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Palaeobiogeographic analysis of Moscovian (Pennsylvanian) brachiopods Productida, Orthotetida, Orthida, Rhynchonellida from Bükk Mts, Hungary

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(with 4 figures, 4 tables and 4 plates)

Two brachiopod faunas from the Moscovian of the Bükk Mts are discussed in the present paper. This paper deals with the Productida, Orthotetida, Orthida, and Rhynchonellida. The outcrops are along the railwaycuts near Nagyvisnyó (Bükk Mts Hungary), at hectometer 416 and 422. The two outcrops contain different faunas in the shales. Eleven families, 25 genera and 33 species. The most abundant elements are *Linoproductus cora* (D'ORBIGNY) and *Chaoiella gruenewaldti* (KROTOW). The fauna of Nagyvisnyó railway cut 422 is closely related to Early Moscovian faunas of Cantabrian Mts, Carnic Alps, Karavanke Mountains, and Western Serbia because of the occurence of *Rugosochonetes acutus* (DEMANET) *Avonia* cf. *echidniformis* (CHAO), *Kozlowskia pusilla* (SCHELLWIEN), *Karavankina rakuszi* WINKLER PRINS and *Echinoconchus* species. The age of the fauna of railwaycut 416 is hard to determine because it contains no stratigraphicaly important species. Possibly, it is younger Moscovian. Both faunas were transported but the fauna of 422 possibly over longer distance.

Introduction

Carboniferous marine faunas are very rare in Hungary. The post-Variscan Málwritten Formation is known to be the richest Auernig-type fauna in the Bükk Mts, North Hungary. The first publication was by VADÁSZ (1909) who collected many specimens from the siltstones and limestones during the construction of the railway line Eger-Putnok. He determined some taxa and put the formation in the middle and upper Carboniferous because of the presence of „*Spirifer mosquensis*” (which was possibly *Choristites fritschi*). He also pointed out that there is a similarity between Carboniferous of Nagyvisnyó and Carboniferous of Dobsina (Slovakia).

The Carboniferous material was first extensively investigated by Gyula RAKUSZ (1932) who studied the faunas of railcuts 416, 422 and comparired to fauna of Dobsina and pointed out many differences. In the 1920s to 40s Ferenc LEGÁNYI was the most important amateur collector who collected the largest part of the specimens from the railway cuts. The Permian brachiopods were first described by SCHRÉTER (1963) who published an excellent article on Upper Permian brachiopods from railcut 5 near Nagyvisnyó. Later publications on the brachiopods only summarized the results (BALOGH 1964, FÜLÖP 1994) particularly. They published faunal lists and figured some specimens. This work aims analysing the brachiopod faunas which have not been investigated since RAKUSZ (1932) and to get new information about the biogeographical situation and biostratigraphy.

Geological situation and locality

The Bükk Mts is located in the north of Hungary within the Pelso mega-unit. The Mályinka Formation is situated on the margin of the Northern Bükkian Anticline and developing from the flysch-like Szilvásvárad Formation (Fig. 1). This formation is widespread in the North Bükkian anticline. The northern part of the anticline, where the investigated outcrops are situated, is devoid of metamorphism. These are good outcrops along Eger-Putnok railway to collect non metamorphic well preserved faunas. This paper deals with two the oldest investigated ones which are in the Nagyvisnyó railway cut of 422 hectometer and 416 hectometer (Fig. 2). The investigated

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faunas were found in the shales in both outcrops and belong to the Berenás Member of the Málінka Formation which is present in the lower part of the formation (Fig. 2). Both stratigraphic colum (Fig. 3) start with approximately 2.5 m thick gray, thick-bedded folded limestone. This limestone contains well preserved bivalves, foraminifers, brachiopods, molluscs and algae. Well folded 17 m thick, gray-green sandy shale follows the limestone in the outcrop of 416. This shale is rather homogenous petrographicaly. The richest fossiliferous localities occur randomly, the greatest part of these localities is lumaschella-like.

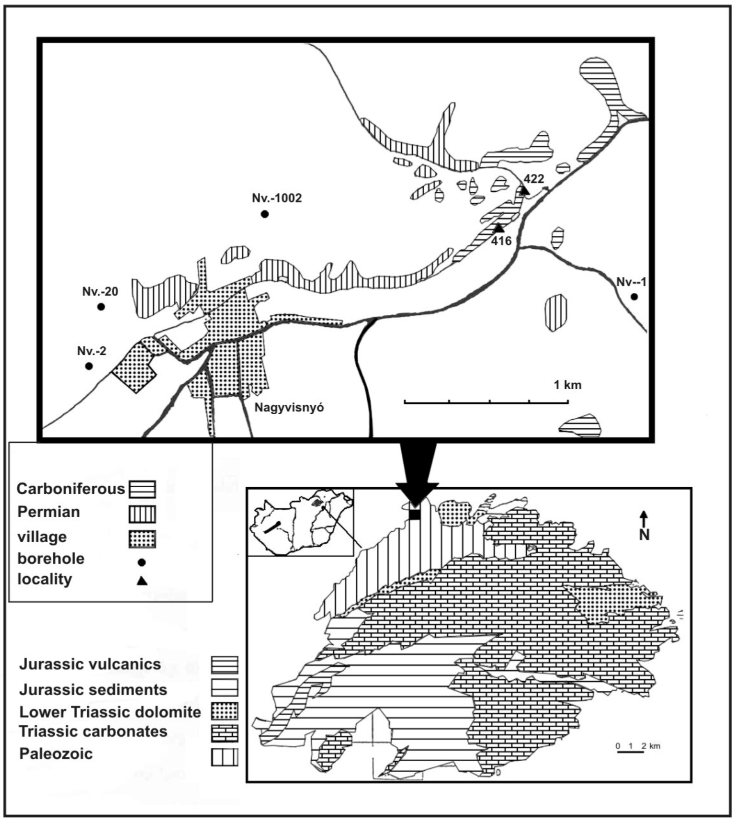


Fig. 1 Localities of Carboniferous brachiopods in Bükk Mts.

In the outcrop of 422, 0.3 m thick, rose-yellow-gray marl follows the limestone. In the border of the limestone and the marl phylloid algal-rich bed can be observed. This marl (A) contains a rich fauna of small chonetoids (Table 1) and some productids. It is followed by 1 m of yellowish sandy-shale with poor fauna; large chonetoids, productids and few fern leaf fragments have been found (B). The following 5 m thinly laminated, grey shale contains the richest fauna, particularly the uppermost 1.5 m (B and C).

Material and Methods

This work studied the earlier collected materials which has not been reviewed by András TASNÁDI KUBACSKA (1951), material of Ferenc LEGÁNYI and recent collections by Mihály DUNAI and the author. Most specimens are kept in the collecton of the Geological Institute of Hungary. Other specimens were investigated from the collection of the Natural History Museum and the Mátra Museum Gyöngyös. The author used the taxonomical method and morphological descriptions of BRUNTON et al. (2000) and WILLIAMS et al.(2000).

