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authors are to be cited with initials following the family name.

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Cícha I. & Seneš J., 1971: Probleme der Beziehung zwischen Bio- und Chronostratigraphie des jungeren Tertiärs. Geol. Zbor. (Bratislava), 56, 2, 529 - 640.

Matula M., 1969: Regional engineering geology of Czechoslovak Carpathians. 1. Ed. Mahel', M., Bratislava, Vyd. Slov. Akad. Vied, 225 p.

Andrusov D., Bystrický J. & Fusán O., 1973: Outline of the Structure of the West Carpathians. Guide-book for geol. exc. X. Congr. CBGA, Geol. Úst. D. Štúra, Bratislava, 5 - 44.

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Ecologic evaluation of malacofauna from the middle terraces loess cover, southern part of the Nitra hilly land.

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Abstract. The paper is dealing with ecologic evaluation of mollusc fauna recovered by some boreholes in the southern part of the Nitra hilly land. In most of the boreholes we found a typical fauna of so called swamp loess represented by a great amount of water species. The studied mollusc assemblages of the southern part of the Nitra hilly land resemble lowland steppes assemblages.

Key words: Quaternary, Pleistocene, Holocene, boreholes, gastropoda, bivalvia, ecology

Introduction

From the geomorphological viewpoint the studied area, located in the southern part of the Nitra hilly land, belongs to the two morphologically conspicuous regions (Košťálik 1974) as follows:

a) - alluvial plain extending from the Danube lowland along Nitra and Váh rivers. The alluvial plain is slightly undulated and it is restricted by a line Soporka - Trnovec nad Váhom - Nové Zámky.

b) - table lowered by an erosion. It is characterized by a higher relief energy, preserved system of eolic dunes as well as a conspicuous erosive escarpment along the line Šintava - Pata - Sládečkovo - Mojmírovce - Komjatice. In the studied area several boreholes (PZ-4 - Ľudovitov, PZ-5 - Malé Čiky (M. Čiky), PZ-7 - Kopec, PZ-9 - Nový Svet, PJ-6 - Kesovský Pereš and PJ-7 - Poľný Kesov) were situated by mapping geologist Dr. Pristaš.

The geological structure of the studied area consists mainly of Pliocene (limnic-fluvial deposits) and Pleistocene deposits as blown sands, loess and loess-like loams, which mask the system of river terraces.

Lithology of described boreholes

The lithology of boreholes described is characterize by a correlation scheme of loess covering middle terraces of the southern part of the Nitra hilly land on Fig. 1.

Systematic overview of identified mollusc fauna

Class: *GASTROPODA*
Subclass: *PROSOBRANCHIA*

Order: *ARCHAEOGASTROPODA*
Family: *VALVATIDAE*
Genus: *Valvata* Müller, 1774 Jurassic - Recent

Valvata cristata Müller, 1774

1952 *Valvata (Valvata) cristata* (Müller) - Žadin: p. 215, fig. 133
1964 *Valvata (Valvata) cristata* (Müller) - Ložek: p. 159, pl. I/9abc
1994 *Valvata cristata* (Müller) - Skompski - Makowska: p. 50, pl. 29/5

Valvata piscinalis (Müller, 1774)

1952 *Valvata (Cincinna) piscinalis* (Müller) - Žadin: p. 212, fig. 129
1964 *Valvata (Cincinna) piscinalis* (Müller) - Ložek: p. 159, pl. I/1abc, 2abc

Valvata pulchella (Studer, 1820)

1952 *Valvata (Tropidina) pulchella* (Studer) - Žadin: p. 214, fig. 132
1964 *Valvata (Cincinna) pulchella* (Studer) - Ložek: p. 160, fig. 23
1994 *Valvata pulchella* (Studer) - Skompski - Makowska: p. 51, pl. 31/1

Family: *HYDROBIIDAE*
Genus: *LITHOGLYPHUS* Hartmann, 1821
Pliocene - Recent

Lithoglyphus naticoides (Pfeiffer, 1828)

1952 *Lithoglyphus naticoides* (Pfeiffer) - Žadin: p. 238, fig. 171

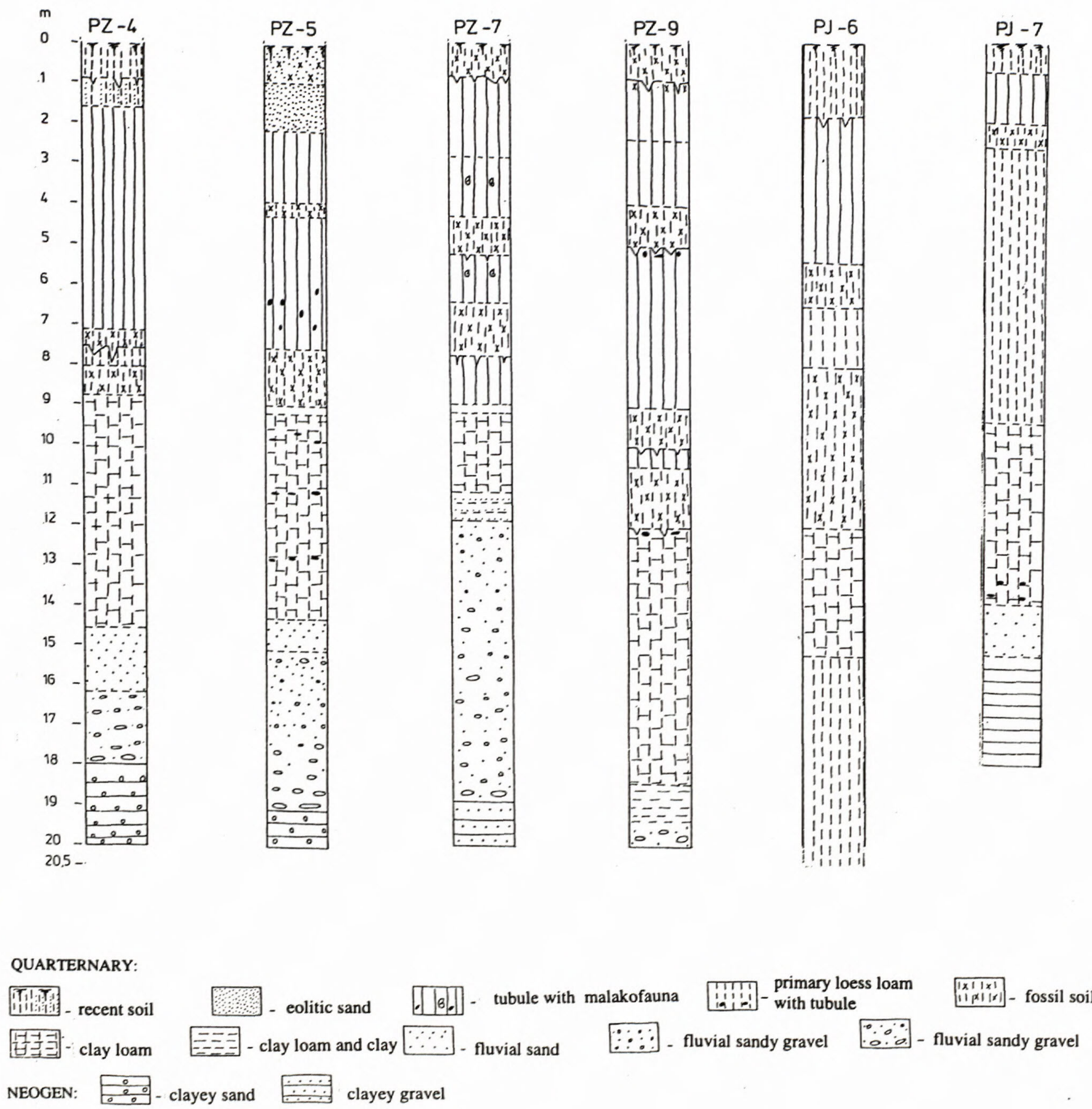

Fig. 1 Correlation scheme of loess blanket of middle terraces on the southern part of the Nitra hilly land (J. Pristaš, 1996)

1964 *Lithoglyphus naticoides* (Pfeiffer)- Ložek: p.165 pl. I/3ab
1994 *Lithoglyphus naticoides* (Pfeiffer) - Skompski - Makowska: p. 54, pl. 31/2

Family: *BITHYNIIDAE*
Genus: *Bithynia* Leach, 1818 Paleocene - Recent

Bithynia tentaculata **(Linne, 1758)**

1952 *Bithynia tentaculata* (Linné) - Žadin: p. 246, fig. 184
1964 *Bithynia (Bithynia) tentaculata* (Linné) - Ložek: p. 166, pl. I/7
1994 *Bithynia tentaculata* (Linné) - Skompski - Makowska: p. 54, pl. 30/4

Family: *THIARIDAE*
Genus: *Fagotia* Boerguignat, 1884 Lower Pliocene - Recent

Fagotia **sp.**

Subclass: *EUTHYNEURA*
Order: *BASOMMATOPHORA*
Family: *CARYCHIIDAE*
Genus: *Carychium* Müller, 1774 Paleocene - Recent

***Carychium tridentatum* (Risso, 1826)**

1964 *Carychium tridentatum* (Risso) - Ložek: p.171, pl.VI/2
1994 *Carychium tridentatum* (Risso) - Skompski - Makowska: p. 57, pl. 33/7

Family: *PHYSIDAE*
Genus: *Aplexa* Fleming, 1820 Jurassic - Recent

***Aplexa hypnorum* (Linne, 1758)**

1964 *Aplexa hypnorum* (Linné) - Ložek: p. 172, pl. III/1
1994 *Aplexa hypnorum* (Linné) - Skomski - Makowska: p. 58, pl.31/4

Genus: *Physa* Draparnaud, 1801

***Physa fontinalis** (Linne, 1758)*

1952 *Physa fontinalis* (Linné) - Žadin: p.178, fig. 81
1964 *Physa fontinalis* (Linné) - Ložek: p. 173, pl. III/2

Family: *LYMNAEIDAE*
Genus: *Lymnaea* Lamarck, 1799

***Lymnaea palustris* (Müller, 1774)**

1952 *Galba palustris* (Müller) - Žadin: p.173, fig.72
1964 *Lymnaea (Galba) palustris* (Müller) - Ložek: p. 175, pl. III/4, 6

***Lymnaea peregra peregra* (Müller, 1774)**

1964 *Lymnaea peregra peregra* (Müller) - Ložek: p. 177, pl. III/5

Family: *PLANORBIDAE*
Genus: *Planorbarius* Froriep,1806

***Planorbarius corneus* (Linne, 1758)**

1952 *Coretus corneus* (Linné) - Žadin: p.183, fig.86
1964 *Planorbarius corneus* (Linné) - Ložek: p. 180, fig. 31
1994 *Planorbarius corneus* (Linné) - Skompski - Makowska: p. 59, pl. 34/3

Genus: *Planorbis* Müller, 1774

***Planorbis planorbis* (Linne, 1758)**

1952 *Planorbis planorbis* (Linné) - Žadin: p.182, fig. 85
1964 *Planorbis planorbis* (Linné) - Ložek: p. 181, pl. IV/1abc
1994 *Planorbis planorbis* (Linné) - Skompski - Makowska: p. 60, pl. 35/5

Genus: *Anisus* Studer, 1820 Miocene (Paleocene?) - Recent

***Anisus spirorbis* (Linne, 1758)**

1952 *Anisus (Anisus) spirorbis* (Linné) - Žadin: p. 185, fig. 90
1964 *Anisus (Anisus) spirorbis* (Linné) - Ložek: p. 183, fig.33
1994 *Anisus spirorbis* (Linné) - Skompski - Makowska: p. 60, pl. 35/2

***Anisus vortex* (Linne, 1758)**

1952 *Anisus (Spiralina) vortex* (Linné) - Žadin: p.184, fig.88
1964 *Anisus (Disculifer) vortex* (Linné) - Ložek: p. 184, pl. IV/4abc
1994 *Anisus vortex* (Linné) - Skompski - Makowska: p. 61, pl. 36/2

***Anisus vorticulus* (Troschel, 1834)**

1952 *Anisus (Spiralina) vorticulus* (Troschel) - Žadin: p. 185, fig. 89
1964 *Anisus (Disculifer) vorticulus* (Troschel) - Ložek: p. 185, pl. IV/5abc
1994 *Anisus vorticulus* (Troschel) - Skompski - Makowska: p. 61, pl. 36/3

Genus: *Gyraulus* Charpentiert, 1837 Eocene - Recent

***Gyraulus albus* (Müller, 1774)**

1952 *Gyraulus albus* (Müller) - Žadin: p.188, fig. 94
1964 *Gyraulus albus* (Müller) - Ložek: p. 187, pl. V/1abc
1994 *Gyraulus albus* (Müller) - Skompski - Makowska: p. 62, pl. 37/2

***Gyraulus laevis* (Alder, 1838)**

1952 *Gyraulus laevis* (Alder) - Žadin: p. 191, fig. 100
1964 *Gyraulus laevis* (Alder) - Ložek: p.188, pl.V/2abc
1994 *Gyraulus laevis* (Alder) - Skompski - Makowska: p. 62, pl. 38/1

***Gyraulus acronicus* (Ferusac, 1807)**

1964 *Gyraulus acronicus* (Ferussac) - Ložek: p.188

Genus: *Bathyomphalus* Charpentier, 1837 Miocene - Recent

***Bathyomphalus contortus* (Linne, 1758)**

1952 *Anisus (Bathyomphalus) contortus* (Linné) - Žadin: p. 187, fig. 93
1964 *Bathyomphalus contortus* (Linné) - Ložek: p. 185, pl. IV/6abc

Genus: *Armiger* Hartmmann, 1843 Miocene - Recent

***Armiger crista cristatus* (Draparnaud, 1805)**

1964 *Armiger crista cristatus* (Draparnaud) - Ložek: p. 189

Armiger crista nautileus (Linne, 1758)

1964 *Armiger crista nnautileus* (Linné) - Ložek:p.189

Genus: *Segmentina* Fleming, 1818 Oligocene - Recent

***Segmentina nitida* (Muller, 1774)**

1952 *Segmentina nitida* (Müller) - Žadin: p. 193, fig. 103
1964 *Segmentina nitida* (Müller) - Ložek: p. 190, pl. V/3abc
1994 *Segmentina nitida* (Müller) - Skompski - Makowska: p. 63, pl.39/1

Order: *STYLOMMATOPHORA*
Family: *COCHLICOPIDAE*
Genus: *Cochlicopa* Risso, 1826 Paleocene - Recent

***Cochlicopa lubrica* Müller, 1774**

1956 *Cochlicopa lubrica* (Müller) - Ložek: p.84, pl. II/3
1964 *Cochlicopa lubrica* (Müller) - Ložek: p. 193, pl. V/7,8
1983 *Cochlicopa lubrica* (Müller) - Kerney - Cameron-Jungbluth: p. 84

***Cochlicopa lubricella* (Porro,1838)**

1964 *Cochlicopa lubricella* (Porro) - Ložek: p.194, pl.V/6
1994 *Cochlicopa lubricella* (Porro) - Skompski - Makovska: p. 64, pl. 39/4

Family: *VERTIGINIDAE*
Genus: *Collumela* Westerlund, 1878 Pleistocene - Recent

***Columella collumela* Martens, 1830**

1956 *Columella edentula columella* (Martens) - Ložek: p. 98, pl. V/2
1964 *Columella columella* (Martens) - Ložek: p.198, pl.VI/3
1983 *Columella columella* (Martens) - Kerney - Cameron-Jungbluth: p. 87
1994 *Columella columella* (Martens) - Skompski - Makowska: p. 64, pl. 39/6

Genus: *Vertigo* Muller, 1774 Paleocene - Recent

***Vertigo antivertigo* (Draparnaud,1801)**

1964 *Vertigo (Vertigo) antivertigo* (Draparnaud) - Ložek: p. 202, pl. VII/1
1994 *Vertigo antivertigo* (Draparnaud) - Skompski - Makowska: p. 65, pl. 40/1

***Vertigo pygmaea* Draparnaud,1801**

1956 *Vertigo pygmaea* (Draparnaud) - Ložek: p. 93, pl. IV/5
1964 *Vertigo (V.) pygmaea* (Draparnaud) - Ložek: p. 203, pl. VII/3
1983 *Vertigo (V.) pygmaea* (Draparnaud) - Kerney - Cameron - Jungbluth: p. 92

***Vertigo genesis* (Gredler, 1856)**

1964 *Vertigo genesis* (Gredler) - Ložek: p. 206, pl. VII/8
1983 *Vertigo (V.) genesii* (Gredler) - Kerney - Cameron - Jungbluth: p. 94

***Vertigo parcedentata* (Braun, 1847)**

1964 *Vertigo parcedentata* (Braun) - Ložek: p. 206, pl.VII/8
1994 *Vertigo parcedentata* (Braun) - Skompski - Makowska: p. 66, pl. 40/2

***Vertigo geyeri* Lindholm, 1925**

1983 *Vertigo (V.) geyeri* (Lindholm) - Kerney - Cameron - Jungbluth: p. 95

Family: *CHONDRINIDAE*
Genus: *Granaria* Turton, 1831 Eocene - Recent

***Granaria frumentum* (Draparnaud, 1801)**

1964 *Abida frumentum* (Draparnaud) -Ložek:p.211,pl. VIII/7
1983 *Granaria frumentum* (Draparnaud) - Kerney - Cameron - Jungbluth: p. 107

Family: *PUPILLIDAE*
Genus: *Pupilla* Fleming, 1828 Oligocene - Recent

***Pupilla triplicata* Studer, 1820**

1956 *Pupilla triplicata* (Studer) -Ložek: p. 102
1964 *Pupilla triplicata* (Studer) - Ložek: p. 244, pl. IX/5,6

***Pupilla muscorum* Linne, 1758**

1956 *Pupilla muscorum* (Linné) - Ložek: p. 99, pl. VI/1
1964 *Pupilla muscorum* (Linné) - Ložek: p. 215, pl. IX/1,7
1983 *Pupilla (Pupilla) muscorum* (Linné) - Kerney - Cameron - Jungbluth: p. 118
1994 *Pupilla muscorum* (Linné) - Skompski - Makowska: p. 66, pl. 40/2

