an evolutionary lineage leading from M. mentzeli to M. ampla, the latter known from Ladinian and Carnian. Occurrence of Pexidella sturi is also remarkable, because elsewhere in the Balaton Highland it seemed to be confined to the Avisianum Zone.

All the above mentioned data suggest the Illyrian age of the brachiopod assemblage. On the other hand, the ammonoid biostratigraphy well-determines the Late Illyrian (Avisianum Zone) age of brachiopod-bearing beds, so new data could be provided on stratigraphic range of these species.

EXPLANATION OF PLATES

Plate I.

1a-b: Stoppaniceras cf. variabilis Rieber, Vászoly, Bed 3/A, X 1
2: Stoppaniceras cf. variabilis Rieber, Vászoly, Bed 3/A, X 1
3: Paraceratites ? subnodosus (Mojsisovics), Vászoly, Bed 5, X 1
4a-b: Hungarites cf. mojsisovicsi (Roth), Vászoly, Bed 14, X 1
5: Hungarites ? boeckhi Hauer, Vászoly, Bed 9, X 1
6: Hungarites cf. lenis (Hauer), Vászoly, Bed 16/A, X 1

Plate II.

1a-b: Hungarites bocsarensis Arthaber, Vászoly, Bed 16/A, X 1
2: Hungarites mojsisovicsi (Roth), Vászoly, Bed 16/A, X 1
3: Parakellnerites cf. meriani Rieber, Vászoly, Bed 16/A, X 1

Plate III.

1a-b: Nevadites ? cf. ecarinatus (Hauer), Vászoly, Bed 14, X 2
2a-b: Nevadites ? cf. hantkeni (Mojsisovics), Vászoly, Bed 14, X 1
3a-b: Xenoprotrachyceras cholnokyi (Frech), Vászoly, Bed 14, X 1
4a-b: Xenoprotrachyceras cholnokyi (Frech), Vászoly, Bed 14, X 1
5a-c: Xenoprotrachyceras reitzi (Böckh), Vászoly, Bed 14, X 1

Plate IV.

1a-b: Norella sp., aff. rosaliae (Salomon), Vászoly, Bed 6, X 2
2a-c: Norella refractifrons (Bittner), Vászoly, Bed 6, X 2
3a-c: Mentzelia mentzeli baconica (Bittner), Vászoly, Bed 5, X 2
4a-c: Koeveskallina ? pannonica (Bittner), Vászoly, Bed 6, X 2
5a-c: Angustothyris ? sp., aff. suspecta (Bittner), Vászoly, Bed 6, X 2
6a-c: Schwagerispira speciosa (Bittner), Vászoly, Bed 6, X 2
7a-c: Mentzelia sp., aff. ampla (Bittner), Vászoly, Bed 3/A, X 2
In each case, a: dorsal view, b: lateral view, c: anterior view

CONCLUSIONS

In the Vászoly section the Upper Anisian Avisianum Zone and the Lower Ladinian Reitzi Zone was proved by ammonoid biostratigraphy. The boundary between these two zones, which represents the Anisian/Ladinian boundary can be drawn at the base of Bed 14. The distribution of ammonoids within the Avisianum Zone follows a Stoppaniceras-Parakellnerites-Hungarites succession.

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HUNGARY

PLATE I.