Usually the preservation of specimens is good but the fauna is compressed, most chonetids and ortotethids contain their shell. Most productids are molds, flanks and spines are very often broken.

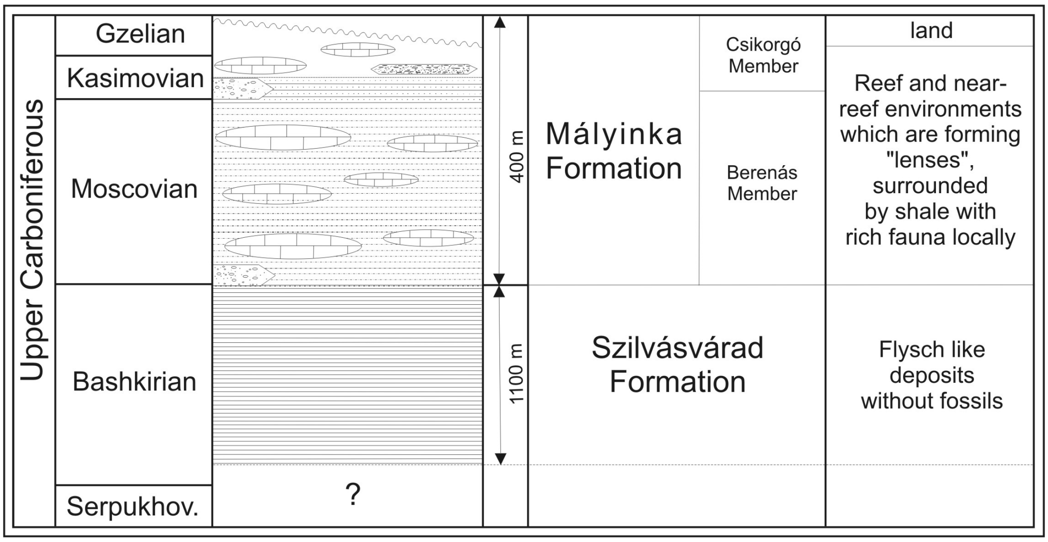


Fig. 2 Stratigraphic scheme of the Carboniferous of Bükk Mts (after FÜLÖP 1994, Modified).

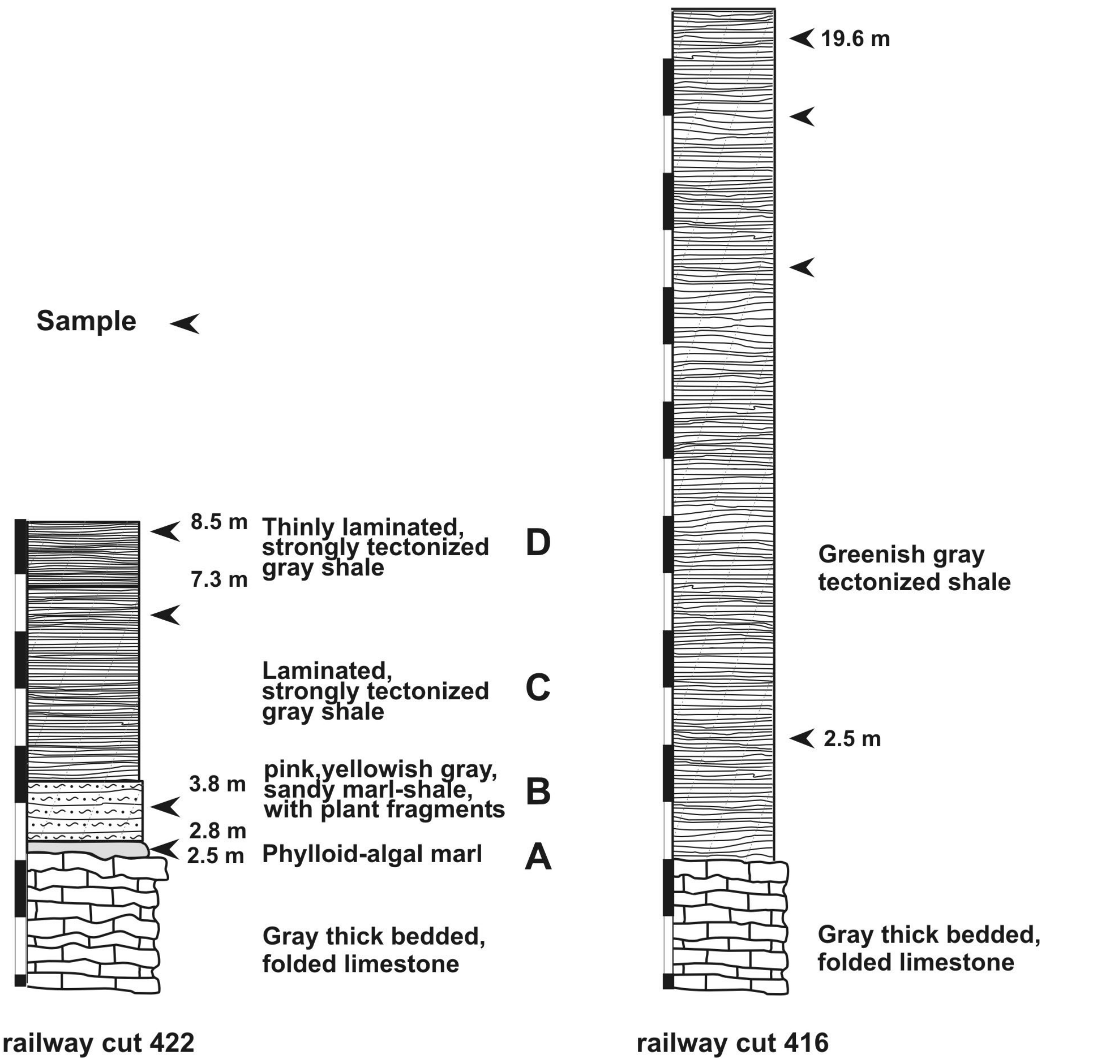


Fig. 3 Stratigraphic columns of outcrops. A: Rosy-yellow-gray marl with phylloid algae and small chonetids and productids. B Yellowish sandy-shale with plant fragments and poor fauna. C-D Thinly laminated, tectonized, grey shale with rich fauna.

Table. 1 Taxa and their localities.