***Pupilla sterri* Voith,1838**

1956 *Pupilla sterri* (Voith) - Ložek: p. 101, pl. VI/3
1964 *Pupilla sterri* (Voith) - Ložek: p.216, pl. IX/2
1983 *Pupilla (Pupilla) sterri* (Voith) - Kerney - Cameron - Jungbluth: p. 120

***Pupilla loessica* Ložek, 1954**

1964 *Pupilla loessica* (Ložek) - Ložek: p. 277, pl. IX/3
1994 *Pupilla loessica* (Ložek) - Skompski - Makowska: p. 67, pl. 40/5

***Pupilla muscorum densegyrata* Ložek, 1954**

1955 *Pupilla muscorum densegyrata* (Ložek) - Ložek: p. 401, pl. II/1, 2
1964 *Pupilla muscorum densegyrata* (Ložek) - Ložek: p . 216, pl.IX/4

***Pupilla* sp.**

Family: *VALLONIIDAE*
Genus: *Vallonia* Risso,1826 Paleocene - Recent

Vallonia pulchella **Müller, 1774**

1955 *Vallonia pulchella* (Müller) - Ložek: p.108, pl.8/3
1964 *Vallonia pulchella* (Müller) - Ložek: p.221, pl.X/5a,b,c
1983 *Vallonia pulchella* (Müller) - Kerney - Cameron- Jungbluth: p.127
1994 *Vallonia pulchella* (Müller) - Skompski - Makowska : p. 67, pl. 41/

Vallonia enniensis (Gredler, 1856)

1964 *Vallonia enniensis* (Gredler) - Ložek: p. 222, pl.X/2abc
1983 *Vallonia enniensis* (Gredler) - Kerney - Cameron - Jungbluth: p.127
1994 *Vallonia enniensis* (Gredler) - Skompski - Makowska: p. 68, pl. 42/1

Vallonia tenuilabris Braun, 1843

1955 *Vallonia tenuilabris* (Braun) - Ložek: p.106
1964 *Vallonia tenuilabris* (Braun) - Ložek: p. 223, pl. X/1a,b,c
1994 *Vallonia tenuilabris* (Braun) - Skompski - Makowska: p. 68, pl. 42/2

Family: *ENIDAE*
Genus: *Chondrula* Beck, 1837 Pliocene - Recent

Chondrula tridens **Müller, 1774**

1955 *Chondrula tridens* (Müller) - Ložek: p. 114, fig. 29, pl. 10/3
1964 *Chondrula tridens* (Müller) - Ložek: p. 225, fig. 41
1983 *Chondrula (Chondrula) tridens* (Muller) - Kerney - Cameron - Jungbluth: p. 133
1994 *Chondrula tridens* (Müller) - Skompski - Makowska: p. 68, pl. 40/3

Family: *SUCCINEIDAE*
Genus: *Succinea* Draparnaud, 1801 Paleocene-Recent

Succinea putris **(Linne, 1758)**

1964 *Succinea (S.) putris* (Linné) - Ložek: p. 229, pl. XII/1,2
1994 *Succinea putris* (Linné) - Skompski - Makowska: p. 69, pl. 40/6

Succinea oblonga **Draparnaud, 1801**

1955 *Succinea (Succinella) oblonga* (Draparnaud) - Ložek: p. 83, pl. II/2
1964 *Succinea (Succinella) oblonga* (Draparnaud) - Ložek: p. 230, pl. 12/7,8,9
1983 *Succinea (S.) oblonga* (Draparnaud) - Kerney - Cameron - Jungbluth: p. 79
1994 *Succinea oblonga* (Draparnaud) - Skompski - Makowska: p. 69, pl. 40/8

Family *ZONITIDAE*
Genus: *Nesovitrea* Cooke, 1921

Nesovitrea hammonis **Ström, 1765**

1955 *Perpolita radiatula* (Alder) - Ložek: p. 151, pl. 1 19/1
1964 *Perpolita radiatula* (Alder) - Ložek: p. 243, pl. 19/3a, b, c
1983 *Nesovitrea hammonis* (Ström) - Kerney - Cameron-Jungbluth: p.168
1994 *Nesovitrea hammonis* (Ström) - Skompski - Makowska: p. 70, pl. 43/1

Family: *LIMACIDAE/ AGRIOLIMACIDAE*

Family: *BRADYBAENIDAE*
Genus: *Bradybaena* Beck,1837 Upper Pliocene - Recent

Bradybaena fruticum **(Müller, 1774)**

1964 *Bradybaena fruticum* (Müller) - Ložek: p. 284, pl. XXII/1abc, XXX/3
1983 *Bradybaena (B.) fruticum* (Müller) - Kerney - Cameron - Jungbluth: p. 242
1994 *Bradybaena fruticum* (Müller) - Skompski - Makowska: p. 73, pl. 44/2

Family: *HELICIDAE*
Genus: *Helicopsis* Titzinger, 1833

Helicopsis striata **Müller, 1774**

1955 *Helicella (Helicopsis) striata* (Müller) - Ložek: p. 195, pl. 30/1
1964 *Helicopsis striata* (Müller) - Ložek: p.289, pl.22/2a,b,c
1983 *Helicella (Helicopsis) striata* (Müller) - Kerney - Cameron - Jungbluth: p. 242

Genus: *Perforatella* Schluter, 1838 Pleistocene - Recent

Perforatella rubiginosa **Schmidt,1853**

1955 *Monachoides rubiginosa* (Schmidt) - Ložek: p. 209, pl. 34/1, 2
1964 *Monachoides rubiginosa* (Schmuidt) - Ložek: p. 289, pl. 22/2a, b, c
1983 *Perforatella (P.) rubiginosa* (Schmidt) - Kerney - Cameron- Jungbluth: p.259
1994 *Perforatella rubiginosa* (Schmidt) - Skompski - Makowska: p. 73, pl. 45/1

Genus: *Trichia* Hartmann, 1840 Paleogene - Recent

Trichia hispida **Linne, 1758**

1955 *Trichia hispida* (Linné) - Ložek: p. 208, pl. 32/3
1964 *Trichia (Trichia) hispida* (Linné) - Ložek: p. 300, pl. 25/1a, b, c
1983 *Trichia (Trichia) hispida* (Linné) - Kerney - Cameron-Jungbluth: p. 261
1994 *Trichia hispida* (Linné) - Skompski - Makowska: p. 74, pl. 44/3

Genus: *Arianta* Turton, 1831 Late Pliocene - Recent

Arianta arbustorum **Linne, 1758**

1955 *Arianta arbustorum* (Linné) - Ložek: p. 221, pl. 37/2

1964 *Arianta arbustorum* (Linné) - Ložek: p. 309, pl. 30/5
1983 *Arianta arbustorum* (Linné) - Kerney - Cameron- Jungbluth: p. 272

Class: *BIVALVIA*
Order: *EULAMELLIBRANCHIATA*
Family: *PISIDIDAE*
Genus: *Pisidium* Pfeiffer, 1821 Tertiary - Recent

Pisidium personatum Malm, 1855

1964 *Pisidium (Rivulina) personatum* (Malm) - Ložek: p. 329

Pisidium obtusale (Lamarck, 1818)

1952 *Pisidium (Eupisidium) obtusale* (Lamarck) - Žadin: p. 334, fig. 294/5, 303
1964 *Pisidium (Rivulina) obtusale* (Lamarck) - Ložek: p. 330, pl. XXXII/5abcd, 6ab
1994 *Pisidium obtusale* (Lamarck) - Skompski - Makowska: p. 45, pl. 25/3

Pisidium sp.

Quantitative - qualitative analysis of the studied fauna

1. Borehole PZ - 4 (Ľudovítov)

More than 332 pieces of fossil mollusc were identified from both samples of the borehole. The mollusc belongs to 15 Families and 26 Taxons (Tab. 1).

2. Borehole PZ - 5 (M. Čiky)

From seven samples of the borehole PZ - 5 more than 1134 fossil mollluscs assigned to 15 Families and 35 varios Taxons were identified. (Tab. 2).

3. Borehole PZ - 7 (Kopec)

From nine samples of the borehole PZ - 7 more than 1155 fosil molluscs assigned to the 17 Families and 44 various Taxons. (Tab. 3).

4. Borehole PZ - 9 (Nový svet)

More than 62 fosil mollusc assigned to the 6 Families and 9 various Taxons were identified from the borehole PZ - 9. (Tab. 4).

Tab. 1. The frequency of individual Taxons and their ecological characteristics in the borehole PZ-4

Main ecological groups	Ecological characteristics	Biostratigraphic date	Species	3,0 - 3,1 (m)	4,6 - 5,0 (m)	Sum
A	L(S)	!	*1. Bradybaena fruticum*		Ú	Ú
	L(M)	(+)	*2. Arianta arbustorum*		Ú	Ú
B	O	(G)	*3. Vertigo pygmaea*		5	5
	O	+	*4. Pupilla muscorum*		3	3
	S	+	*5. Pupilla sterri*		Ú	Ú
	O	++	*6. Pupilla muscorum densegyrata*		5	5
	O	G	*7. Valonia pulchela*		22	22
	O	++	*8. Vallonia tenuilabris*	5	3	8
	S	+	*9. Helicopsis striata*		2	2
C	VS	!	*10. Carychium tridentatum*		2	2
	VS	+	*11. Succinea oblonga*	11	48	59
	M	+	*12. Trichia hispida*		14	14
	M	(+)	*13. Nesovitrea hammonis*		7	7
	M	(+)	*14. Limacidae/Agriolimacidae*		18	18
D	B	(+)	*15. Succinea putris*	2	33	35
	B		*16. Vertigo geyeri*		2	2
	H		*17. Lymnaea peregra peregra*		16	16
	H		*18. Physa fontinalis*		2	2
	H		*19. Planorbarius corneus*	1j		1
	H		*20. Planorbis planorbis*		1	1
	H		*21. Gyraulus laevis*		45	45
	H		*22. Gyraulus laevis*	2j	66	68
	H		*23. Bythynia tentaculata-viečka*	2		2
	H		*24. Valvata pulchella*		3	3
	H		*25. Pisidium obtusale*		6	6
	H		*26. Pisidium personatum*		8	8
			Sum	23	309	332+Ú

Tab. 2 The frequency of individual Taxons and their ecological characteristics in the borehole PZ-5

				1	3	4	5	6	7	11	
Main ecological groups	Ecological characteristics	Biostratigraphic date	Species	2,1 - 3,1 (m)	4,7 - 5,3	5,3 - 6,1	6,1 - 6,9	7,7 - 8,0	8,0 - 8,8	13,0 - 13,2	Sum
A	L(S)	!	*1. Bradybaena fruticus*		Ú						Ú
	L(M)	(+)	*2. Arianta arbustorum*		Ú	Ú		Ú			Ú
	O	++	*3. Columella columella*	17	4						21
	O	(G)	*4. Vertigo pygmaea*			10	13	2	3		28
	O	+	*5. Pupilla muscorum*			8	8	2			18
	S	+	*6. Pupilla triplicata*			2					2
B	S	+	*7. Pupilla sterri*			3					3
	O	++	*8. Pupilla muscorum densegyrata*	9	11	11	21	4	2		58
	O	++	*9. Pupilla loessica*			2	3	2			7
	O	G	*10. Vallonia pulchella*		4	60	80	20		2	166
	O	++	*11. Vallonia tenuilabris*	6			2	1			9
	O	(+)	*12. Vallonia costata*			23	15	2	7		47
	S	+	*13. Helicopsis striata*			1					1
	M		*14. Vallonia enniensis*			2	25	6	2		35
	VS	+	*15. Succinea oblonga*	50	13	80	45	25	28	30	271
C	M	(+)	*16. Cochlicopa lubrica*			4			2		6
	M	+	*17. Trichia hispida*	5		21	20	10	13	1	70
	M	(+)	*18. Nesovitrea hammonis*				4	2	2	2	10
	M	(+)	*19. Limicidael/ Agriolimicidae*			29				6	35
	B	(+)	*20. Succinea putris*	9						7	16
	B		*21. Vertigo genesii*	5							5
	H		*22. Lymnaea peregra peregra*	12	1j	1	1j			4	19
	H		*23. Planorbarius corneus*							1j	1
	H		*24. Anisus vortex*	14							14
	H		*25. Anisus spirorbis*	10		13	55	14	10	40	142
	H		*26. Gyraulus laevis*		2						2
D	H		*27. Gyraulus albus*							35	35
	H		*28. Armiger crista cristatus*	1							1
	H		*29. Lithoglyphus naticoides*							2	2
	H		*30. Bythynia tentaculata -viečka*	5			1			22	28
	H		*31. Valvata piscinalis*	7						5	12
	H		*32. Valvata pulchella*	1			2			35	38
	H		*33. Valvata cristata*							30	30
	H		*34. Pisidium obtusale*	1							1
	H		*35. Pisidium personatum*	1							1
			Sum	135	35+Ú	270+Ú	295	90+Ú	69	222	1134+Ú

Main ecologic groups
A - forest (generally)
B - treeless land (generally)
C - forest and treeless land
D - water, bogs

Ecologic characteristics (Biotop)
1 - L(M) forest, locally also moderately wet treeles sites
2 - L(S) forest, locally also dry treeless sites
3 - S steppes, xerotermous rocks
4 - O open land
5 - XS drier forest and treeless sites
6 - M moderately or variably wet sites
7 - RL moderately wet rocks, tree trunks in forest
8 - VS more wet forest and treeless sites
9 - B banks, bogs
10 - H water environment

Biostratigraphic data
! - typical kind of warm periods
\+ - loess species
(+) - local or occasional loess species
++ - index loess species
G - species surviving glacial outside loess zone
(G) - species surviving glacial outside loess zone as a relic
j - juvenil individual
Ú - fragments

Tab. 3. The grequency of individual Taxons and their ecological characteristics in the borehole PZ-9

Main ecological characteristics	Ecological characteristics	Biostratigraphic date	Species	0,6 - 0,8 (m)	1,0 - 1,4	1,8 - 2,0	2,6 - 2,7	3,0 - 3,4	4,0 - 4,4	5,0 - 5,4	5,6 - 6,0	6,5 - 6,9	Sum
A	L(S)	!	*1. Bradybaena fruticum*				Ú						Ú
	XS	!	*2. Cochlicopa lubricella*					1					1
	O	++	*3. Columella columella*				1						1
	O	(G)	*4. Vertigo pygmaea*				1	11	4		12	2	30
	O	+	*5. Vertigo parcendentata*					1					1
	S		*6. Granaria frumentum*									Ú	Ú
	O	+	*7. Pupilla muscorum*					3					3
B	S	+	*8. Pupilla triplicata*					3					3
	S	+	*9. Pupilla sterri*		2								2
	O	++	*10. Pupilla muscorum densegyrata*				7	9	6	12		1	35
	O	++	*11. Pupilla loessica*					12		5			17
			12. Pupilla sp.		Ú								Ú
	O	G	*13. Vallonia pulchella*				1	13	2		15	5	36
	O	++	*14. Vallonia tenuilabris*		1		Ú	1					2+Ú
	S	(+)	*15. Chondrula tridens*									Ú	Ú
	VS	+	*16. Succinea oblonga*	1			4	20	4	52		5	86
C	M	(+)	*17. Cochlicopa lubrica*							1		Ú	1+Ú
	M	(+)	*18. Limacidae/ Agriolimacidae*	1			4		1		1		7
	B	(+)	*19. Succine putris*	1			5	30	40	15	8		99
	B		*20. Vertigo antivertigo*					1	1				2
	B		*21. Vertigo genesii*					2				2	4
	B		*22. Perforatella rubiginosa*		Ú	1		1			1		3+Ú
	H		*23. Lymnaea peregra peregra*				5	30	14	12	2	1	64
	H		*24. Lymnaea palustris*					1					1
	H		*25. Aplexa hypnorum*					1					1
	H		*26. Planorbarius corneus*						7				7
	H		*27. Planorbis planorbis*					10	Ú	23			33+Ú
	H		*28. Anisus vortex*					7			2		9
	H		*29. Anisus vorticulus*							2			2
	H		*30. Anisus spirorbis*				10	110	19	80	50	18	287
D	H		*31. Gyraulus laevis*				8	22	39	5			74
	H		*32. Gyraulus acronicus*					30					30
	H		*33. Gyraulus albus*									1	1
	H		*34. Bathyomphalus contortus*					2		2			4
	H		*35. Armiger crista cristatus*					10	2				12
	H		*36. Armiger crista nautileus*					1	2				3
	H		*37. Segmentina nitida*					2					2
	H		*38. Bithynia tentaculata viečka*				14	20	30		2		66
			39. Fagotia sp.				Ú						Ú
	H		*40. Valvata piscinalis*				1	11	8	5	Ú		25+Ú
	H		*41. Valvata pulchella*				16	89	52	22	7		186
	H		*42. Valvata cristata*						4				4
	H		*43. Pisidium obtusale*				1		5	1			7
	H		*44. Pisidium sp.*				Ú	4					4+Ú
			Spolu	3	3+Ú	1	78+Ú	458	240+Ú	235	100+Ú	35+Ú	1156+Ú

5. Borehole PJ-6 (Kesovský Pereš)

From the depth interval 0.0 - 10. 0 m in the borehole PJ - 6 more than 87 individuals of fossil molluscs assigned to 8 Families and 11 Taxons were identified. (Tab. 5).

6. Borehole PJ - 7 (Poľný Kesov)

From four samples of the borehole PJ - 7 518 fossil molluscs assigned to 11 Families and 26 Taxons were identified. (Tab. 6).