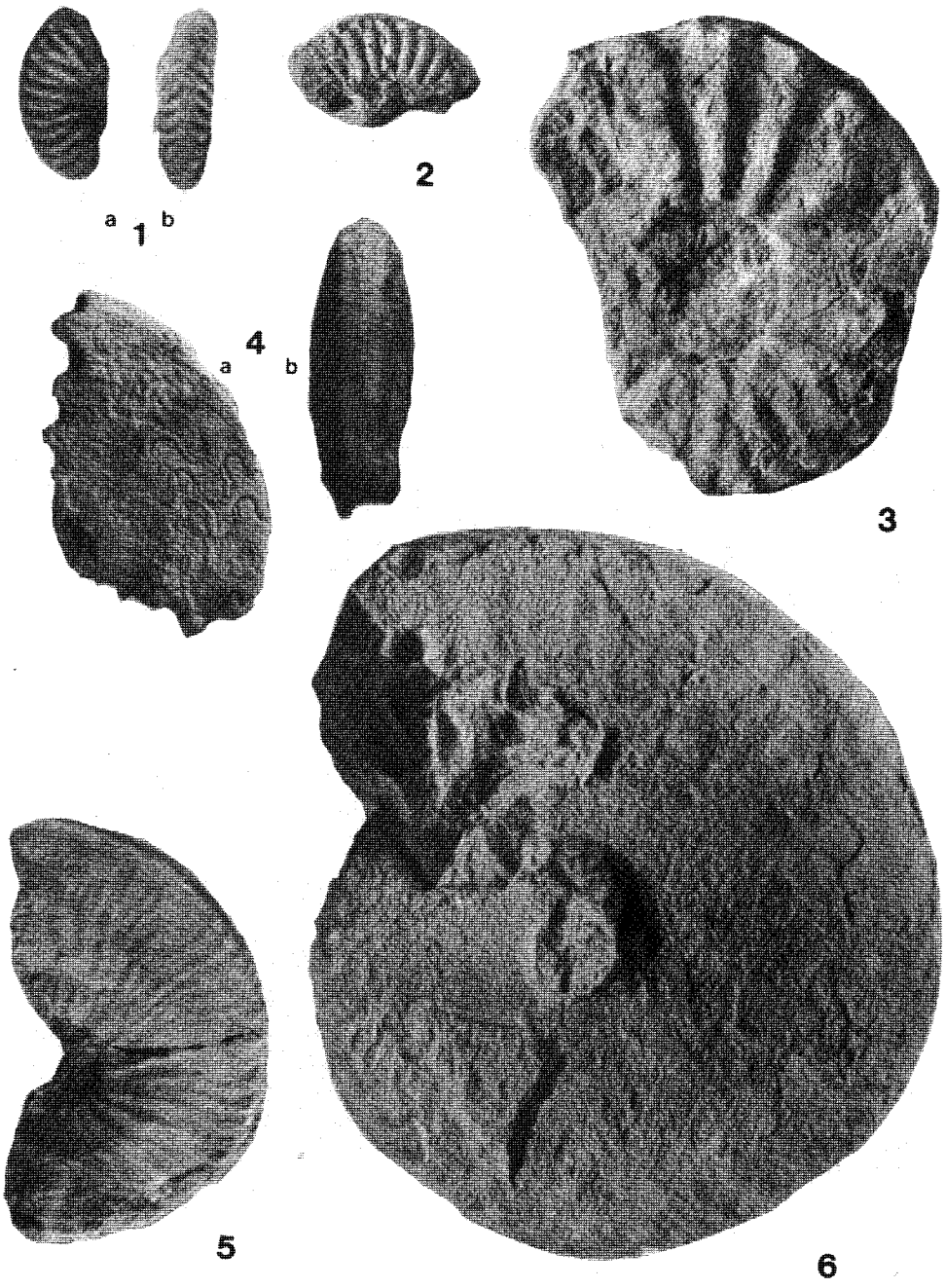
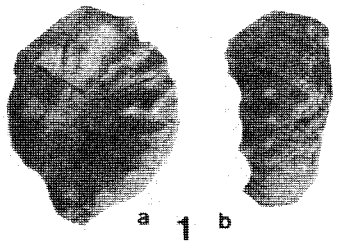
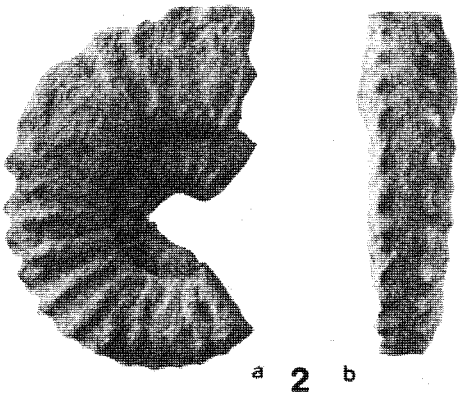


PLATE II.

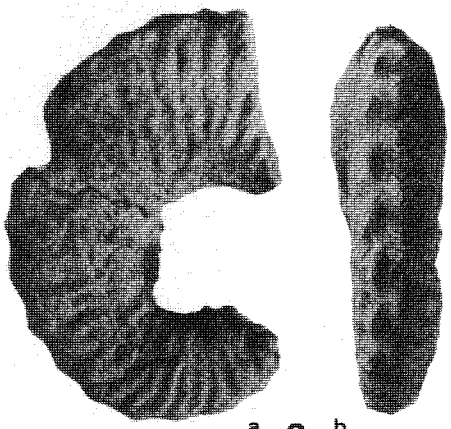
PLATE III.



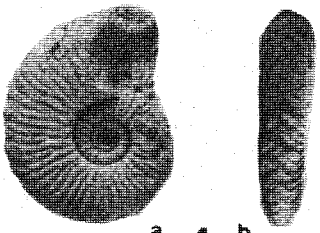
a 1 b



a 2 b



a 3 b



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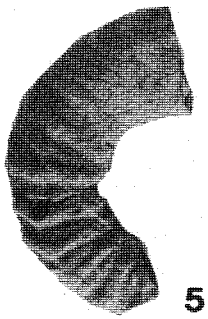
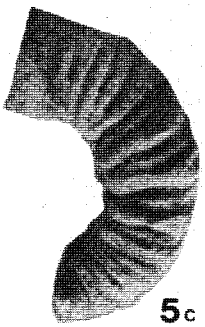


5a

5b



5c

PLATE IV.