Locality	416	422/A	422/B	422/C	422/D	**sum.**
Taxa	number of specimens					
Rugosochonetes latesinuatus		1		16	7	24
Rugosochonetes acutus		3		2	5	10
Rugosochonetes acanthophorus		2				2
Sokolskya sp.		3	1	2		6
Paramesolobus sp.		3			2	5
Megachonetes papilionaceus		1	3			4
Lissochonetes sp.		2				2
Alitaria sp.					4	4
Avonia echidniformis		3	1			4
Quasiavonia aculeata			2			2
Dictyoclostus inflatiformis	34					34
Kozlowskia pusilla		1			2	3
Chaoiella gruenewaldti	21	1		10	16	48
Reticulatia cf.moelleri		2	1		8	11
Reticulatia sp.					3	3
Buxtonia sp.					2	2
Juresania juresanensis	4			4	7	15
Echinoconchus punctatus	1	10		3	7	21
Echinoconhella elegans		1			2	3
Karavankina praepermica		7	1	2		10
Karavankina rakuszi		6	1			7
Linoproductus lineatus	8					8
Linoproductus cora	93		2	13	12	120
Linoproductus neffedievi	9				2	11
Fluctuaria sp.					1	1
Cancrinella cf. cancriniformis					1	1
Orthotetes plana	18					18
Orthotetes radiata (?)					1	1
Derbyia multicostellata	24					24
Drahanorhynchus sp.					1	1
Rhipidomella sp.				1	1	2
Parenteletes sp.				1		1
Stenoscisma sp.					2	2
Undetermined	9	3			4	16
total	212	46	12	54	90	426

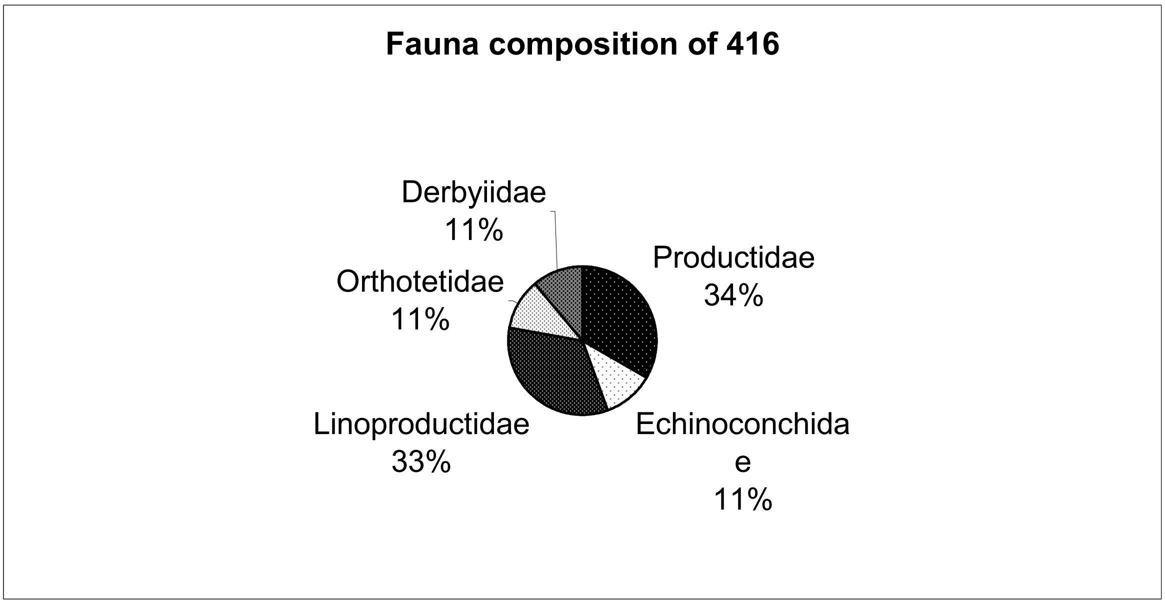
Features of the fauna

The specimens were collected from four-four sample points of both outcrops (Fig. 3).

There are some families which in were created many new genera and species in the last ten years, for example MARTÍNEZ CHACÓN and WINKLER PRINS (2000) newly revised the Rugosochonetidae group of the Cantabrian Mountains, and creared some new genera and species. These newest species are previously described as *Neochonetes acanthophorus* (GIRTY, 1934). Most of genera and species were created by the internal structures characters. Unfortunately, these characters couldn't be observed on the Bükkian specimens in most of cases. Because the lack of these characters, the bükkian specimens were classified to *Neochonetes acanthophorus*.

There are great variability of width, hight and deepth parameters of the sulcus of *Rugosochonetes latesinuatus*. According to some authors this variety is the separate lineage of *Rugosochonetes*, and might leads to *Paramesolobus* genera. Similar parameters were observed in the Bükkian specimens. All specimens which have not median fold were classified to *Rugosochonetes latesinuatus*.

This work contains 410 determined specimens which belong to 33 taxa and 26 genera (Table 1), these 25 genera belong to 11 families. The distribution of families are shown in (Fig .4). Most abundant families are Productidae and Linoproductidae in both outcrops,but there are big differences in composition.



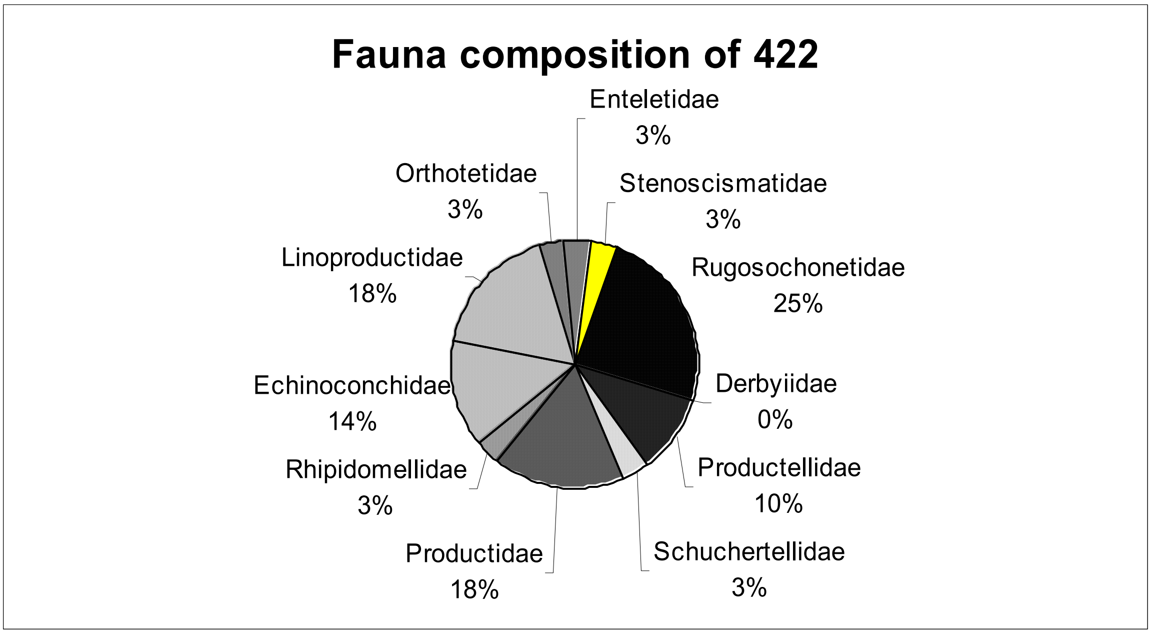


Fig. 4 Composition of families.

The fauna of outcrop 416 is rather homogeneous, very similar faunas were collected from each sample point. Most numerous productid families are the Linoproductidae and Productidae. Most peculiar productid species are *Linoproductus cora*, *Dictyoclostus inflatiformis*, *Chaoiella gruenewaldti*, and very typical orthotetid is *Derbyia multicostellata*.