Tab. 4. The frequency of individual Taxons and their ecological characteristics in the borehole PZ-9

Main ecological groups	Ecological characteristics	Biostratigraphic date	Species	5,5 - 5,6 (m)	Sum
	O	+	*1. Pupilla muscorum*	3	3
	S	+	*2. Pupilla triplicata*	3	3
B	S	+	*3. Pupilla sterri*	5	5
	O	++	*4. Pupilla muscorum densegyrata*	10	10
	O	++	*5. Vallonia tenuilabris*	10	10
	S	+	*6. Helicopsis striata*	5	5
	VS	+	*7. Succinea oblonga*	22	22
C	M	(+)	*8. Cochlicopa lubrica*	Ú	Ú
	M	(+)	*9. Limacidae/ Agriolimacidae*	4	4
			Sum	62+Ú	62+Ú

Tab. 5. The frequency of individual Taxons and their ecologic chracteristics in the borehole PJ-6

Main ecological groups	Ecological characteristics	Biostratigraphic date	Species	9,0 - 10,0 (m)
	O	(G)	*1. Vertigo pygmaea*	2
	O	+	*2. Pupilla muscorum*	10
B	O	++	*3. Pupilla muscorum densegyrata*	3
	O	G	*4. Vallonia pulchella*	1
	VS	+	*5. Succinea oblonga*	20
C	M		*6. Vallonia enniensis*	3
	M	(+)	*7. Limacidae/ Agriolimacidae*	1
	H		*8. Lymnaea peregra peregra*	2
	H		*9. Anisus spirorbis*	40
D	H		*10. Gyraulus albus*	4
	H		*11. Valvata pulchella*	1
			Sum	87

Ecologic evaluation of fauna

Borehole PZ - 4 (Ľudovitov)

The species typical by higher afinity to moisture are most conspicuously represented in the borehole PZ-4 in the depth interval 3.0 - 3.1 m. These species have not unambiguous stratigraphic assignment. As shown in Tab. 1 and Chart 1, moist environments as swamps, bogs and water environment in general are most frequent. The presence of these species suggests the vicinity of a water flow during the deposition. The presence of index loess species *Vallonia tenuilabris* indicates the environment of an open land and a cool and relatively dry climate. The above mentioned characteristics suggest a steppes environment with a possible depression with shrubs nearby a water flow. The climate is cool.

The more variable association of environments is observed in depth 4.6 - 5.0 m. The species with higher afinity to a moist environment prevail again. The variability of species represented as well as their environment suggests slightly warmer and moister climatic fluctuation during some stadial. The environmental composition indicates a land as park taiga and steppes.

Borehole PZ - 5 (M. Čiky)

In the borehole PZ - 5 moister environments are present in the depth interval 2.1 - 3.1 m. The environments are probably represented by moist forest and treeless lands, swamp banks and water environment in general. The open land represented by cool fauna of Columela and Pupila is partly represented (see Tab. 2, Chart 2).

In the depth interval 4.7 - 5.3 the frequency of species characteristic for moist and water environment decreases. The species typical for an open land are more frequent. Some of species suggest forest environment and locally dry or moderately medium dry treeless land. The above mentioned finding as well as the presence of the transition type fauna suggests a warmer condition during some stadial.

In depth intervals 5.3 - 6.1 m, 6.1 - 6.9 m and 7.7 - 8.0 m variable sites are found. There is relatively equivalent frequency of an open land and steppes and moderately moist, moist and water environments. In the depth interval 8.0 - 8.8 m the moister environments indicating a warmer climatic phase prevail and the environment of an open land occurs less frequently.

In the depth interval 13.0 - 13.2 m the increasing frequency of water environment is observed and a retreat of other environments as banks and swamps, moist and moderately moist forest and treeless sites. The open land is represented only by tenth of percents in this composition. The studied sediment is clayey loam suggesting a fluvial origin. This origin is confirmed by the identified fauna. Finally it is possible to state that the land in the vicinity of the borehole was formed by a cool climate steppes typical by slightly moister and warmer climatic fluctuations. These fluctuations enabled the plant development and the change of the land character to a park taiga. The depositional environment was periodically flooded suggesting a vicinity of a water flow.

Tab. 6. The frequency of individual Taxons and their ecologic characteristics in the borehole PJ-7

Main ecological groups	Ecological characteristics	Biostratigraphic date	Species	0,8 - 1,3 (m)	1,3 - 1,5	2,6 - 3,6	6,8 - 7,9	Sumar
	O	++	*1. Columella columella*			42		42
	O	(G)	*2. Vertigo pygmaea*				4	4
	O	+	*3. Pupilla muscorum*			20	4	24
	S	+	*4. Pupilla sterri*			10	2	12
B	O	++	*5. Pupilla muscorum densegyrata*			40	10	50
	O	++	*6. Pupilla loessica*			10		10
	O	G	*7. Vallonia pulchella*				20	20
	O	++	*8. Vallonia tenuilabris*			20		20
	S	+	*9. Helicopsis striata*				3	3
	VS	+	*10. Succinea oblonga*	2	30	60	55	147
	M		*11. Vallonia enniensis*				5	5
C	M	(+)	*12. Limacidae/ Agriolimacidae*		2	1	1	4
	M	+	*13. Trichia hispida*			8	3	11
	B	(+)	*14. Succinea putris*		11			11
	H		*15. Lymnaea peregra peregra*		4		8	12
	H		*16. Anisus spirorbis*		24		65	89
	H		*17. Gyraulus laevis*				2	2
	H		*18. Gyraulus albus*		18			18
	H		*19. Armiger crista cristatus*				1	1
D	H		*20. Armiger crista nautileus*		3			3
	H		*21. Bithynia tentaculata viečka*		7		2	9
	H		*22. Valvata piscinalis*		1		1	2
	H		*23. Valvata pulchella*	1	2		9	12
	H		*24. Valvata cristata*		1			1
	H		*25. Pisidium obtusale*				1	1
	H		*26. Pisidium personatum*		5			5
			Sum	3	108	211	196	518

Borehole PZ - 7 (Kopec)

In the depth interval 0.6 - 0.8 m species with higher affinity to moisture are found. The species suggest moister forest and treeless sites, moderately or variably moist sites, swamps and banks (Tab. 3, Chart 3). The increasing frequency of the steppes and open land and a retreat of moister sites is observed in the depth interval 1.0 - 1.4 m . In the depth 1.8 - 2.0 m the water environment in general is represented by the only individual of species *Perforatella rubiginosa.* This depth interval makes a boundary between two different developments. From the interval downward the variable frequency of water environment species, species with higher moist afinity typical for banks, swamps, moderately moist and moist sites and species typical for open land occur. Only a small percentage of this variable environmental range is made by forest, steppes and drier sites. But in all samples from depth intervals 2.6 - 2.7 m, 3.0 - 3.4 m, 4.0 - 4.4 m, 5.0 - 5.4 m, 5.6 - 6.0 m, 6.0 - 6.9 m water environment prevails. The environmental and species composition of the studied fauna enables to interpret a presence of steppes land or park taiga in the vicinity of water flow with local surface depressions. This enabled the development of species with afinity to moisture. It is possible to discern at least three climatic oscillations in the whole studied profile. The samples nr. 4 - 9 from the depth interval 2.0 - 6.9 indicate a cool climate with moister and warmer oscillations. The samples from the depth interval 1.1 - 1.4 m suggest cooler and drier climatic fluctuation. In the depth interval 0,6 - 0.8 m again onset of moister and wa9rmer climatic oscillation occurs.

Borehole PZ - 9 (Nový svet)

In the borehole PZ - 9 loess species and species occasionally found in loesses occur. The species indicate following environment: open land, steppes, moist and moderately moist sites (Tab.4, Chart 4). The environmental composition of the studied fauna indicates a cool steppes during the deposition of the sediment studied. The climate is cool and relatively dry.

Borehole PJ - 6 (Kesovský Pereš)

In the borehole PJ-6 in the depth interval 9.0 - 10.0 m the species of following environment are present: open

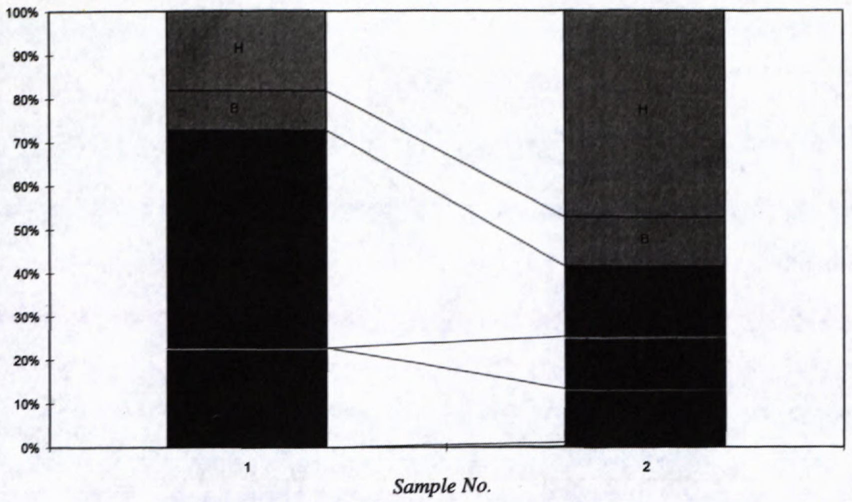

Chart 1 The frequency of Biotops in samples of the borehole PZ-4

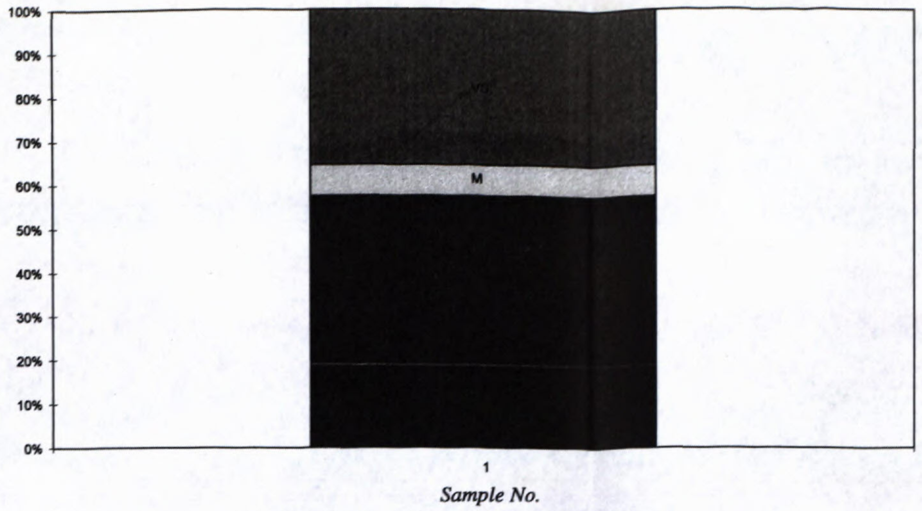

Chart 4 The frequency of Biotops in samples of the borehole PZ-9

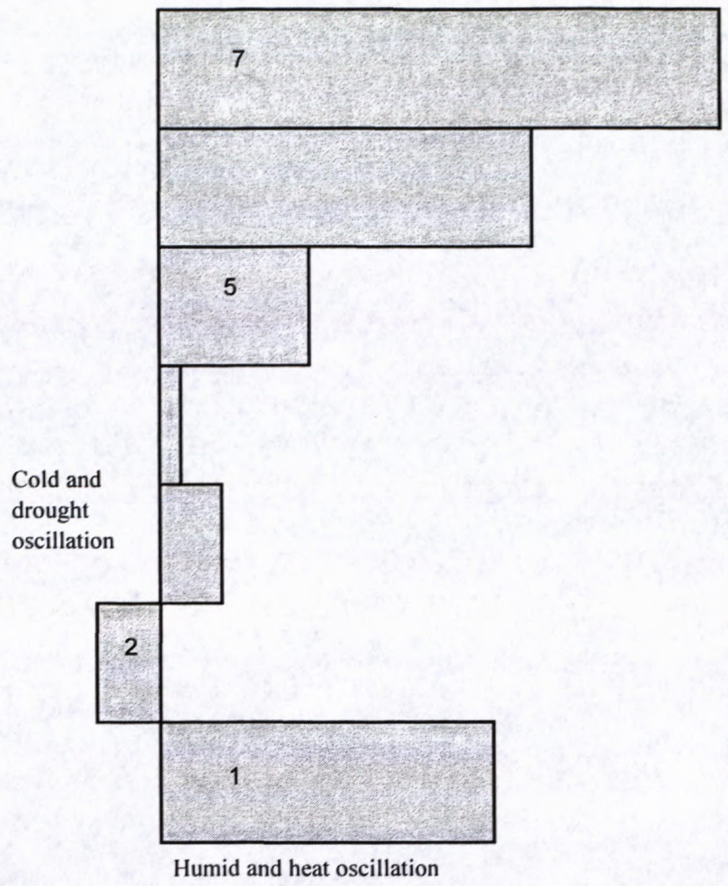

Chart 7 Climatic oscillation in the borehole PZ-5

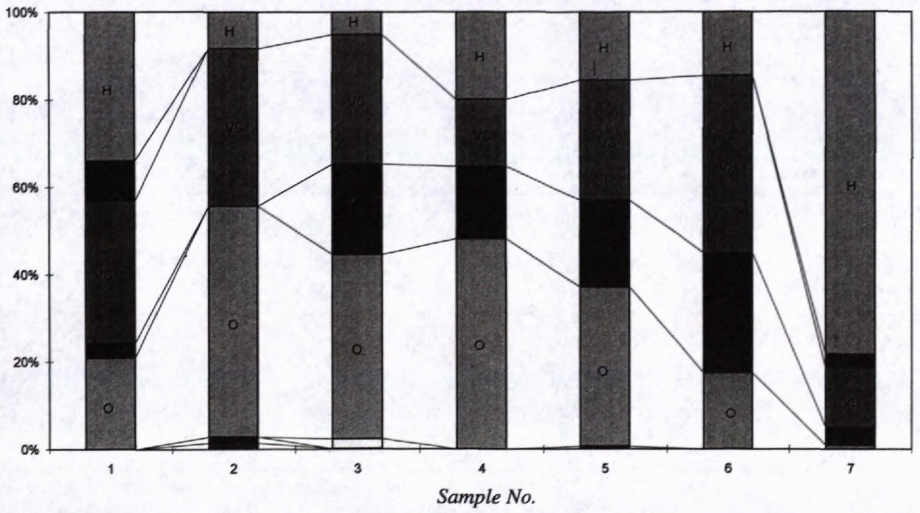

Chart 2 The frequency of Biotops in samples of the borehole PZ-5

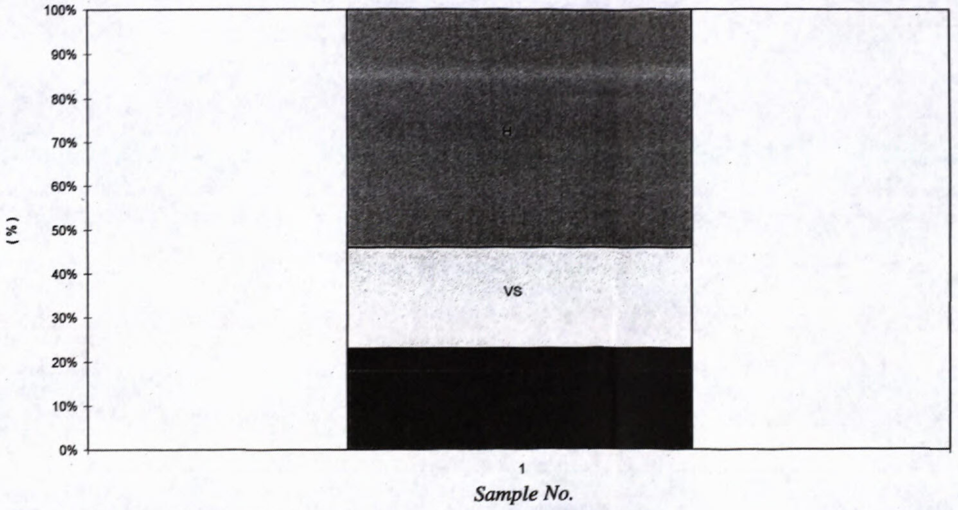

Chart 5 The frequency of Biotops in samples of the borehole PZ-6

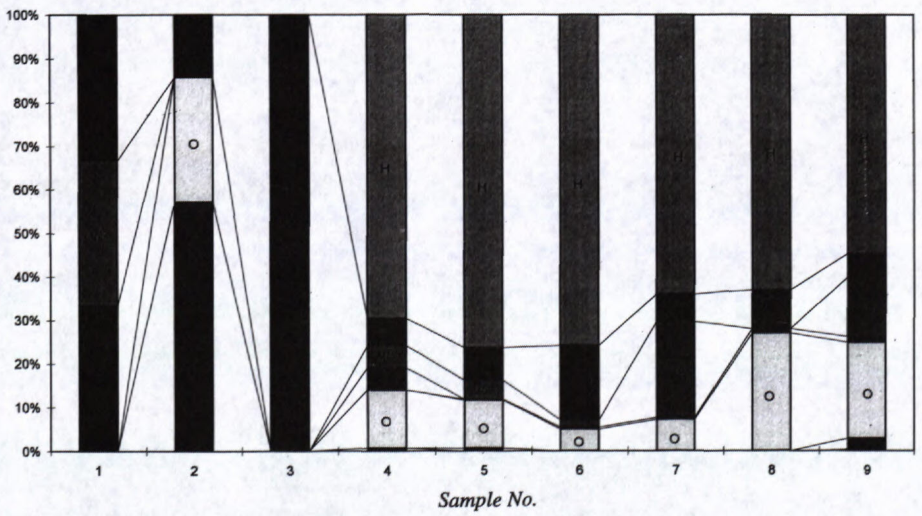

Chart 3 The frequency of Biotops in samples of the borehole PZ-7

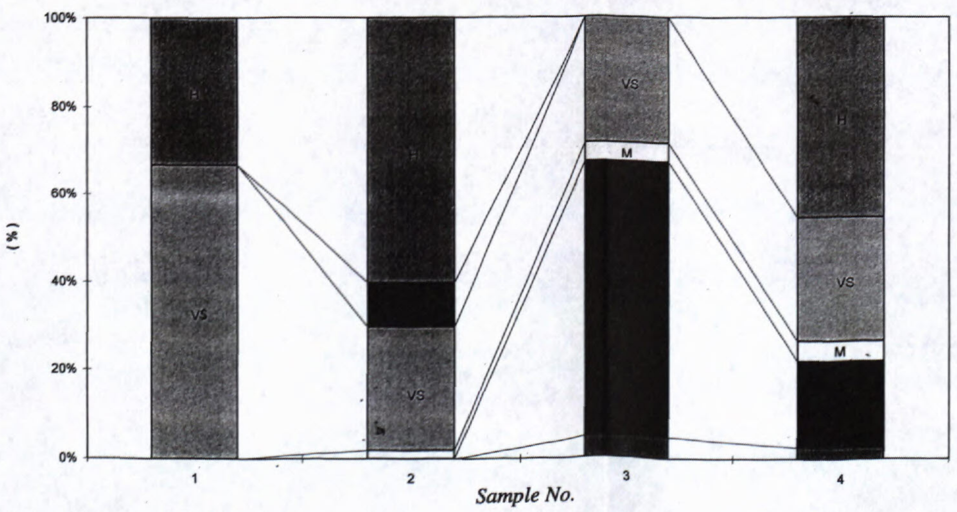

Chart 6 The frequency of Biotops in samples of the borehole PZ-7

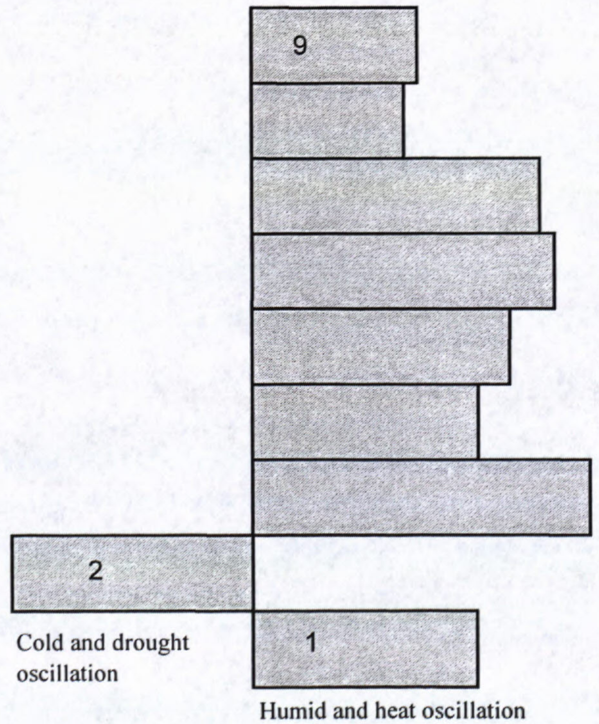

Chart 8 Climatic oscillation in the borehole PZ-7

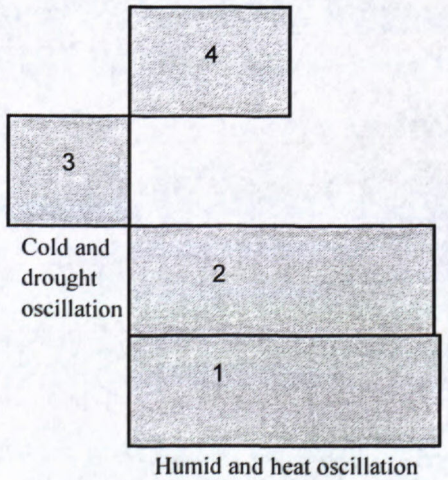

Chart 9 Climatic oscillation in the borehole PJ-7

land, moist and moderately moist sites, water environment in general. The more frequent occurrence of species with higher afinity to moisture (Tab.5, Chart 5) is also reflected in a higher extent of moister environment in the studied sample.

Environmental composition as well as species fauna composition indicate steppes with a cool climate with a possible water flow in the vicinity of the borehole.

Borehole PJ - 7 (Poľný Kesov)

In the borehole PJ - 7 only two species with higher afinity to moisture and water occur. A relation of identified species to the moister environments as swamps, bogs and water environment in general is preserved in the depth interval 1.3 - 1.5 m. The environmental composition of the sample is more variable as in the previous sample (Tab.6, Chart 6). It suggests a periodically flooded local depression watered by a flow in vicinity. This enabled the development of species assemblage typical for standing waters and periodical swamps. In the depth interval 2.6 - 3.6 m we observe an abrupt retreat of water species and species with higher afinity to moisture. Index loess species and occasional species occurring in loesses prevail in this interval, suggesting steppes and open land. This indicates an abrupt climatic change connected with a pronounce cooling and dry climate of steppes and tundra.

In the depth interval 6.8 - 7.9 fauna consisting of both terrestrial and aquaous mollusc species is identified. It suggests moderately moist and moister environment and water environment in general. In less extent steppes environment and open land is present. As to number and amount of environments, this sample is most variable.

The environmental analysis as well as species composition of fauna enabled to interpret the land during the deposition as a steppes in the vicinity of water flow. The climate is cool and interrupted by more wet climatic oscillation.

Conclusion

A detail ecological evaluation of the malacofauna and an environmental analysis of single Taxons enabled to record a climatic development of the area, especially during the Upper (Young/ Pleistocene. The analyses reflect very good local environment.

According to identified molluscs, small climatic oscillations directed toward inrease of humidity and temperature occur also in cool periods of stadials and vice versa (Charts 7, 8 and 9). The presence of a great amount of species with afinity to water is not only connected with climatic oscillations but it is also connected with the vicinity of two big rivers, Nitra and Váh rivers, and their tributaries. It represents species enrichment of the whole biocenosis, which especially in poorly loess covers is usually poor on species. The method of environmental analysis is very suitable especially for covered areas which miss sufficient amount of outcrops. The determined climatic oscillations are consistent with change of both fauna and depositional environment. These oscillations govern the general stratigraphic assignment of Quaternary deposits.

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Tables captions

Tab. I.

Fig. 1	*Trichia hispida*	width: 3,5 mm
	Borehole PZ-7, hĺbka: 4, 6 - 5,0 m	hight: 2,3 mm
Fig. 2	*Nesovitrea hammonis*	width: 3,1 mm
	Borehole PZ-5, depth: 6,1 - 6,9 m	hight: 1,5 mm

Tab. II.

Fig. 3	*Anisus spirorbis*	width: 6,2 mm
	Borehole PZ-7, depth: 5,0 - 5,4 m	hight: 1,5 mm
Fig. 4	*Anisus vortex*	width: 4,2 mm
	Borehole PZ-5, depth: 2,1 - 3,1 m	hight: 0,5 mm
Fig. 5	*Anisus vorticulus - monstrositas scalaris*	width: 1,8 mm
	Borehole PZ-7, depth 5,0 - 5,4 m	hight: 1,9 mm

Tab. III.

Fig. 6	*Valvata pulchella*	width: 3,3 mm
	Borehole PZ-7, depth 5,0 - 5,4 m	hight: 2,5 mm
Fig. 7	*Valvata pincinalis*	width: 2,0 mm
	Borehole PZ-7, depth 5,0 - 5,4 m	hight: 3,0 mm
Fig. 8	*Valvata cristata*	width: 2,0 mm
	Borehole PZ-5, depth: 13,0 - 13,2m	hight: 0,7 mm
Fig. 9	*Segmentina nitida*	width: 3,0 mm
	Borehole PZ-7, depth: 3,0 - 3,4 m	hight: 1,0 mm
Fig. 10	*Gyraulus acronicus*	width: 2,0 mm
	Borehole PJ-5, depth: 15,0 - 16,0 m	hight: 0,9 mm

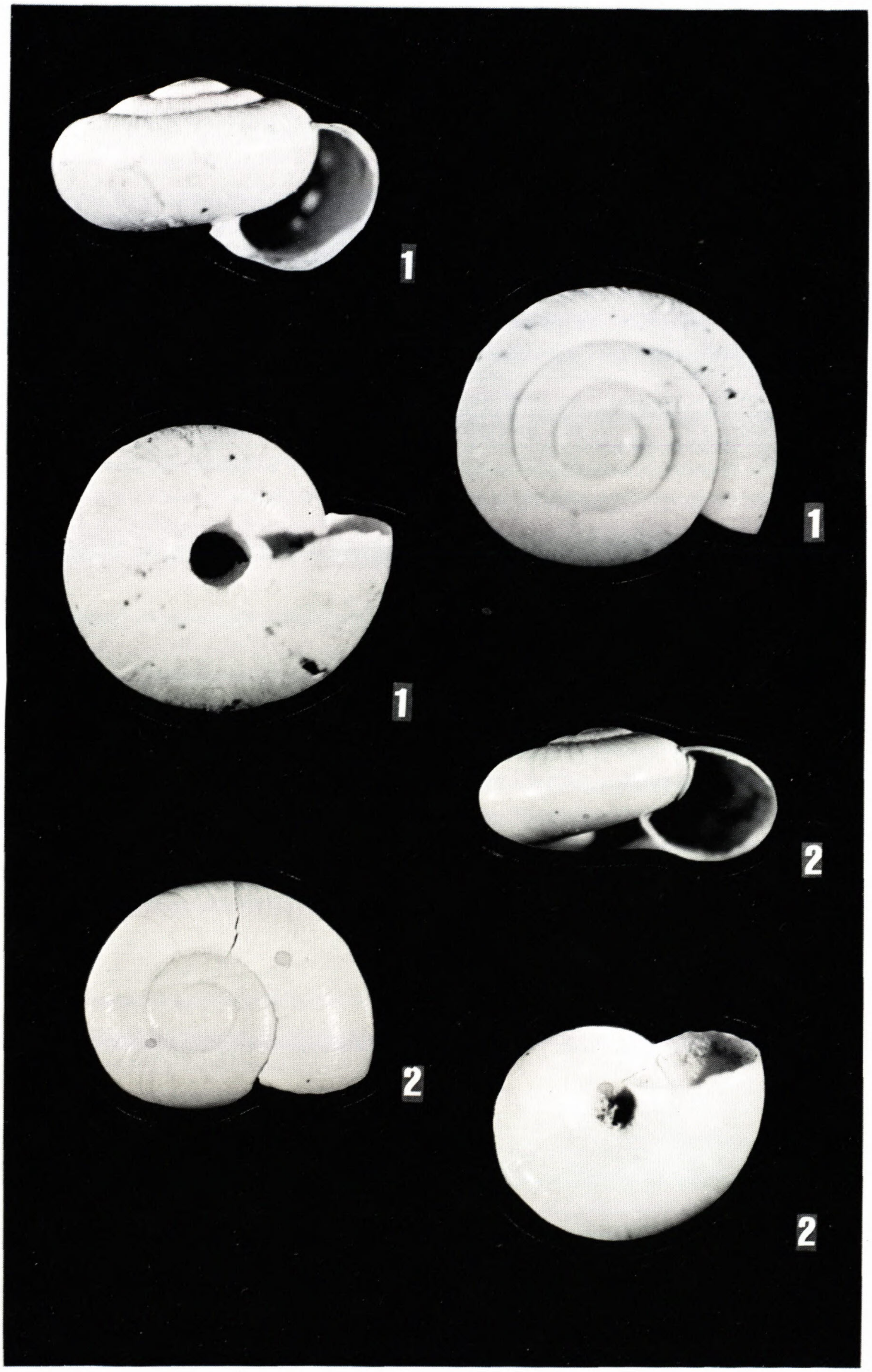
Tab. IV.

Fig. 11	*Planorbis planorbis*	width: 7,3 mm
	Borehole PZ-7, depth: 5,0 - 5,4 m	hight: 1,9 mm
Fig. 12	*Gyraulus laevis*	width: 3,2 mm
	Borehole PZ-7, depth: 5,0 - 5,4 m	hight: 1,2 mm
Fig. 13	*Vallonia enniensis*	width: 2,5 mm
	Borehole PZ-5, depth: 6,1 - 6,9 m	hight: 1,1 mm

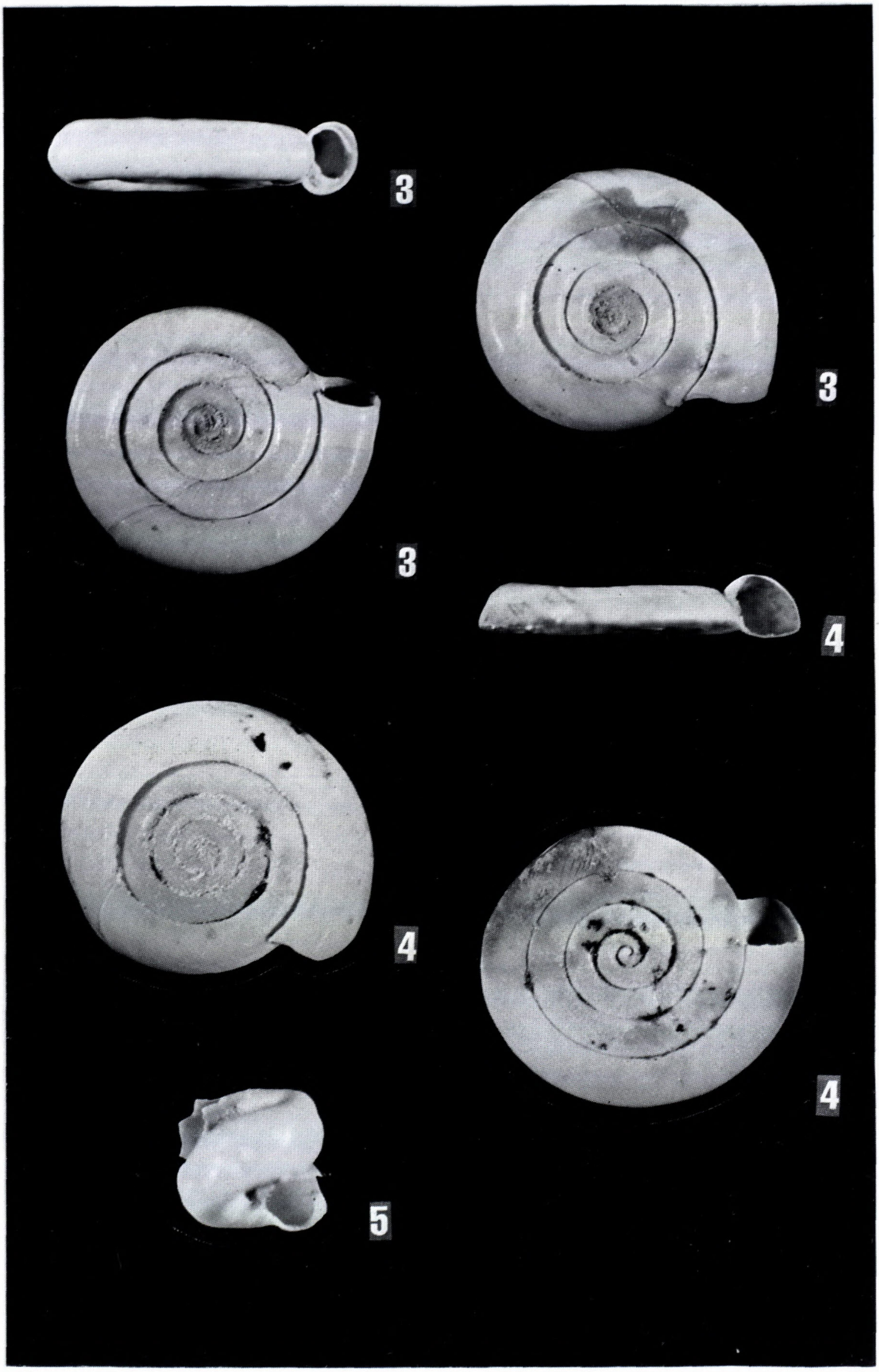
Tab. V.

Fig. 14	*Bathyomphalus concortus* incomplete individual Borehole PZ-7, depth: 5,0 - 5,4 m	
Fig.15	*Armiger crista cristatus*	width: 2,0 mm
	Borehole PZ-7, depth: 3,0 - 3,4 m	hight: 0,5 mm
Fig. 16	*Armiger crista nautileus*	width: 1,9 mm
	Borehole PZ-7, depth: 3,0 - 3,4 m	hight: 0,5 mm
Fig. 17	*Pisidium obtusale*	hight: 1,2 mm
	Borehole PZ-4, depth: 4,6 - 5,0 m ;	d: 1,5 mm