More diverse faunas were collected from outcrop 422 (Figs 3, 4). There are differences between each sample point. Very typical small chonetid fauna was found in the sample point A. Most typical families are

Rugosochonetidae with *Rugosochonetes*, *Sokolskya*, *Paramesolobus* genera and the productid Echinoconchidae with typical *Echinoconchus punctatus* and *Karavankina praepermica* species. Very poor fauna is known in sample point B. Only a few large-size chonetids: *Megachonetes papilionaceus, Sokolskya* sp., and small productids are known. Most important taxa are the *Avonia echidniformis* and *Quasiavonia aculeata* of the Productellidae. In sample point C and D very similar faunas were found, but small elements are greater proportions in sample point C. Other difference is that the specimens of C have limonitic coating. Most typical elements are *Chaoiella gruenewaldti*, *Linoproductus cora* and *Juresania juresanensis* in the Productidae and Linoproductidae families.

Taphonomic observations

There are some important taphonomic circumstances and features could be observed in the outcrops. In the railwaycut 416 the following were found:

The distribution of fossil remains is not homogenous, the majority is concentrated in certain horizons. In these horizons the most common fossil remains are crinoid skeletal fragments. Crinoid calix has never been found but the arm fragments composed of 3-8 noditaxis are common. The crinoidal arms are usually orientated. Mostly brachiopod shells occur together with bryozoa and crinoid fragments. The large shells of orthothetids very often occur as a lumachella. The geniculated productoids mostly occur in a reverse position. The anchor and halteroid spines had been broken in almost all cases (except *Karavankina rakuszi* Plate II, fig 14.) and a the flanks are not often fit preserved. The broken off flanks and halteroid spines of brachiopods mean that these animals are non in situ. The long crinoidal arms may suggest rapid burial. Crinoidal arm disintegrate in a few days unless rapid burial stops disintegration (MEYER 1971, LIDDELL 1975, AUSICH & SEVASTOPULO 1994). Taphonomic observations suggest that the fauna has been transported only a short distance. Likely presumed situation is that a portion of this fauna is transported a short distance and mixed with the local faunas. Very similar conditions could be observed in the railwaycut number 422 but the crinoidal skeleton fragments are much more damaged there. These features suggest that the burial in 422 might have lasted longer than in number 416 and possibly, the mixing was higher.

Biostratigraphy

The most suitable fossil groups to determine the correct age in the marine Carboniferous series are fusulinids and conodonts.

There very scarce biostratigraphic informations about the age of the shales of the Mályinka Formation. MAJZON (1955) mentioned *Aljutovella* sp. from the shales of outcrop 416 but this species has rather wide range to determine the exact age. ROSOVSKAYA (1963) determined *Hemifusulina moelleri* rauser from the 416 and thought older than Upper-Moscovian. KOZUR (1984) investigated the conodonts from the limestone of 422 and found that the fauna is older than latest Moscovian. ZÁGORSEK (1993) pointed out the age difference between 416 and 422 by bryozoans but put both outcrops in the Upper-Moscovian.

The biostratigraphic evaluation of brachiopods of this paper followed the appreciation of Moscovian faunas (WINKLER PRINS 1968, MARTÍNEZ CHACÓN 1979, RÍO GARCÍA & MARTÍNEZ CHACÓN 1988, ARCHBOLD & STOJANOVIC-KUZENKO 1995, 1996).

The outcrop 422 contains several stratigraphically useful taxa (Table 2). The most diagnostic are *Avonia echidniformis* (CHAO), *Quasiavonia aculeata* (SOWERBY), *Kozlowskia pusilla* (SCHELLWIEN), *Echinoconchus punctatus* (SOWERBY), *Echinoconchella elegans* (MCCOY), *Karavankina praepermica* RAMOVŠ, *Karavankina rakuszi* WINKLER PRINS. Although co-occurence of *Quasiavonia aculeata* (SOWERBY), *Echinoconchus punctatus* (SOWERBY), *Echinoconchella elegans* (MCCOY), *Chaoiella gruenewaldti* (KROTOW), *Reticulatia moelleri* (STUCKBERG) could indicate the *Echinoconchus-Chaoiella* Zone of Viséan age. WINKLER PRINS (1968) pointed out that this association could occur later, too. However, the fauna is typical Moscovian due to the occurrence of *Rugosochonetes acutus* (DEMANET), *Avonia echidniformis* (CHAO), *Karavankina rakuszi* WINKLER PRINS and particularly, *Kozlowskia pusilla* (SCHELLWIEN). This composition is characteristic for the Kashirian (uppermost lower-Moscovian) Kozlowskia-Karavankia Zone (WINKLER PRINS 1968). Accordingly, I assume that this fauna belongs to lower Moscovian because much older elements are found (*Echinoconchus* species and *Quasiavonia aculeata* (SOWERBY)) which are not found in the higher Moscovian, but there are number of taxa which started in the early Moscovian and are typical for it (*Karavankina* species, *Kozlowskia* species) (WINKLER PRINS 1968). The age of locality 416 is harder to determine, because there is no species to decide the correct age. It is possible that this outcrop is younger because the occurence of some younger taxa such as: *Derbyia multicostellata* GAURI, *Orthotetes* *plana* IVANOV, *Linoproductus lineatus* (WAAGEN) and the lack of older orthothetids such as *Orthotetes radiata* (FISCHER DE WALDHEIM). Although, one specimen of *Echinoconchus punctatus* SOWERBY contradicts this result and would suggest an older age early Moscovian.

Table. 2 Stratigraphic distribution of genera of outcrop number of 422

Taxa / Stage													
	Ko.	N / B	N / C	W / A	W / B	W / C		W / D		Stephanian			
	Sp.	Valdetja		Lena				C.Ast.Sam.		B	Barruelo	Villablino-Sabero	
	Mo.	Lower-Aza		Upper-Aza		Ver.	Kas.	Pod.	Mja.	Kre. Kha. Do.		Rec. Am. Pav-Pos.N.-M.	
	Te.	Bashkirian				Moscovian				Kasimovian		Gzelian	Orenburgian
Rugosochonetes latesinuatus						?							
Rugosochonetes acutus													
Rugosochonetes acanthophorus													
Sokolskya						?	?	?	?				
Paramesolobus													
Megachonetes papilionaceus						?	?	?	?				
Lissochonetes sp.													
Alitaria sp.						?	?	?	?				
Avonia cf. *echidniformis*												?	
Quasiavonia aculeata						?	?						
Kozlowskia pusilla													
Chaoiella gruenewaldti													
Buxtonia sp.													
Juresania juresanensis													
Reticulatia cf. *moelleri*								?	?				
Echinoconchus punctatus						?	?	?	?				
Echinoconchella elegans						?							
Karavankina cf. *praepermica*													
Karavankina rakuszi											?		
Linoproductus cora												?	
Linoproductus neffedievi													
Fluctuaria sp.													
Cancrinella cf. *cancriniformis*													
Orthotetes radiata (?)										?	?		
Drahanorhynchus sp.						?	?	?	?				
Rhipidomella sp.													
Parenteletes sp.													
Stenoscisma sp.													