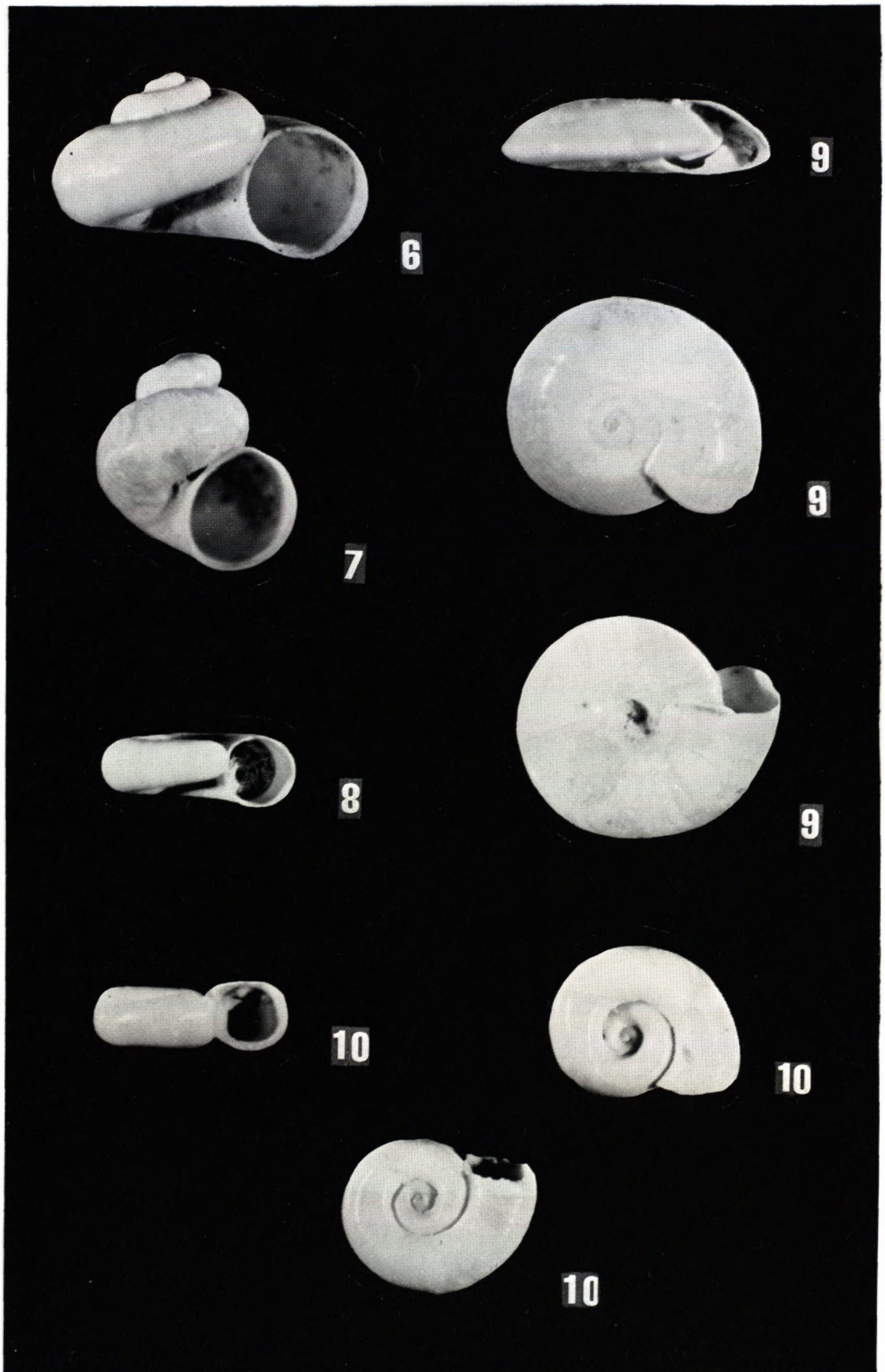
Tab. I



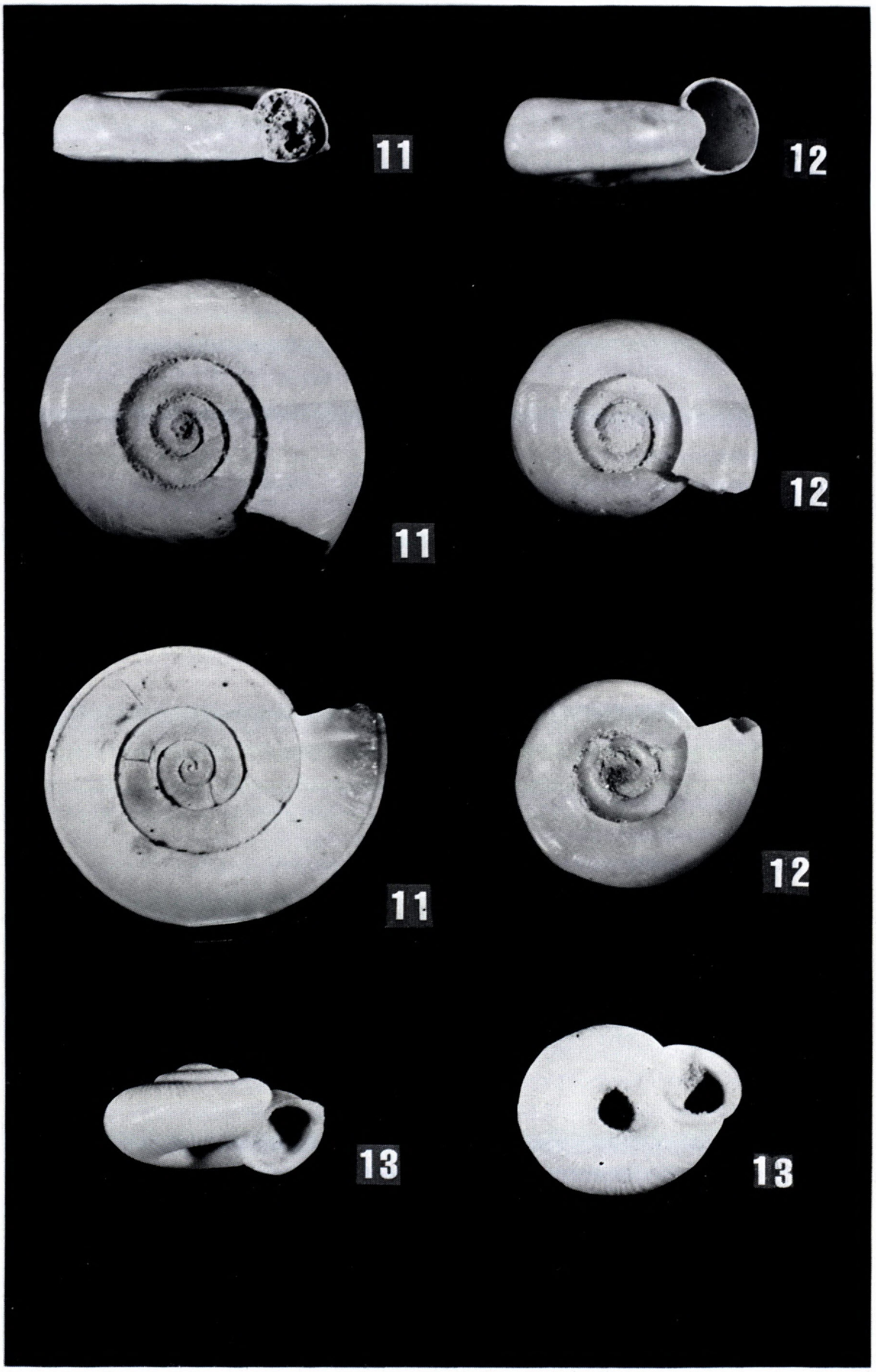
Tab. II



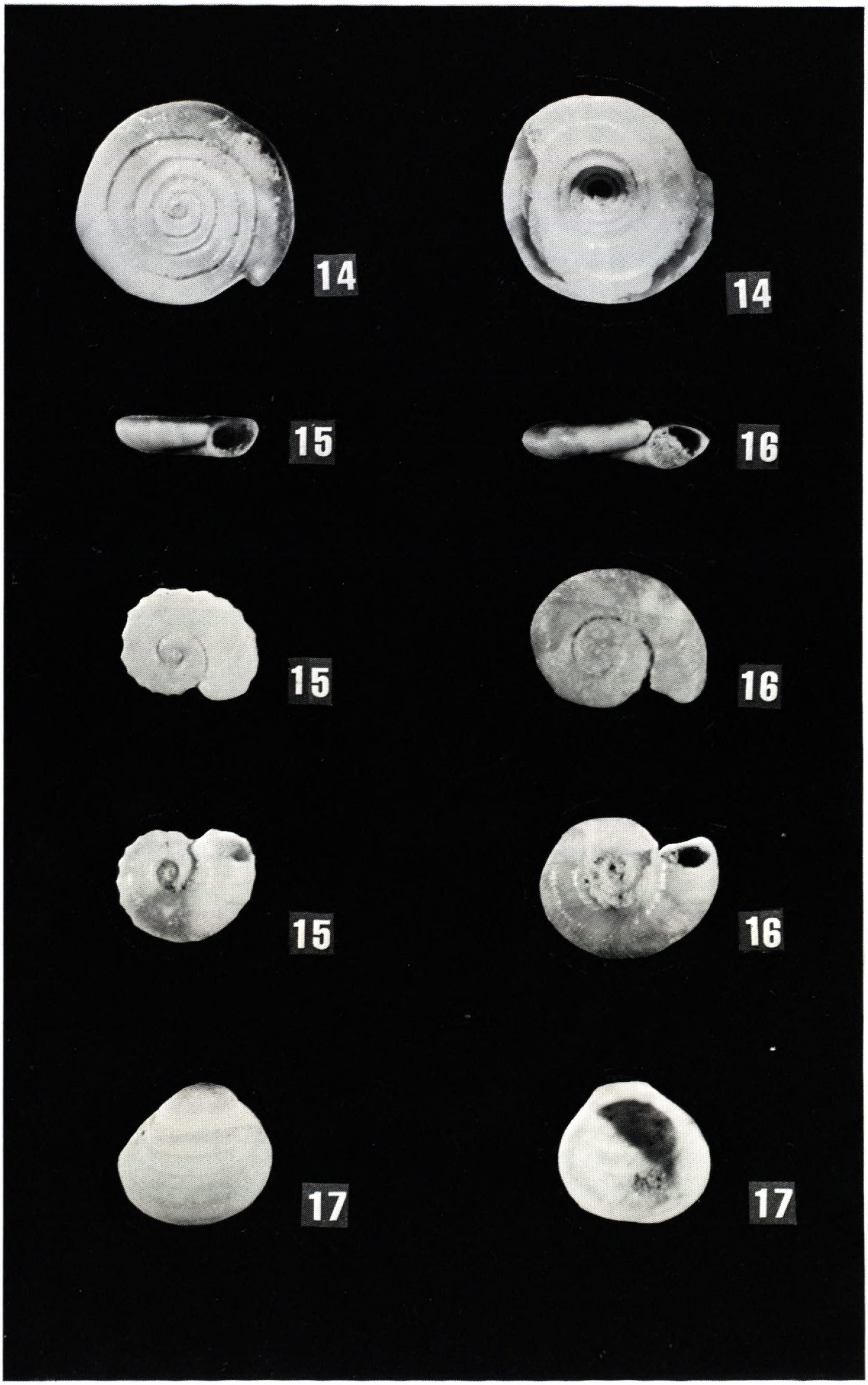
Tab. III



Tab. IV



Tab. V



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Mollusc Fauna of loess complex from Mnešice locality, Danube Basin

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Abstract. A detail lithologic, physical-chemical and biostratigraphic research of the locality Mnešice - near cow-house is described in the work. The main part of the paper consists of systematic overview of the identified mollusc fauna and its ecologic and biostratigraphic evaluation. This renders a good correlation with other localities of Lower Váh river area.

Key words: Quaternary, Pleistocene, loess complex (loess serie), continental gastropoda, stratigraphy, palaeoecology, granulometry

Introduction

The locality Mnešice with the occurrence of Late and Middle Pleistocene loesses separated by several soil complexes and with the occurrence of archeological findings suggesting the existence of Older Palaeolith, belongs to a few important loess profiles in the Lower Váh river area.

The morphological most important phenomenon of the area is a conspicuous pseudoterrace consisting of several loess horizons separated by soil complexes. It overlies the gravel of river Váh Middle terrace. The base of the terrace occurs max. 10 m above the contemporary Váh valley (Vaškovský, 1970). The deposits forming the pseudoterrace fill the valley cut with exposed underlying rocks at the bottom. We meet here dell type of stratigraphy resulting in pinching out of some beds of loess complex.

Overview of existing biostratigraphic researches

Locality	Stratigraphic assignment	References
Mnešice– Búdy	W_3, $W_{2/3}$, W_2, $W_{1/2}$, W_1, R/W, R_2, $R_{1/2}$,?, R_1?	Ložek – Tyráček, 1960
Mnešice - brick kiln	W_3, $W_{2/3}$, W_2, $W_{1/2}$, W_1, R/W, R_2, $R_{1/2}$?, R_1?	Kukla – Ložek – Barta, 1962 Halouzka – Maglay, 1995

Description of loess complex

Mnešice are a part of a Nové Mesto nad Váhom town suburb. Loess outcrop Mnešice - is located to the NE behind the village near the local vaste deposit. It is an artificial outcrop in a slope about 11 m high and 150 m wide (Fig. 1)

Lithofacial analysis distinguished 17 various lithologic beds at the profile. Schematic illustration of the lithologic profile (Fig. 2).

Overview of some physical-chemical properties of the studied sediments

As seen from Tab. 1 and Chart 1 the studied deposits especially fit into two lithotype categories consisting of sandy-clayey silt and clayey silt. Sample No. 14 with sand fraction up to 29 % and sample No. 45 with clay fraction reaching up to 79.5 % do not match these categories.

The amount of silt and clay fractions differs in the samples taken from loess beds and from soils. In loess beds the silt fraction content is above 63 % while in soils the silt fraction varies from 50 to 59 %. An increase of clay fraction and decrease of $CaCO_3$ content is observable in soil layers. These changes of physical-chemical properties of soils reflect a climate warming, increased precipitation and decalcification of soil horizons pointing to their development during some warm interstadial or even interglacial period.

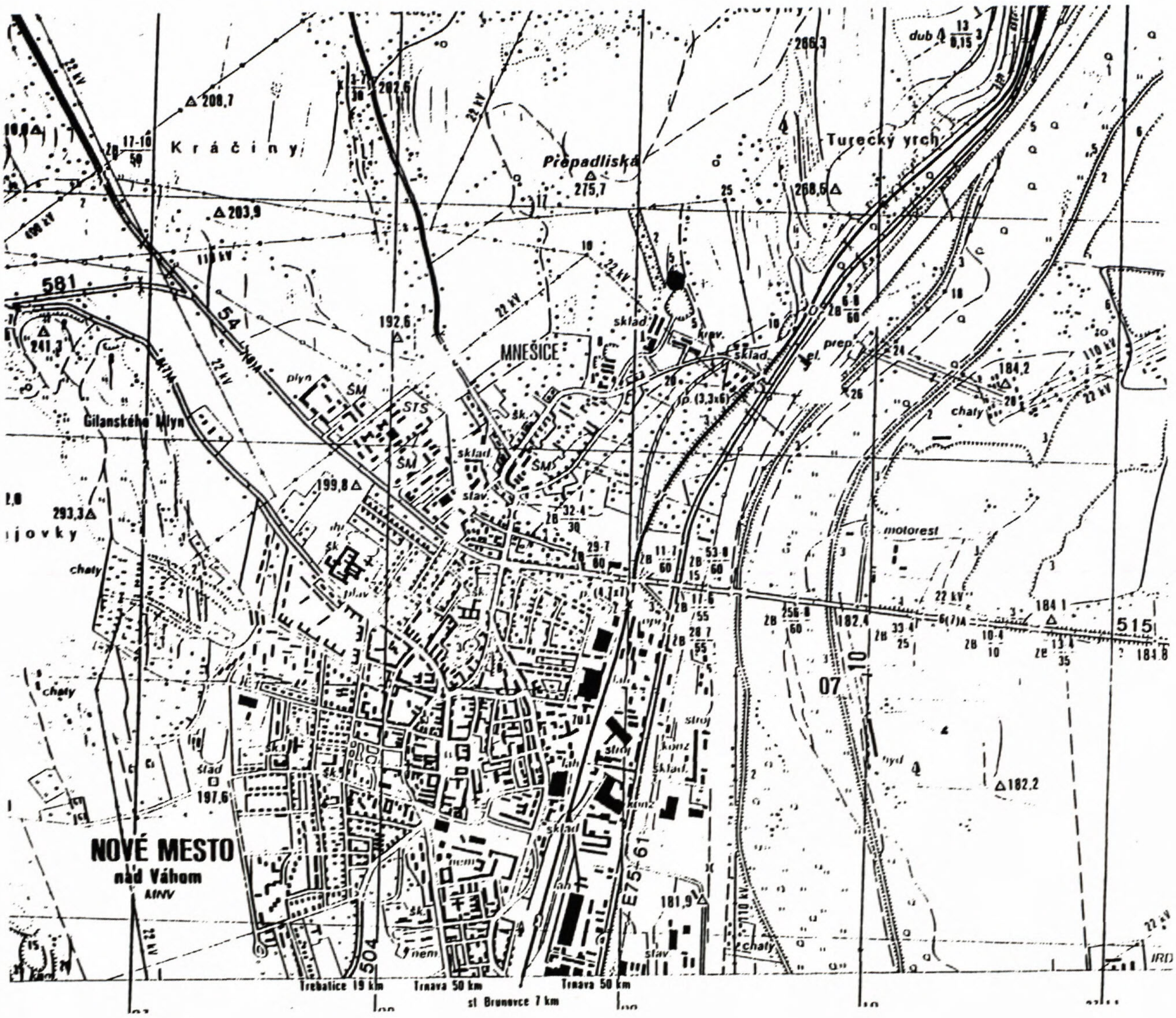


Fig. 1

The $CaCO_3$ content in the loesses of the studied profile also varies. It decreases from youngest superposed beds toward the underlying beds consisting of older loesses (Chart 2).

Systematic overview of the identified mollusc fauna

Class: *GASTROPODA*
Subclass: *PROSOBRANCHIA*
Order: *ARCHAEOGASTROPODA*

Family: *ACICULIDAE*
Genus: *Acicula* Hartmann, 1821 Eocene- Recent

***Acicula* sp.**

Subclass: *EUTHYNEURA*
Order: *BASOMMATOPHORA*

Family: *LYMNAIDAE*
Genus: *Lymnaea* Lamarck, 1799

***Lymnaea truncatula* Muller, 1774**

1952 *Galba truncatula* (Muller) - Žadin: p.175, Fig. 76
1964 *Lymnaea (G.) truncatula* (Müller) - Ložek: p.176, Tab. III/7
1994 *Lymnaea truncatula* (Müller) - Skompski - Makowska: p. 59, Tab. XXXIV/2

Order: *STYLOMMATOPHORA*
Family: *COCHLICOPIDAE*
Genus: *Cochlicopa* Risso, 1826 Paleocene - Recent

***Cochlicopa lubrica* Müller, 1774**

1956 *Columella edentula columella* (Martens) - Ložek: p. 98, Tab. V/2

1964 *Columella columella* (Martens) - Ložek: p. 198, Tab. VI/3

1983 *Columella columella* (Martens) - Kerney - Cameron-Jungbluth: p. 87

1994 *Columella columella* (Martens) - Skompski - Makowska: p. 64, Tab. 39/6

Genus *Vertigo* Müller, 1774 Paleocene - Recent

Vertigo pygmaea Draparnaud, 1801

1956 *Vertigo pygmaea* (Draparnaud) - Ložek: p. 93, Tab. IV/5

1964 *Vertigo (V.) pygmaea* (Draparnaud) - Ložek: p. 203, Tab. VII/3

1983 *Vertigo (V.) pygmaea* (Draparnaud) - Kerney - Cameron - Jungbluth: p. 92

1994 *Vertigo pygmaea* (Draparnaud) - Skompski - Makowska: p. 64, Tab. 39/6

Vertigo parcedentata Braun, 1847

1964 *Vertigo parcedentata* (Braun) - Ložek: p.206, Tab. VII/8

1994 *Vertigo parcedentata* (Braun) - Skompski - Makowska: p. 66, Tab. 40/2

Vertigo sp.