Table. 3 Stratigraphic distribution of genera of outcrop number of 416.

Taxa / Stage													
	Ko.	N / B	N / C	W / A	W / B	W / C		W / D		Stephanian			
	Sp.	Valdetja		Lena				C.Ast.Sam.		B	Barruelo	Villablino-Sabero	
	Mo.	Lower-Aza		Upper-Aza		Ver.	Kas.	Pod.	Mja.	Kre. Kha. Do.		Rec. Am. Pav-Pos.N.-M.	
	Te.	Bashkirian				Moscovian				Kasimovian		Gzelian	Orenburgian
Chaoiella gruenewaldti													
Dictyoclostus inflatiformis													
Echinoconchus punctatus						?	?	?	?				
Juresania juresanensis													
Linoproductus lineatus													
Linoproductus cora												?	?
Linoproductus neffedievi													
Orthotetes plana													
Derbyia multicostellata													

Table. 4 Comparison table for brachiopod fauna elements of Bükk Mts and Paleotethys region by (SCHELLWIEN1892, GIRTY 1911, KRENKEL 1913, DIENER 1915, YANISHEVSKY 1918, FREDERICKS 1924, RAKUSZ 1926, CHAO 1927, 1928, HERITSCH 1931, DORSMAN 1945, SOKOLSKAYA 1950, 1954, AISENVERG 1951, ROTAI 1951, SARYCHEVA & SOKOLSKAJA 1952, SARYCHEVA 1977, STOJANOVIC-KUZENKO 1966, 67, GAURI 1965, NYELZINA 1965, WINKLER PRINS 1968, PECAR 1986, MARTINEZ CHACON 1979, MARTINEZ CHACON & WINKLER PRINS 1979, MARTINEZ CHACON 1990, ARCHBOLD & STOJANOVIC-KUZENKO 1991, 1995, 1995b, CALVER 1971, ZDANOWSKI & ZAKOWA 1995)

Taxa / Locality	Dobsina Michaeli	Carnic Alps, Karavanka Mts.	Western Serbia (Ivovik, Obrado-vici)	Crna Gora Budva	Velebit Mts.	Bosnia (Praca)	North Spain	Moscow basin	Donetz basin and Siberia	Western Europe and Silesia	Kashmir (India), Pakistan, China and Tien-shan	North America
Rugosochonetes latesinuatus		x	x				x		x			
Rugosochonetes acutus	x	(?)	x			x	x			x		
Rugosochonetes acanthophorus		x			x		x	x	x			x
Sokolskya sp.		(?)	x				x	(?)	x			
Megachonetes papilionaceus		x	(?)		(?)		x(?)		x	x	x	
Avonia cf. *echidniformis*	x			x	x		x	x			x	
Quasiavonia aculeata	x	x					x	x	x	x		
Karavankina praepermica		x					x					
Karavankina rakuszi	x						x					
Linoproductus lineatus	x		x		x						x	x
Cancrinella cf. *cancriniformis*		x						x	x		x	x
Orthotetes plana	x	x	(?)					x				
Derbyia multicostellata		x										
Drahanorhynchus sp.			x				x					

Palaeobiogeography

The Moscovian faunas differ considerably from Bashkirian ones, and this change commenced in the Upper Bashkirian because they started to separate from western European faunas. The Moscovian faunas have markedly Mediterranean features which was shown in the Hungarian faunas by (RAKUSZ, 1932) and in the faunas from the Cantabrian Mts (WINKLER PRINS 1968, MARTÍNEZ CHACÓN 1979, MARTÍNEZ CHACÓN & WINKLER PRINS 1979, RÍO GARCÍA & MARTÍNEZ CHACÓN 1988) pointed relationships between the the faunas from the Cantabrian Mts fauna and faunas of Carnic Alps (SCHELLWIEN 1892, GAURI, 1965), Dobsina (FRECH, 1906), Moscow region, Donetz basin, Bashkiria , Kazahstan, Fergana, China and the Pennsylvanian of U.S.A. Although we have no faunistical data to support the connection between Bükk Mts and Pennsylvanian U.S.A., but a close connection is assumed with Carnic Alps, Dobsina, Dinarids (western Serbia (Ivovik, Obradovici), Velebit Mts) (ARCHBOLD & STOJANOVIC-KUZENKO 1991, 1995), Cantabrian Mts, Moscow basin and Donetz basin (SOKOLSKAYA, 1950, 1954) (Table 4). Weak connections are supposed between Bükk Mts and Siberia (SARYCHEVA, 1977), Fergana (YANISHEVSKY, 1918), Far East and China (CHAO, 1927, 1928). Apparently, the Bükkian fauna belonged to Europe-Tien-shan province, especially the productoids characterized by *Avonia echidniformis* (Chao), *Kozlowskia* sp., *Karavankina* and *Linoproductus* taxa (WINKLER PRINS 1968, MARTINEZ CHACÓN & WINKLER PRINS 1983, 1993). Most taxa are cosmopolitan such as *Echinoconchus*, *Cancrinella*, but there are some eastern element such as *Orthotetes plana* Ivanov, *Megachonetes papilionaceus* (PHILLIPS), *Sokolskya* sp., *Linoproductus lineatus* (WAAGEN), *Cancrinella* cf. *cancriniformis* (TSCHERNYSCHEW). There are some Mediterranean species specific for the Cantabrian Mountains-Southern Alps-Dinarids-Bükk Mts region. These are *Rugosochonetes latesinuatus* and *Rugosochonetes acutus* (DEMANET), *Karavankina* cf. *praepermica* RAMOVS, *Karavankina rakuszi* WINKLER PRINS, *Drahanorhynchus* sp. There are some genera which could appear only in the European and the North American region, these are: *Alitaria*, *Echinoconchella*, *Karavankina* (MARTINEZ CHACÓN & WINKLER PRINS 1993).

Conclusions

This work investigated two brachiopod faunas from Nanyvisnyó Bükk Mts in the railway cut 416 and 422. The brachiopod faunas have not been investigated since RAKUSZ (1932). Taphonomic observations suggest that these faunas were transported over a short distance and the faunal composition was mixed. Diverse lower Moscovian faunas were determined from the railwaycutt 422 which belongs to Kozlowskia-Karavankina Zone of the lower Moscovian. In outcrop 416 no stratigraphicaly important taxa were found. The age of this fauna is possibly younger. Both faunas related to the faunas of the Mediterranean-Southern Alpine-Dinarids region.

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Plate I

1. *Rugosochonetes latesinuatus* SCHELLWIEN, 1892. interior mold of dorsal valve, Nagyvisnyó railwaycutting of 422/ (C ?) c.1373, collection of the Geological Institute of Hungary

2. *Rugosochonetes latesinuatus* SCHELLWIEN, 1892. exterior view of vental valve, Nagyvisnyó railwaycutting of 422/C c1377, collection of the Geological Institute of Hungary

3. *Rugosochonetes* cf. *latesinuatus* SCHELLWIEN, 1892. exterior view of vental valve, Nagyvisnyó railwaycutting of 422/D c1379, collection of the Geological Institute of Hungary

4. *Rugosochonetes latesinuatus* SCHELLWIEN, 1892. interior view of dorsal valve, Nagyvisnyó railwaycutting of 422 MNM-36, collection of the Natural History Museum of Hungary

5. *Rugosochonetes acanthophorus* (GIRTY, 1934) exterior view of ventral valve, Nagyvisnyó railwaycutting of 422/ A c.1372, collection of the Geological Institute of Hungary

6. *Rugosochonetes acanthophorus* (GIRTY, 1934) exterior view of dorsal valve, Nagyvisnyó railwaycutting of 422/ A c.1373, collection of the Geological Institute of Hungary

7. *Rugosochonetes acutus* (DEMANET, 1938) exterior view of ventral valve, well preserved hinge spines could be observed, Nagyvisnyó railwaycutting of 422/ D c.1373, collection of the Geological Institute of Hungary

8. *Rugosochonetes* cf. *acutus* (DEMANET, 1938) exterior portion of dorsal valve and exterior sculpture of ventral valve, , Nagyvisnyó railwaycutting of 422/ C c.1379, collection of the Geological Institute of Hungary

9. *Paramesolobus* sp. exterior view of ventral valve , Nagyvisnyó railwaycutting of 422/ A c.1369, collection of the Geological Institute of Hungary

10. *Sokolskya* sp. exterior view of dorsal valve , Nagyvisnyó railwaycutting of 422/ A c.1373, collection of the Geological Institute of Hungary

11. *Sokolskya* (?) sp. exterior view of ventral valve , Nagyvisnyó railwaycutting of 422/ A collection of Mihály Dunai

12. *Lissochonetes* sp. exterior view of ventral valve , Nagyvisnyó railwaycutting of 422/ A c.1372, collection of the Geological Institute of Hungary

13. *Lissochonetes* (?) sp. exterior view of ventral valve , Nagyvisnyó railwaycutting of 422/ A collection of Mihály Dunai

14. *Megachonetes papilionaceus* (PHILLIPS, 1892), exterior view of ventral valve , Nagyvisnyó railwaycutting of 422/ B c.1378, collection of the Geological Institute of Hungary

14. *Megachonetes papilionaceus* (PHILLIPS, 1836), exterior view of ventral valve , Nagyvisnyó railway cut of 422/ B c.1378, collection of the Geological Institute of Hungary

15. *Megachonetes papilionaceus* (?) (PHILLIPS, 1836), exterior view of ventral valve , Nagyvisnyó railway cut of 422/ B c.1380, collection of the Geological Institute of Hungary

Plate 1

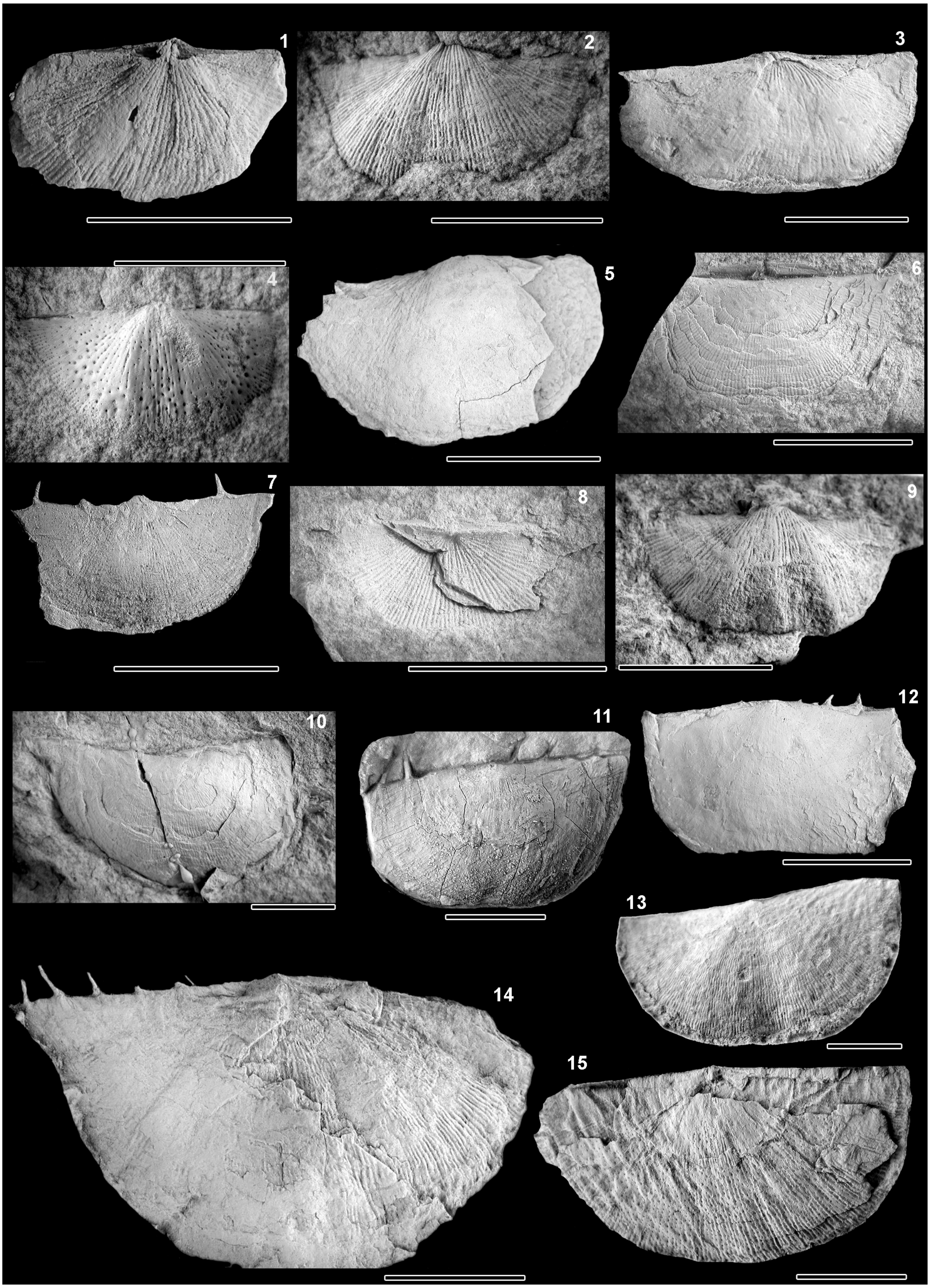

Plate 2

1. *Alitaria* sp. exterior view of ventral valve, ears are lacking, Nagyvisnyó railwaycutting of 422/ A, collection of Mihály DUNAI

2. *Kozlowskia pusilla* (SCHELLWIEN, 1892), exterior view of ventral valve , Nagyvisnyó railwaycutting of 422/ D c.1667, collection of the Geological Institute of Hungary