Family: *ORCULIDAE*

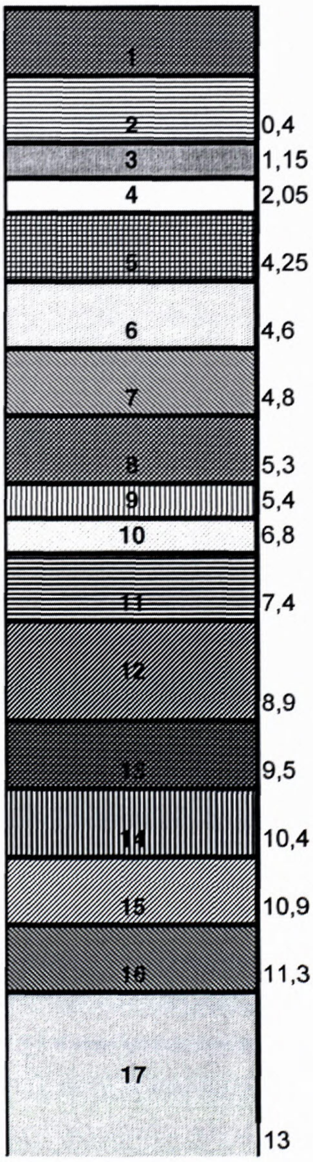
Genus *Orcula* Held, 1837 Paleocene - Recent

Orcula dolium Draparnaud, 1801

1956 *Orcula dolium* (Draparnaud) - Ložek: p. 103, Tab. VII/2

1964 *Orcula dolium* (Draparnaud) - Ložek: p. 208, Tab. VIII/6

1983 *Orcula dolium* (Draparnaud) - Kerney - Cameron-Jungbluth: p. 99



1 - Oak soil with many roolets, and fine cloddy structure

2 - Brown soil with calcium precipitates, on one´s back cloddy structure

3 - Oak loess with solitary clay dols of calcium, firm

4 - Progressive crossing to brown soil, firmly fluffy

5 - Light firmly calcified loess with large calcium clay dols on contact with soil. Loess is firm and compact.

6 - Brown soil with tone to red. Firmly about pass between loess and soil

7 - Oak soil, firm, thick mo, with solitary calcium aggromerate, on fissures are magnesium oxids precipitates, calcareous

8 - Dark brown soil with tone to red firm, on overhead part are solitary magnesium oxids precipitates, calcareous

9 - Oak soil, firmly fluffty

10 - Oak loess with calcium clay dols

11 - Yellow brown loess, firmly clayer with solitary magnesium oxides precipitates and clay dols

12 - Dark brown firm gumbo, magnesium oxides, infrequent clay dols with more clay parting till clear clay 8,3 - 8,9 darkly brown gumbo with clay dols and noduls of Mn and Fe

13 - Light brown clay primary loess with magnesium oxides, solitary calcium noduls.

14 - Dark brown clay loess with magnesium oxides, for dept calcium noduls are decrease

15 - Oak with fine tone to red, slightly clay loess (immature soil), magnesium oxides

16 - Oak slightly clay loess with clay dols many meroleim

17- Brown, firmly clay loess (clay loam) on fissures are calcium clay dols and for dept meroleim are increase, solitary grey and terracotta spottiness (veined). From 12,7 m dept parts of clay are decrease

Fig. 2 Litologic profile on the outcop Mnešice

Tab 1 Granulotype and physicochemical properties of sediments

Layer No.	Sample No.	Sampling depth (m)	Granulotype	Granulotype	pH	Humus v (%)	Content of calcium
			Classification of sedimentology	Pedological scale			
2	1	0.15 - 0.30	clayey mo	loam			13.21
	2	0.40 - 0.60	sandy clayey mo	loam			22.36
·3	3	0.60 - 0.80	sandy clayey mo	loam			17.3
	4	0.80 - 1.00	sandy clayey mo	loam			25.83
	5	1.00 - 1.15	sandy clayey mo	loam			11.14
4	6	1.15 - 1.35	sandy clayey mo	loam	7.25	0.42	6.8
	7	1.35 - 1.60	sandy clayey mo	clay loam	7.16	0.4	3.34
	8	1.60 - 1.80	clayey mo	clay loam	7.2	0.37	2.12
	9	1.80 - 2.05	clayey mo	loam	7.2	0.2	2.4
5	10	2.05 - 2.30	clayey sandy mo	loam			24.27
	11	2.30 - 2.60	clayey sandy mo	loam			23.55
	12	2.60 - 2.90	clayey sandy mo	loam			17.87
	13	2.90 - 3.20	sandy clayey mo	loam			15.77
	14	3.20 - 3.50	clayey sandy mo	loam			15.07
	15	3.50 - 3.80	sandy clayey mo	loam			17.1
	16	3.80 - 4.10	sandy clayey mo	loam			17.23
	17	4.10 - 4.25	sandy clayey mo	loam	7.5	0.2	11.37
6	18	4.25 - 4.45	sandy clayey mo	loam			10.23
	19	4.45 - 4.60	clayey mo	loam			7.33
7	20	4.60 - 4.80	clayey mo	clay loam	7.3	0.46	1.91
8	21	4.80 - 5.00	clayey mo	clay loam	7.2	0.41	0.58
	22	5.00 - 5.30	clayey mo	clay loam	7.1	0.44	0.49
9	23	5.30 - 5.40	clayey mo	loam			0.28
10	24	5.40 - 5.70	sandy clayey mo	loam			11.65
	25	5.70 - 6.00	sandy clayey mo	loam			11.25
	26	6.00 - 6.30	sandy clayey mo	loam			8.78
	27	6.30 - 6.60	sandy clayey mo	sandy mo load			8.38
	28	6.60 - 6.80	sandy clayey mo	sandy mo load			9.08
11	29	6.80 - 7.10	sandy clayey mo	loam	7.4	0.16	5.29
	30	7.10 - 7.40	clayey mo	loam			4.87
12	31	7.40 - 7.70	clayey mo	loam			4.95
	32	7.70 - 8.00	sandy clayey mo	loam			1.04
	33	8.00 - 8.30	clayey mo	loam	7.35	0.3	1.26
	34	8.30 - 8.60	clayey mo	loam	7.35	0.38	0.99
	35	8.60 - 8.90	clayey mo	loam			1.28
13	36	8.90 - 9.20	clayey mo	loam			0.65
	37	9.20 - 9.50	clayey mo	loam			0.73
14	38	9.50 - 9.80	sandy clayey mo	loam			1.05
	39	9.80 - 10.10	sandy clayey mo	loam			0.65
	40	10.10 - 10.40	sandy clayey mo	loam			0.23
15	41	10.40 - 10.70	clayey sandy mo	loam	7.1	0.26	0.36
	42	10.70 - 10.90	clayey sandy mo	loam	6.9	0.4	0.45
16	43	10.90 - 11.10	clayey mo	loam			0.38
	44	11.10 - 11.30	clayey mo	clay loam	6.8	0.51	0.3
17	45	11.30 - 11.50	sandy mo	clay	6.6	0.45	0.15
	46	11.50 - 11.80	sandy clayey mo	loam			0.21
	47	11.80 - 12.10	sandy clayey mo	loam			0.32
	48	12.10 - 12.40	clayey mo	loam			0.23
	49	12.40 - 12.70	sandy clayey mo	loam			0.3
	50	12.70 - 13.00	sandy clayey mo	loam			0.27

Family: *PUPILLIDAE*
Genus: *Pupilla* Fleming, 1828 Oligocene- Recent

Pupilla triplicata Studer, 1820

1956 *Pupilla triplicata* (Studer) -Ložek: p.102
1964 *Pupilla triplicata* (Studer) - Ložek: p. 244, Tab. IX/5,6
1983 *Pupilla (Pupilla) triplicata* (Studer) - Kerney - Cameron - Jungbluth: p.119

Pupilla muscorum Linne, 1758

1956 *Pupilla muscorum* (Linne) - Ložek: p. 99, Tab. VI/1
1964 *Pupilla muscorum* (Linne) - Ložek: p. 215, Tab. IX/1,7
1983 *Pupilla (Pupilla)muscorum* (Linne) - Kerney - Cameron - Jungbluth: p. 118
1994 *Pupilla muscorum* (Linne) - Skompski - Makowska: p. 66, Tab. 40/2

Pupilla sterri Voith,1838

1956 *Pupilla sterri* (Voith) - Ložek: p. 101, Tab. VI/3
1964 *Pupilla sterri* (Vopith) - Ložek: p. 216, Tab. IX/2
1983 *Pupilla (Pupilla) sterri* (Voith) - Kerney - Cameron-Jungbluth: p.120

Pupilla loessica Ložek, 1954

1964 *Pupilla loessica* (Ložek) - Ložek: p.277, Tab.IX/3
1994 *Pupilla loessica* (Ložek) - Skompski - Makowska: p. 67, Tab. 40/5

Pupilla muscorum densegyrata Ložek, 1954

1955 *Pupilla muscorum densegyrata* (Ložek) - Ložek: p. 401, Tab. II/1,2
1964 *Pupilla muscorum densegyrata* (Ložek) - Ložek: p. 216, Tab. IX/4

Pupilla sp.

Family: *VALLONIIDAE*
Genus: *Vallonia* Risso,1826 Paleocene - Recent

Vallonia costata Müller, 1774

1955 *Vallonia costata* (Müller) - Ložek: p.107, Tab.VIII/1
1964 *Vallonia costata* (Müller) - Ložek: p. 219, Tab. X/3a,b,c
1983 *Vallonia costata* (Müller) - Kerney - Cameron-Jungbluth: p.125
1994 *Vallonia costata* (Müller) - Skompski - Makowska: p. 67, Tab. 41/1

Vallonia pulchella Müller, 1774

1955 *Vallonia pulchella* (Müller) - Ložek: p. 108, Tab. 8/3
1964 *Vallonia pulchella* (Müller) - Ložek: p. 221, Tab. X/5a, b, c
1983 *Vallonia pulchella* (Müller) - Kerney - Cameron-Jungbluth: p.127
1994 *Vallonia pulchella* (Müller) - Skompski - Makowaska: p. 67, Tab. 41

Vallonia tenuilabris Braun, 1843

1955 *Vallonia tenuilabris* (Braun) - Ložek: p.106
1964 *Vallonia tenuilabris* (Braun) - Ložek: p. 223, Tab. X/1a,bc
1994 *Vallonia tenuilabris* (Braun) - Skompski - Makowska: p. 68, Tab. 42/2

Family: *ENIDAE*
Genus: *Chondrula* Beck, 1837 Pliocene - Recent

Chondrula tridens Muller, 1774

1955 *Chondrula tridens* (Muller) - Ložek: p.114, Fig. 29, Tab.10/3
1964 *Chondrula tridens* (Muller)- Ložek: p.2, i. 41
1983 *Chondrula (Chondrula) tridens* (Muller) - Kerney - Cameron- Jungbluth: p.133
1994 *Chondrula tridens* (Muller) - Skompski - Makowska: p. 68, Tab. 40/3

Family: *SUCCINEIDAE*
Genus: *Succinea* Draparnaud, 1801 Paleocene - Recent

Succinea oblonga Draparnaud, 1801

1955 *Succinea (Succinella) oblonga* (Draparnaud) - Ložek: p. 83, Tab. II/2
1964 *Succinea (Succinella) oblonga* (Draparnaud) - Ložek: p. 230, Tab.12/7, 8, 9
1983 *Succinea (Succinella) oblonga* (Draparnaud) - Kerney - Cameron- Jungbluth: p. 79, 2/2
1994 *Succinea oblonga* (Draparnaud) - Skompski - Makowska: p. 69, Tab. 40/8

Genus: *Catinella* Pease, 1870 Pleistocene - Recent

Catinella arenaria Bouchard-Chantereaux, 1837

1964 *Catinella (Quickella) arenaria* (Bouchard-Chantereaux) - Ložek: p. 232, Tab. 12/5,6
1983 *Catinella (Quickella) arenaria* (Bouchard-Chantereaux) - Kerney - Cameron- Jungbluth: p.78, Tab. 2/3

Family: *ENDODOTIDAE*
Punctum Morse, 1864 Upper Oligocene - Recent

Punctum pygmaeum Draparnaud, 1801

1955 *Punctum pygmaeum* (Draparnaud) - Ložek: p.146, Tab.18/1
1964 *Punctum pygmaeum* (Draparnaud) - Ložek: p. 233, Tab.13/2 a,b,c
1983 *Punctum (Puncum) pygmaeum* (Draparnaud) - Kerney - Cameron - Jungbluth: p.135
1994 *Punctum pygmaeum* (Draparnaud) - Skompski - Makowska: p. 70, Tab. 47/2

Family: *VITRINIDAE*
Genus: *Semilimax* Agassiz, 1845 end of Pliocene - Recent

Tab. 2 The frequency of individual Taxons and their ecological characteristics on the outcrop Mnešice

Main ecological groups	Ecological characteristics	Biostratigraphic date	Sampling depth (m)	0.15 - 0,30	0,40 -0,60	0,60 -0,80	0,80 - 1,0	1,0 - 1,15	1,15 - 1,35	1,35 - 1,60	1,8 - 2,05	2,05 - 2,30	2,30 - 2,60	2,60 - 2,90	2,90 - 3,20	3,20 - 3,50	3,50 - 3,80	3,80 - 4,10	4,10 - 4,25
A	L/V/	/ + /	1 *Vitrea crystallina*																
	L		2 *Semilimax semilimax*																
	L/V		3 *Clausilia pumila*																
	L/V/		4 *?Perforatella rubiginosa*			U								1					
	L/V	/ + /	5 *Perforatella bidentata*																
	L/M/	/ + /	6 *Arianta arbustorum*	U					U			U		U					U
B	O	+ +	7 *Columella columella*																
	O	/ G /	8 *Vertigo pygmaea*																
	O	+	9 *Vertigo parcedentata*						1										
	S	+	10 *Pupilla triplicata*										63	46	65	17	1		4
	O	+	11 *Pupilla muscorum*										33	4	37				
	S	+	12 *Pupilla sterri*									1	22	6	5	1		4	
	O	+ +	13 *Pupilla loessica*	1										2		5			1
	O	+ +	14 *Pupilla musc. densegyrata*											2		1		2	
	O	/ + /	15 *Vallonia costata*			2			1				2				3	3	
	O	G	16 *Vallonia pulchella*		1							1				1			
	O	+ +	17 *Vallonia tenuilabris*	1									106	106	97	8			
	S	/ + /	18 *Chondrula tridens*		1			1	2	2		1			2		1		
	O	/ + /	19 *Catinella arenaria*									1	17	3	17	3	2		
	S	+	20 *Helicopsis striata*		1	1	2	2	2				4	U	7	5	2	U	1
C	M	/ + /	21 *Cochlicopa lubrica*					1				1							
	RL	/ + /	22 *Orcula dolium*	1	1				1										
	VS	+	23 *Succinea oblonga*		1														
	M	/ + /	24 *Punctum pygmaeum*																
	M	/ + /	25 *Nesovitrea hammonis*				1			1				1					
	M	/ + /	26 *Limacidae/Agriolimacidae*				1	1	3						1				
	RL	/ + /	27 *Clausilia dubia*			1	5	1											
	M	+	28 *Trichia hispida*	1											1				
D	H	/ + /	29 *Lymnaea truncatula*																
			30 *? Acicula sp.*							U									
			31 *Vertigo sp.*																
			32 *Pupilla sp.*														U		
			33 *Clausilidae*	U	U				U	U			U	U	U			U	
			34 *Helicidae*																
			35 *Rodentia*																
			Sum	4 + U	5 + U	4 + U	5	6	10 + U	3 + U	U	5+U	247+U	171+U	232+U	41	9+U	9+U	6+U

Main ecologic group:
A - forest (in general)
B - tree-less landscape
C - forest and tree-less landscape
D - water, bogs

Ecologic characteristics (Biotop)
L - forest
L(V) - forest, locally moderately humid tree-less locality
L/V - humid forest
O - open landscape
S - steppes, xerotherm rocks
M - moderately or variosly humid locality
RL - moderately humid rocks, tree logs in forest
VS - more humid forest and tree-less localities
H - water environment

Tab. 2 The frequency of individual Taxons and their ecological characteristics on the outcrop Mnešice

4,25 - 4,45	4,45 - 4,60	4,60 - 4,80	5,0 - 5,30	5,30 - 5,40	5,40 - 5,70	5,70 - 6,0	6,0 - 6,30	6,30 - 6,60	6,60 - 6,80	6,80 - 7,10	7,10 - 7,40	7,40 - 7,70	7,70 - 8,0	8,30 - 8,60	8,60 - 8,90	8,90 - 9,20	9,20 - 9,50	9,50 - 9,80	9,80 - 10,10	10,10 - 10,40	10,70 - 10,90	10,90 - 11,10	11,30 - 11,50	11,50 - 11,80	11,80 - 12,10	12,10 - 12,40	12,40 - 12,70	Sum
							1	11	25	5	2																	44
					1		1		1																			3
							1	1	1	2	1	U																6+U
																												1+U
									1		1	2																4
	U	U				U	U	U	U	U	U	U	U															U
					1	6	5	20	30																			62+U
									2																			2
									1			1																3
	1					1		5	8																			211
						4	3	8	13	12	7	4																125
3					3	2		9	9																			65
							2	4	6																			21
					2			5	6	5	3																	26
					1			1	2																			15
		1									1																	5
					1			2	12																			333
							1																					11
																												43
	1				1																							29+U
								2	4	5	4	1																18
					1			15	15	3	12																	49
					3	17	25	30	50	32	38	17																213
													1															1
																												3
							2	U	2		2	1																13+U
						1		2	1		1																	8
						U		2	1	U	U																	5+U
									2																			2
																												U
								U																				U
	U											U												U				U
		U											U															U
																U												U
													U				U											U
3+U	2+U	1+U	U	0	14+U	31+U	41	117+U	192	64+U	72+U	26+U	1+U	0	0	U	U	0	0	0	0	U	0	U	U	0	0	1321

Biostratigraphic data:

\+ - loess species
++ - index loess species
(+) - local or occasional loess species
g - species surviving glacial outside the loess zone
(G) - species surviving glacial outside the loess zone as a relic

U - fragments
W3 - the third Würm stadial
W2/3 - the second Würm interstadial
W2 - the second Würm stadial
W1/2 - the first Würm interstadial
W1 - the first Würm stadial
R/W - interglacial Riss - Würm
R2 - the second Riss glacial
R1/2 - Riss interglacial
R1 - the first Riss glacial

***Semilimax semilimax* Ferussac, 1802**

1964 *Semilimax semilimax* (Ferussac) - Ložek: p. 240, Tab. XIV/3a, b
1983 *Semilimax (Semilimax) semilimax* (Ferussac) - Kerney - Cameron - Jungbluth: p.152

Family: *ZONITIDAE*

***Nesovitrea hammonis* Ström,1765**

1955 *Perpolita radiatula* (Alder) - Ložek: p.151,Tab.1 19/1
1964 *Perpolita radiatula* (Alder) - Ložek: p. 243, Tab. 19/3a,b,c
1983 *Nesovitrea hammonis* (Ström) - Kerney - Cameron - Jungbluth: p.168
1994 *Nesovitrea hammonis* (Ström) - Skompski - Makowska: p. 70, Tab. 43/1

Genus: *Vitrea* Fitzinger, 1833 Neogene - Recent

***Vitrea crystallina* Müller, 1774**

1955 *Vitrea crystallina* (Müller) - Ložek: p.164, Tab.22/2
1964 *Vitrea crystallina* (Müller) - Ložek: p. 256, Tab. XVII/1a,b,c
1983 *Vitrea (Crystallus) crystallina* (Müller) - Kerney - Cameron - Jungbluth: p.162

Family: *LIMACIDAE / AGRIOLIMACIDAE*
Family: *CLAUSILIIDAE*
Genus: *Clausilia* Draparnaud, 1805 Pliocene - Recent

***Clausilia dubia* Draparnaud, 1805**

1955 *Clausilia dubia* (Draparnaud) - Ložek: p.127, Tab.12/3
1964 *Clausilia dubia* (Draparnaud) - Ložek: p. 269, Tab. 20/10,11
1983 *Clausilia (Clausilia) dubia* (Draparnaud) - Ložek: p. 228

***Clausilia pumila* Pfeiffer, 1828**

1955 *Clausilia pumila* (Pfeiffer) - Ložek: p. 128, Tab. 12/4
1964 *Clausilia pumila* (Pfeiffer) - Ložek p. 270, Tab. 20/10, 11
1983 *Clausilia Clausilia) pumila* (Pfeiffer) - Kerney - Cameron - Jungbluth: p. 230

Family: *HELICIDAE*
Genus: *Helicopsis* Fitzinger, 1833

***Helicopsis striata* Müller, 1774**

1955 *Helicella (Helicopsis) striata* (Müller) - Ložek: p. 195, Tab. 30/1
1964 *Helicopsis striata* (Müller) - Ložek: p. 289, Tab. 22/2a, b, c
1983 *Helicella (Helicopsis) striata* (Müller) - Kerney - Cameron - Jungbluth: p. 251

Genus: *Perforatella* Schluter, 1838 Pleistocene - Recent

***Perforatella rubiginosa* Schmidt,1853**

1955 *Monachoides rubiginosa* (Schmidt) - Ložek: p.209, Tab. 34/1,2
1964 *Monachoides rubiginosa* (Schmidt) - Ložek: p. 289, Tab. 22/2a, b, c
1983 *Perforatella (Pseudotrichia) rubiginosa* (Schmidt) - Kerney - Cameron - Jungbluth: p. 259
1994 *Perforatella rubiginosa* (Schmidt) - Skompski - Makowska: p. 73, Tab. 45/1

***Perforatella bidentata* Gmelin, 1788**

1955 *Perforatella bidens* (Chemnitz) - Ložek: p. 213, Tab. 35/1
1964 *Perforatella bidentata* (Gmelin) - Ložek: p. 294, Tab. 23/2a,b,c
1983 *Perforatella (Perforatella) bidentata* (Gmelin) - Kerney - Camaron - Jungbluth: p. 254
1994 *Perforatella bidentata* (Gmelin) - Skompski - Makowska: p. 74, Tab. 45/2

Genus: *Trichia* Hartmann, 1840 Paleogene - Recent

***Trichia hispida* Linne, 1758**

1955 *Trichia hispida* (Linne) - Ložek: p. 208, Tab. 32/3
1964 *Trichia (Trichia) hispida* (Linne) Ložek: p. 300, Tab. 25/1a, b, c
1983 *Trichia (Trichia) hispida* (Linne) - Kerney - Cameron-Jungbluth: p.261
1994 *Trichia hispida* (Linne) - Skompski - Makowska: p. 74, Tab. 44/3

Genus: *Arianta* Turton, 1831 - Recent

***Arianta arbustorum* Linne, 1758**

1955 *Arianta arbustorum* (Linne) - Ložek: p. 221, Tab. 37/2
1964 *Arianta arbustorum* (Linne) - Ložek: p. 309, Tab. 30/5
1983 *Arianta arbustorum* (Linne) - Kerney - Cameron-Jungbluth: p. 272

Quantitative - qualitative analysis of the studied fauna

From the loess profile Mneaice - near cow-house 44 samples were analyzed in order to identify fauna, ten samples of them were negative. From this amount of samples 1231 pieces of fossil molluscs, which belongs to 15 families and 32 species were obtained (Tab. 2). The occurrence of individual taxons in the whole profile and the occurrence of taxons in the individual samples of the profile in percentage are depicted on charts from 3 to 10.

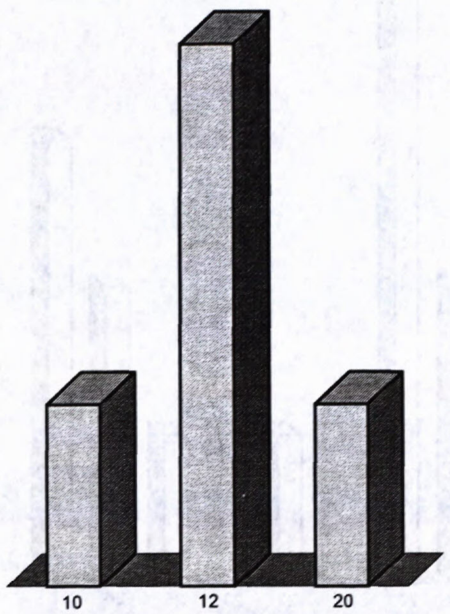


Chart 7 The frequency of Taxons in Bed No. 6

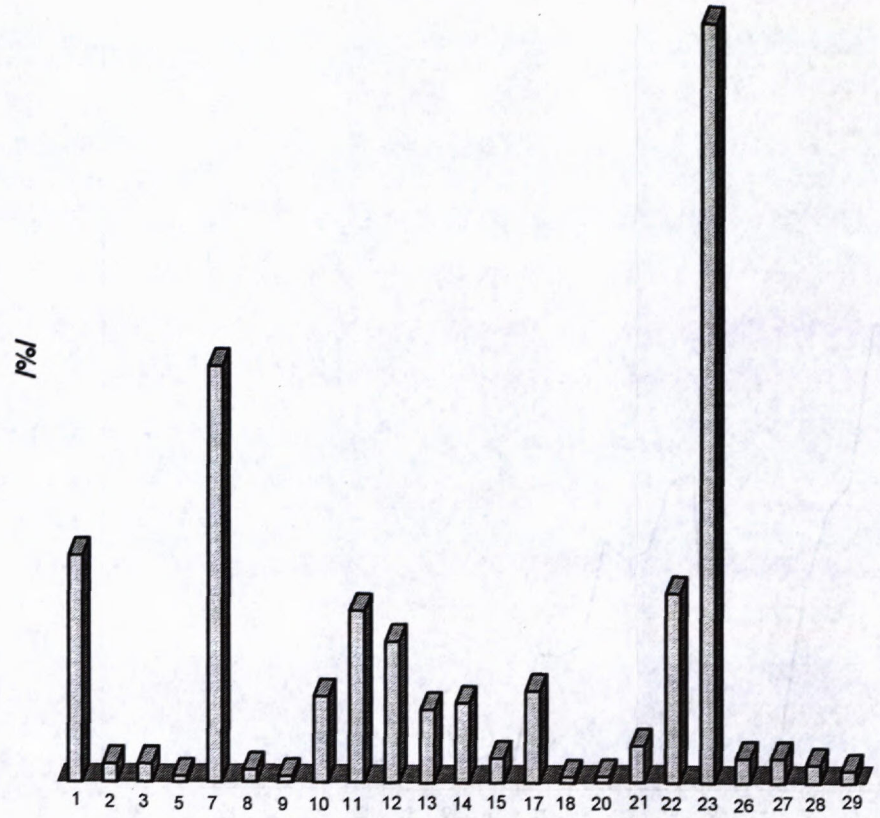


Chart 8 The frequency of Taxons in Bed No. 10

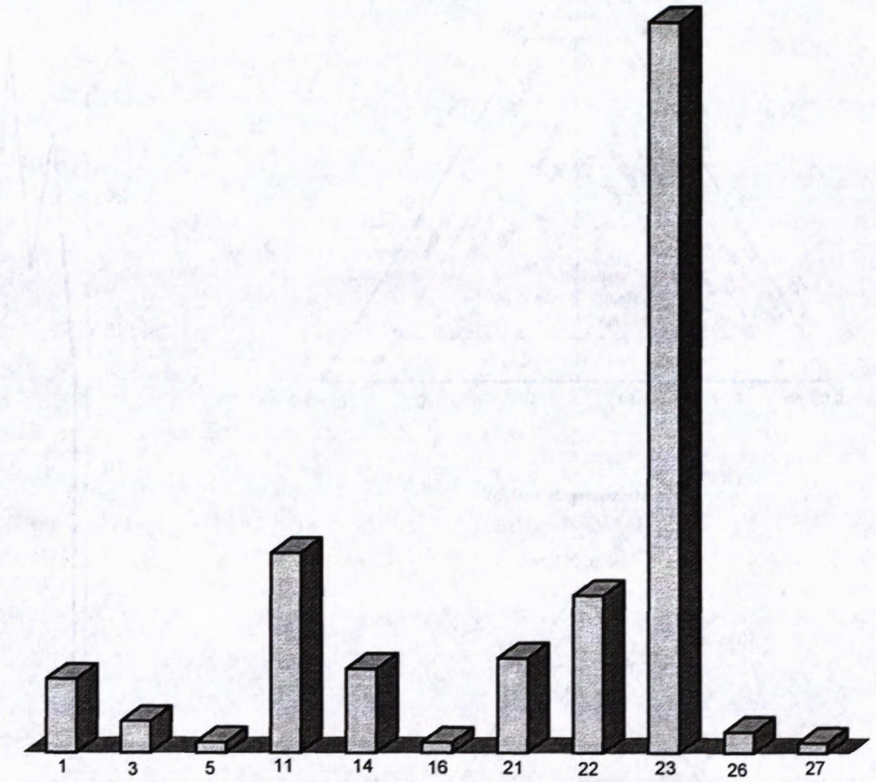


Chart 9 The frequency of Taxons in Bed no. 11

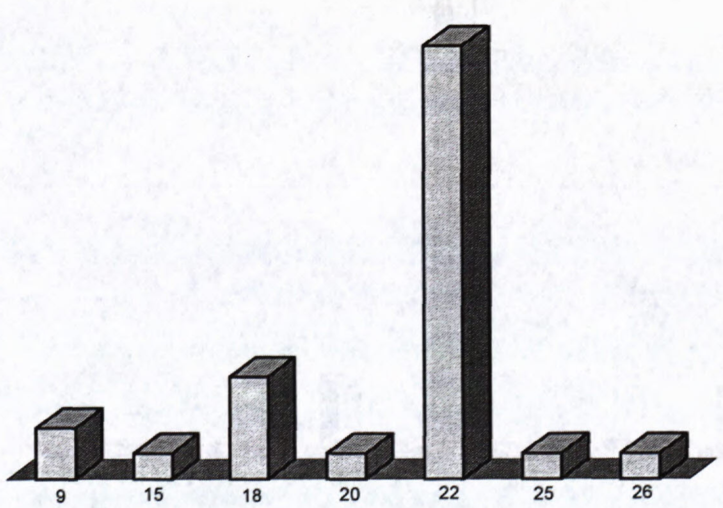


Chart 10 The frequency of Taxons in Bed No. 12

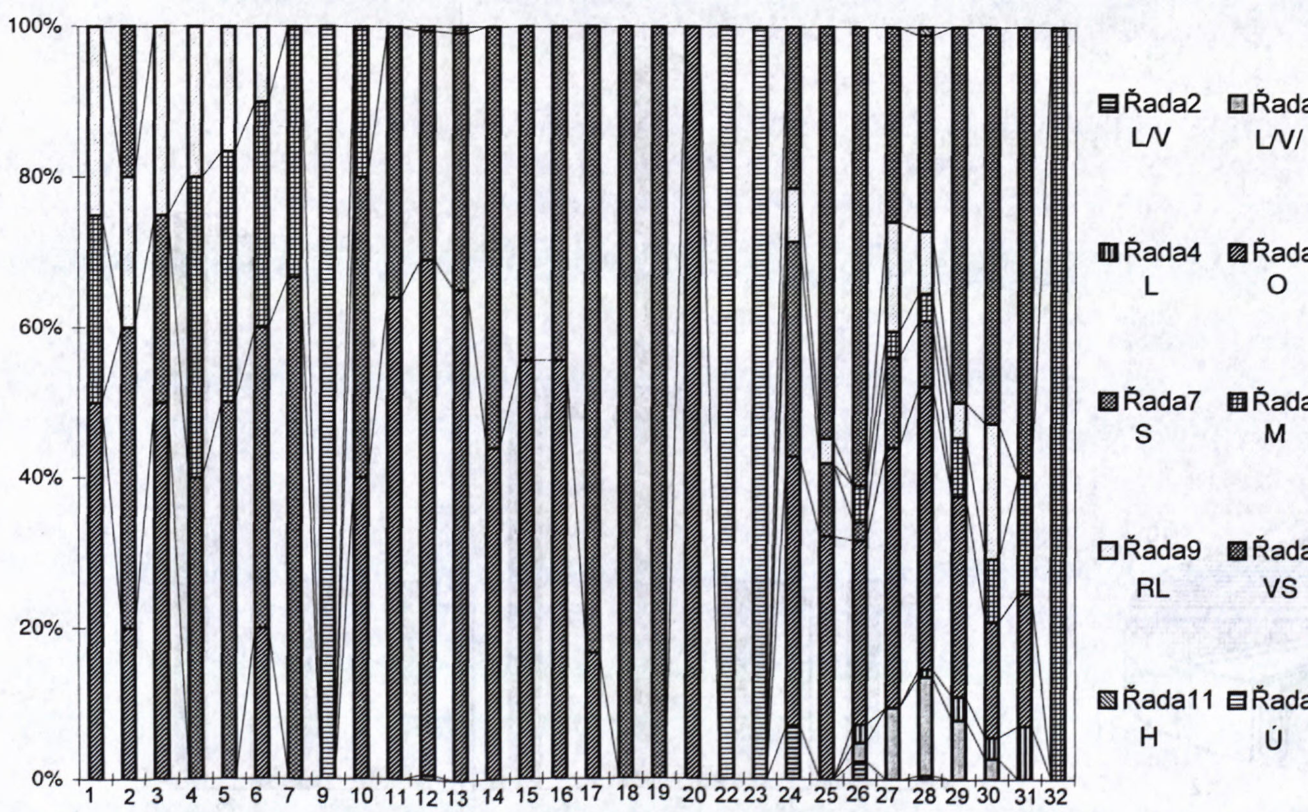


Chart 11 The frequency of Biotops in individual Samples on the outcrop Mnešice

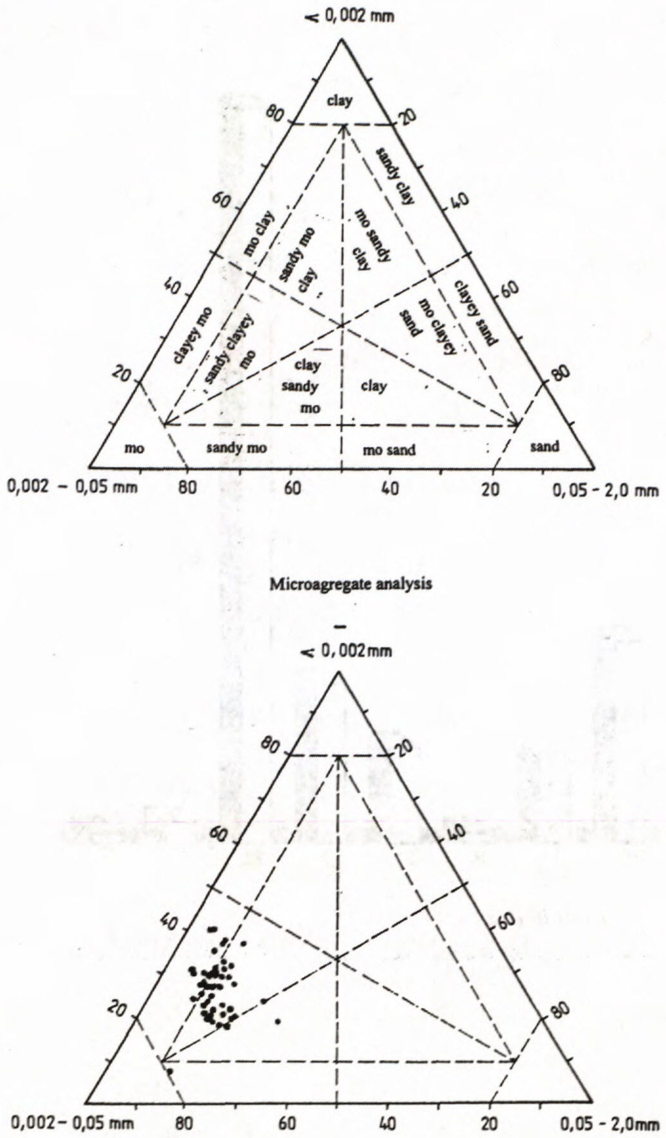


Chart 1 Grafics of classification from J. Konta (1972)