3. *Kozlowskia pusilla* (SCHELLWIEN, 1892), interior view of dorsal valve, brachial ridges, adductor scars and median septum can be observed, cardinal process and ears are lacking, Nagyvisnyó railwaycutting of 422/ D, c.1667, collection of the Geological Institute of Hungary

4. Marginiferinae indet. Exterior view of ventral valve, Nagyvisnyó railway cut of 422/ D, c.1373, collection of the Geological Institute of Hungary

5. *Chaoiella gruenewaldti* (KROTOW, 1888), exterior view of ventral valve , Nagyvisnyó railwaycutting of 422/ D, c.1208, collection of the Geological Institute of Hungary

6. *Chaoiella gruenewaldti* (KROTOW, 1888), exterior view of dorsal valve , Nagyvisnyó railwaycutting of 422/ D, collection of Author

7. *Dictyoclostus inflatiformis* IVANOV, 1935 exterior view of ventral valve , Nagyvisnyó railwaycutting of 422/ D, collection of Author

8. *Chaoiella gruenewaldti* (KROTOW, 1888), exterior view of dorsal valve , Nagyvisnyó railway cut of 422/ D, collection of Author

9. *Reticulatia* sp. 1935 exterior view of ventral valve , Nagyvisnyó railway cut of 422/ D, collection of Author

10. *Buxtonia* sp. exterior view of dorsal valve , Nagyvisnyó railway cut of 422/ D , collection of Author

11. *Juresania juresanensis* (TSCHERNYSCHEW, 1902), exterior view of dorsal valve , Nagyvisnyó railway cut of 422/ C , c.1495, collection of the Geological Institute of Hungary

12. *Karavankina* cf. *praepermica* (TSCHERNYSCHEW, 1902), exterior view of ventral valve , Nagyvisnyó railway cut of 422 (?), collection of Mihály Dunai

13. *Karavankina* cf. *praepermica* (TSCHERNYSCHEW, 1902), interior view of ventral valve , Nagyvisnyó railway cut of 422/ (C ?) , c.1390, collection of the Geological Institute of Hungary

14. Karavankina rakuszi WINKLER-PRINS, 1968 exterior view of dorsal valve, anchor spines could be shown starting anterior margin, Nagyvisnyó raiway cut of 422/A, collection of Mihály Dunai

Plate 2

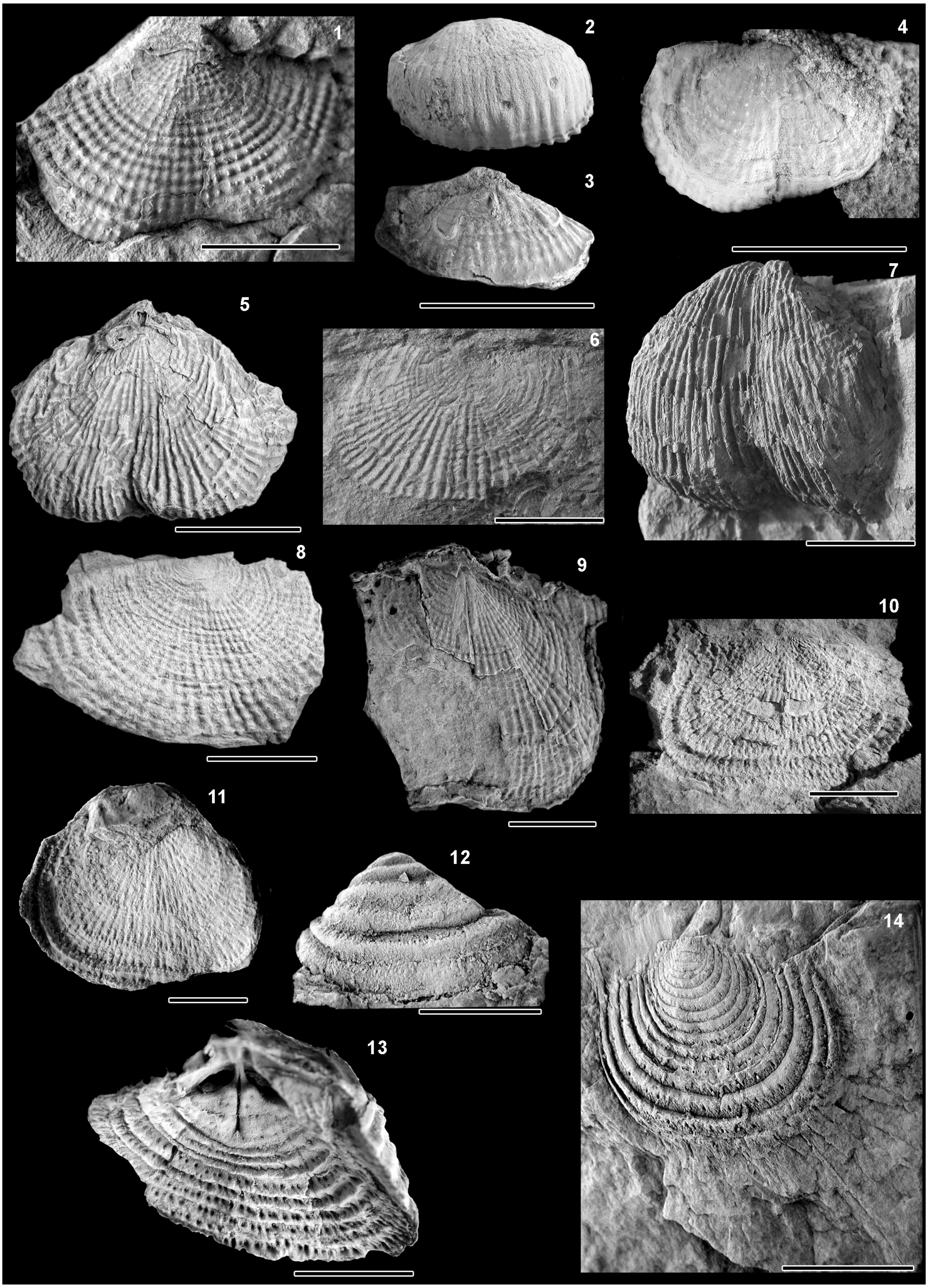

Plate 3

1. *Karavankina* cf. *rakuszi* WINKLER-PRINS, 1968 exterior view of dorsal valve, Nagyvisnyó railway cut of 422/A, collection of Mihály Dunai

2. *Karavankina* (?) sp. exterior view of dorsal valve , Nagyvisnyó railway cut of 422/C, c.1601 collection of the Geological Institute of Hungary

3. *Echinoconchella elegans* (MCCOY, 1844), exterior view of ventral valve , Nagyvisnyó railway cut of 422/ A , c.1362, collection of the Geological Institute of Hungary

4. *Echinoconchus punctatus* (SOWERBY, 1822), exterior view of ventral valve , Nagyvisnyó railway cut of 422/ A , c.1396, collection of the Geological Institute of Hungary

5. *Echinoconchus punctatus* (SOWERBY, 1822), lateral-exterior view of ventral valve , Nagyvisnyó railway cut of 422/ A , c.1396, collection of the Geological Institute of Hungary

6. *Echinoconchus punctatus* ? (SOWERBY, 1822) interior of dorsal valve, Nagyvisnyó railway cut, c. 1319 collection of the Geological Institute of Hungary

7. *Linoproductus cora* (D'ORBIGNY, 1842) exterior view of ventral valve, Nagyvisnyó railway cut of 416, collection of Mihály Dunai

8. *Linoproductus cora* (D'ORBIGNY, 1842) exterior view of dorsal valve, Nagyvisnyó railway cut of 416, collection of Mihály Dunai

9. *Linoproductus lineatus* (WAAGEN, 1884) exterior view of ventral valve, Nagyvisnyó railway cut of 416, c.2369 collection of the Geological Institute of Hungary

10. *Linoproductus neffedievi* (VERNEUIL, 1845) exterior view of ventral valve, Nagyvisnyó railway cut of 416, no inventory number, collection of the Geological Institute of Hungary

11. *Cancrinella* cf. *cancriniformis* (VERNEUIL, 1845) exterior view of ventral valve, Nagyvisnyó railway cut of 422/D , no inventory number, collection of the Natural History Museum of Hungary

12. *Quasiavonia aculeata* (SOWERBY, 1814) exterior view of ventral valve of two specimens, Nagyvisnyó railway cut of 422/B, c.1384 collection of the Geological Institute of Hungary

Plate 3

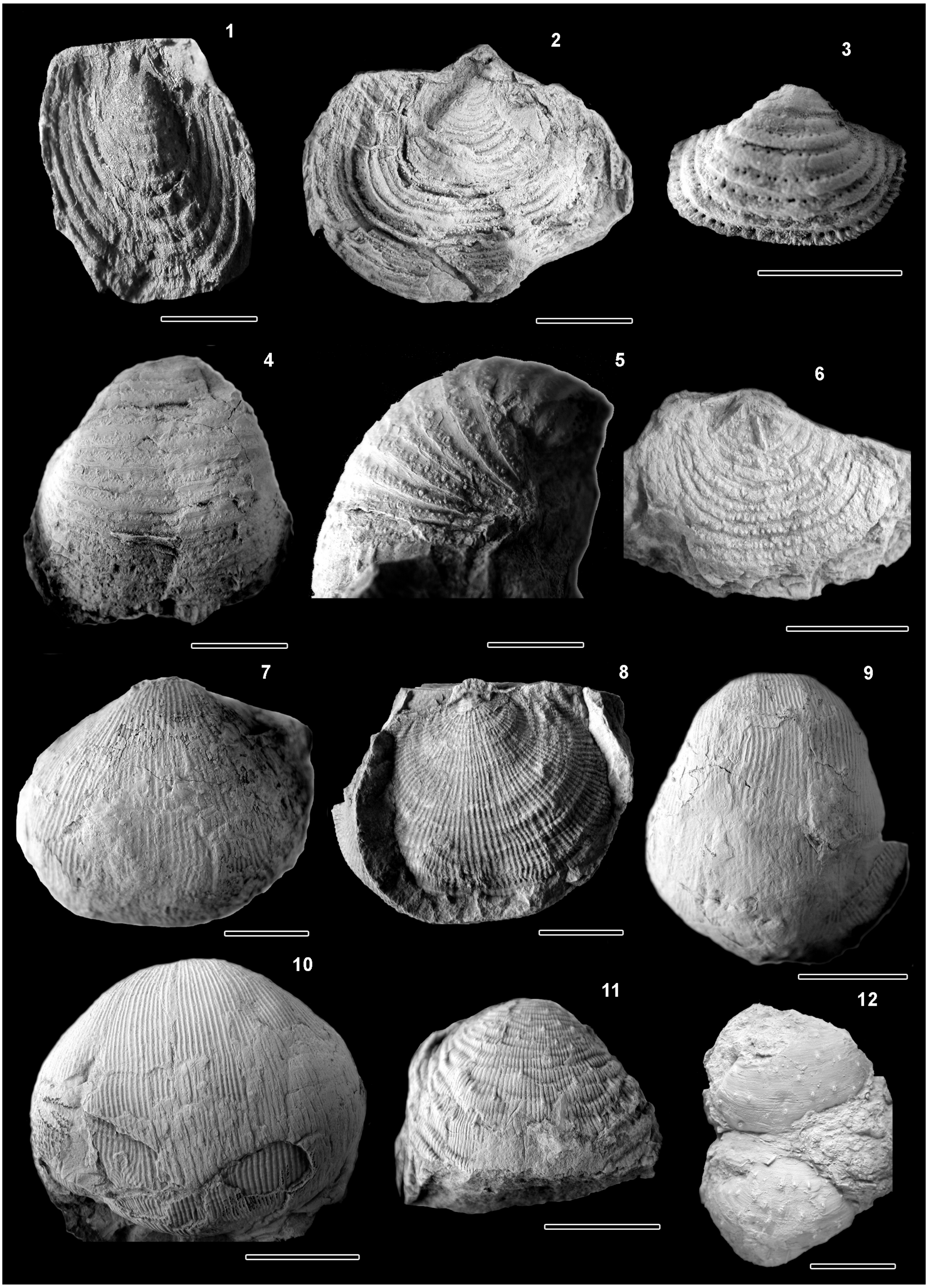

Plate 4

1. Avonia echidniformis (CHAO, 1925), exterior view of ventral valve Nagyvisnyó railway cut of 422/A, c.1369 collection of the Geological Institute of Hungary

2. *Orthotetes* cf. *radiata* (FISCHER DE WALDHEIM 1850), view of ventral valve Nagyvisnyó railway cut of 422/D, c.1385 collection of the Geological Institute of Hungary

3. *Orthotetes plana* (?) IVANOV, 1926 exterior view of ventral valve , Nagyvisnyó railway cut of 416, c.1712 collection of the Geological Institute of Hungary

4. *Derbyia* cf. *multicostellata* GAURI,1965 exterior mold of dorsal valve , Nagyvisnyó railway cut of 416, c.1978 collection of the Geological Institute of Hungary

5. *Drahanorhynchus* (?) sp. exterior mold of dorsal valve , Nagyvisnyó railway cut of 422/D, c.1497 collection of the Geological Institute of Hungary

6. *Rhipidomella* sp. interior mold of dorsal valve , Nagyvisnyó railway cut of 422/C, c.1369 collection of the Geological Institute of Hungary

7. *Parenteletes* sp. anterior view, Nagyvisnyó railway cut of 422/C, c.1939 collection of the Geological Institute of Hungary

8. *Stenoscisma* sp. exterior view of ventral valve, Nagyvisnyó railway cut of 422/D, c.1383 collection of the Geological Institute of Hungary

9. *Stenoscisma* sp. interior view of ventral valve fragment, Nagyvisnyó railway cut of 422/D, collection of Author

Plate 4