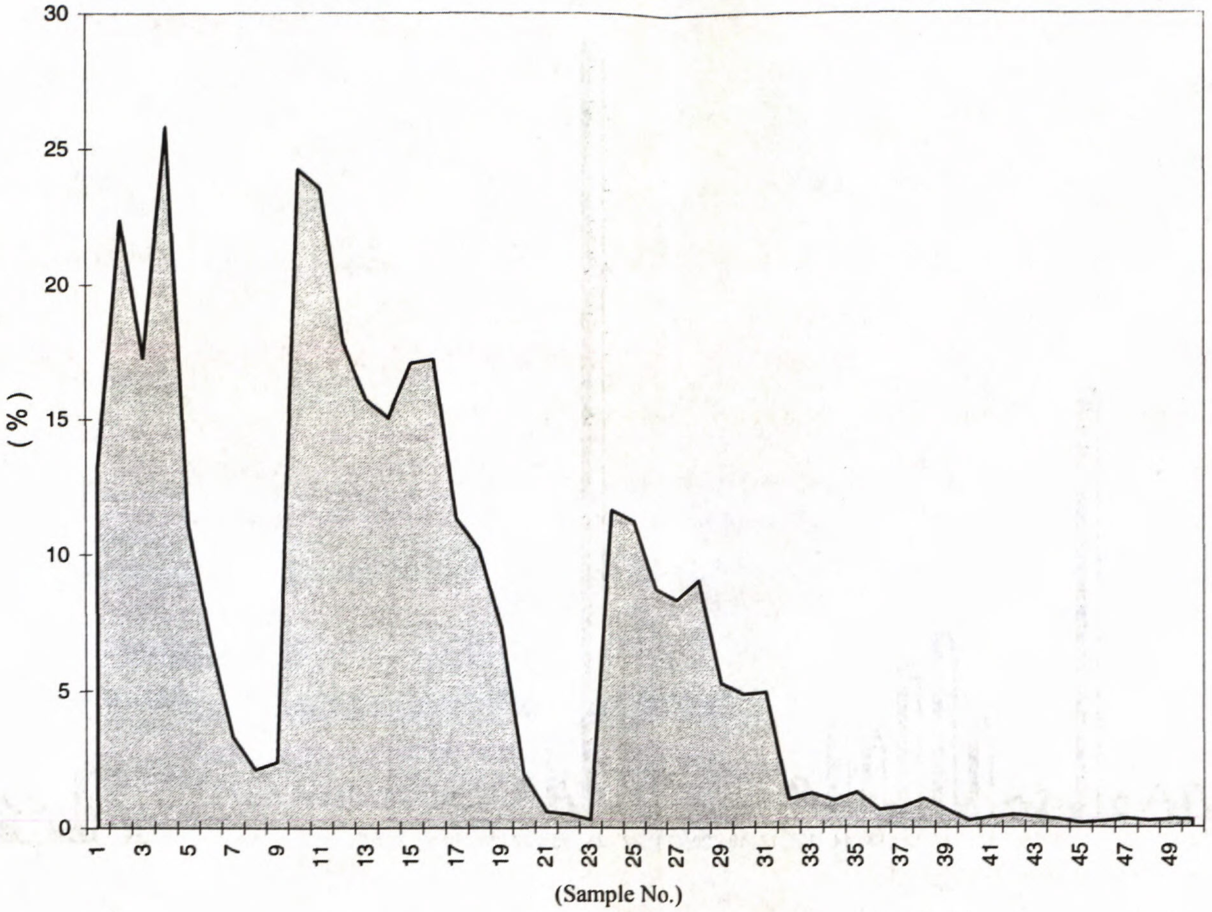


Chart 2 The Content of Calcium bicarbonate in samples on the outcrop Mnešice

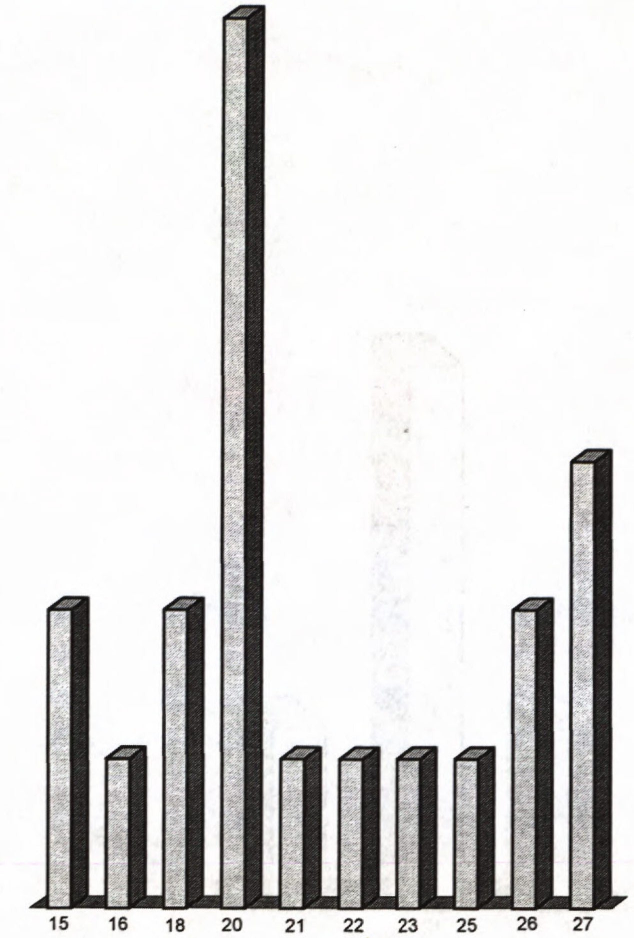


Chart 4 The frequency of Taxons in Bed No. 3

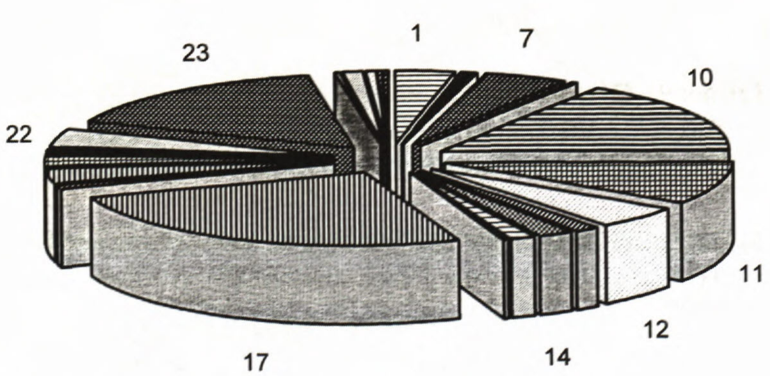


Chart 3 The frequency of assessment Taxons on the outcrop Mnešice

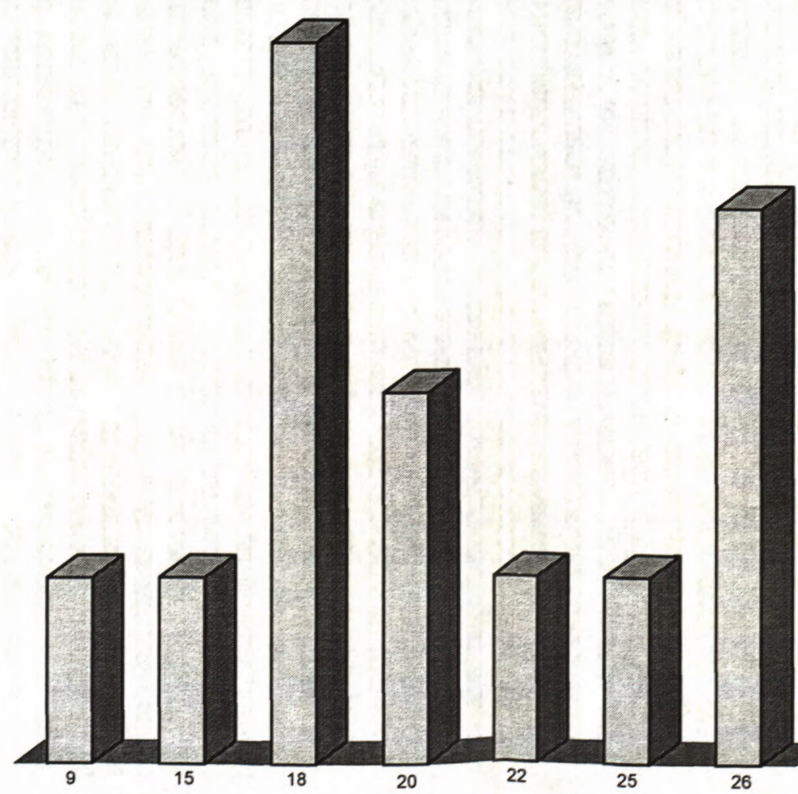


Chart 5 The frequency of Taxons in Bed No. 4

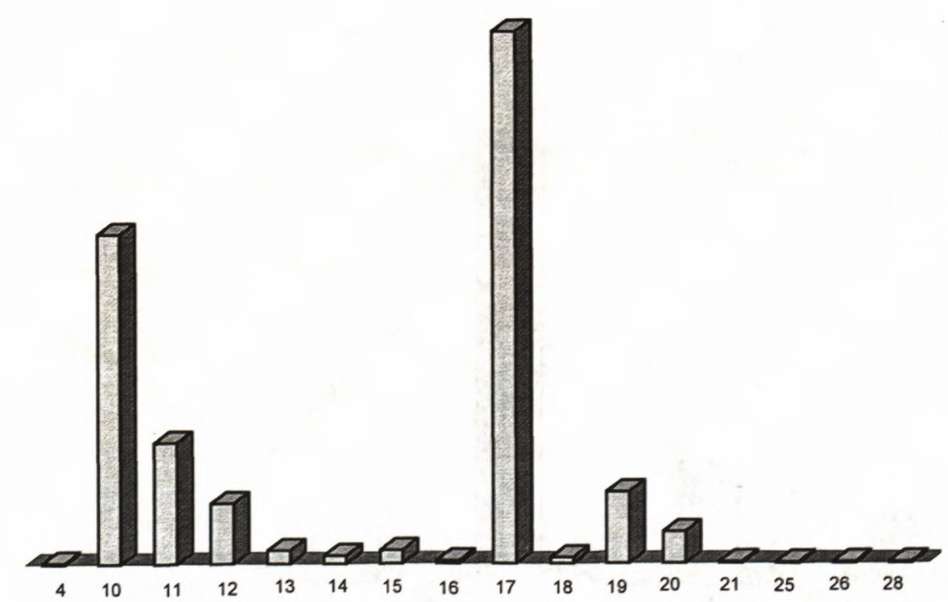


Chart 6 The frequency of Taxons in Bed No. 5

Tab. 3 The frequency of Biotops on the outcrop Mnešice

Sample No.	Sampling depth (m)	L	L / V /	L / V	L / M /	O	S	M	RL	VS	H
1	0.15 - 0.30	-	-	-	-	50.00	-	25.00	25.00	-	-
2	0.40 - 0.60	-	-	-	-	20.00	40.00	-	20.00	20.00	
3	0.60 - 0.80	-	-	-	-	50.00	25.00	-	25.00	-	-
4	0.80 - 1.00	-	-	-	-	-	40.00	40.00	20.00	-	-
5	1.00 - 1.15	-	-	-	-	-	50.00	33.30	16.60	-	-
6	1.15 - 1.35	-	-	-	-	20.00	40.00	30.00	10.00	-	
7	1.35 - 1.60	-	-	-	-	-	66.60	33.30	-	-	-
9	1.80 -2.05	fragments of fauna									
10	2.05 - 2.30	-	-	-	-	40.00	40.00	20.00	-	-	-
11	2.30 - 2.60	-	-	-	-	63.96	36.03	-	-	-	-
12	2.60 - 2.90	-	0.58	-	-	68.42	30.40	0.58	-	-	-
13	2.90 - 3.20	-	-	-	-	65.08	34.05	0.86	-	-	-
14	3.20 -3.50	-	-	-	-	43.90	56.09	-	-	-	-
15	3.50 - 3.80	-	-	-	-	55.55	44.44	-	-	-	-
16	3.80 - 4.10	-	-	-	-	55.55	44.44	-	-	-	-
17	4.10 -4.25	-	-	-	-	16.66	83.33	-	-	-	-
18	4.25 -4.45	-	-	-	-	-	100.00	-	-	-	-
19	4.45 - 4.60	-	-	-	-	-	100.00	-	-	-	-
20	4.60 - 4.80	-	-	-	-	100.00	-	-	-	-	-
22	5.00 - 5.30	fragments of fauna									
23	5.30 - 5.40	negative sample									
24	5.40 - 5.70	7.10	-	-	-	35.71	28.57	-	7.10	21.42	-
25	5.70 - 6.00	-	-	-	-	32.25	9.67	-	3.22	54.83	-
26	6.00 - 6.30	2.43	2.43	2.43	-	24.39	2.43	4.87	-	60.97	-
27	6.30 - 6.60	-	9.40	0.85	-	34.18	11.96	3.41	14.52	25.64	-
28	6.60 - 6.80	0.52	13.02	1.04	-	37.50	8.85	3.64	8.33	26.04	1.04
29	6.80 - 7.10	-	7.81	3.12	-	26.56	-	7.81	4.68	50.00	-
30	7.10 - 7.40	-	2.77	2.77	-	15.27	-	8.33	18.05	52.77	-
31	7.40 - 7.70	-	-	7.69	-	19.23	-	17.09	-	65.38	-
32	7.70 -8.00	-	-	-	-	-	-	100.00	-	-	-
34	8.30 - 8.60	negative sample									
35	8.60 - 8.90	negative sample									
36	8.90 - 9.20	fragments of fauna									
37	9.20 - 9.50	fragments of fauna									
38	9.50 -9.80	negative sample									
39	9.80 - 10.10	negative sample									
40	10.10 - 10.40	negative sample									
42	10.70 - 10.90	negative sample									
43	10.90 - 11.10	negative sample									
45	11.30 - 11.50	negative sample									
46	11.50 - 11.80	negative sample									
47	11.80 - 12.10	negative sample									
48	12.10 - 12.40	negative sample									
49	12.40 - 12.70	negative sample									

Ecologic characteristics

According to ecology the identified fauna represents forest-free, forest and even water biotops. A detail analysis of the occurrence of biotops typical for every identified species in the individual samples is shown in Tab. 3 and schematicaly on the chart 11.

On the basis of biotop analysis of the identified fauna species we can divide the profile into three major units from the viewpoint of ecology. In the superposed beds 2, 3 and partly also 4 (samples 1 - 9) we observe open landscape and steppes biotops prevailing biotops with higher requirements for humidity. An entire substitution of humid biotops with biotops of open landscape and steppes is observable in the central part of the profile corresponding to the beds number 5, 6 and 7 (samples 10 - 20). On the contrary in the beds 10, 11 and partly also in the bed 12 (samples 24 - 35) we observe a progressive substitution of biotops of open landscape and steppes with biotops with smaller requirements for humidity. We meet here even forest and water biotops.

The changes of relative occurrence of biotops in the individual parts of the profile reflect climatic changes which were taking place during formation of the studied deposits. Together with the analysis of taphocenosis of identified species in individual profile beds they suggest the stratigraphy of loess profile.

Biostratigraphic conclusions

Bed No. 2 (sample 1: 0.15 - 0.40 m)

Loess species of cold glacial climate as North-Asian species Vallonia tenuilabis and European? species *Pupilla loessica* occur in bed No. 2. Together with them species occasionally occurring in loesses are present in the sample e.g. European species *Trichia hispida*, Meridial species Orcula dolium and Central- and North-European species *Arianta arbustorum.* These species occur in moderately humid and humid biotops. They represent pupilla and columella fauna of cold periods. The species Arianta arbustorum indicates forest environment. It especially occurs in the late cold or early warm period. On the basis of biotops and species composition we can characterize the landscape during the deposition of the bed as a steppes with islands of park taiga. The climate is cold with conspicuous warmer and more humid fluctuations (-1(C +3(C). Stratigraphicaly we assign this bed to the latest Würm glacial, at the beginning of the late glacial.

Bed No. 3 (samples 2 - 5: 0.40 - 1.15 m):

Loess species and the species occasionally present in loess occur in the bed No. 3. They represent both the unpretentious fauna of steppes containing the main species as the Central- European species Helicopsis striata, Pontomeridial species *Chondrula tridens* nd also more humid fauna containing species as Euro-Sibirian species Perforatella rubiginosa, holoarctic species *Vallonia costata* and *Nesovitrea hammonis* and Central-European species *Clausilia dubia.* According to the occurrence of species *Vallonia costata* suggesting a mild climate as well as other indications we assign the bed No. 3 to the final phases of the Latest Würm (W3) main glacial . The sedimentary environment is thought to be steppes with park taiga islands.

Bed No. 4 (samples 6 - 9: 1.15 - 2.05 m):

The fauna of loess species and species occassionally occurring in loess is described in the bed No. 4. The warm or cold character of the fauna is ambiguous. It does not contain representants of the Pupilla fauna. We characterize it as a mixtured fauna. It contains Central-North European species *Arianta arbustorum*, Boreoalpine extinct species *Vertigo parcedentata*, holoarctic species *Vallonia costata,* Central-European species *Helicopsis striata*, Pontomeridial species *Chondrula tridens* and *Orcula dolium* and others. The increased number of mollusc test fragments, especially in depth 1.8 - 2.05 m may suggest deposition by rainwash. On the basis of grain-size analysis, environmental fauna composition as well as general characteristics of the identified fauna we assign the origin of the bed to a warmer phase of a glacial, most likely to the last Würm interstadial W2/3. It may be an uncompletely developed soil complex PK-1 corresponding to the Stillfried B soil complex.

The depositional environment is interpreted as a park taiga with average temperature about 0 °C. The climate is little warmer but not too humid according to the occurrence of xerophilous species *Helicopsis striata.*

Bed No. 5 (samples 10 - 17: 2.05 - 4.25 m):

In the bed No. 5 there are again present loess species and species sporadically occurring in loesses. They indicate dry and cool climate of a glacial, especially the Central-European species *Helicopsis striata* as an indicator of a dry climate and species of a cool Boreoalpine assemblage as North-Asian species *Vallonia teniulabris*, *Pupilla loessica* and *Pupilla muscorum densegyrata.* Interesting is a complete absence of the Euro-Sibirian species Succinia oblonga and its substitution by the Atlantic species *Catinella arenaria*, which is by Kovanda (1991) considered as a representant of the Early Pleistocene. However, the occurrence of this species in Slovakia is proved in younger deposits of the Middle Würm (e.g. in Trnava brick kiln). On the basis of the environmental as well as species composition of the fauna we interpret the depositional environment as a cold steppes of the main Würm glacial - stadial W2.

Bed No. 6 (samples 18 - 19: 4.25 - 4.60 m), No. 7 (sample 20: 4.60 - 4.80), No. 8 (sample 21 - 22: 4.80 - 5.30 m), No. 9 (sample 23: 5.30 - 5.40):

The above mentioned beds belong to the lithofacially described soils. Only sporadically occurring fauna determines only approximate environmental and biostratigraphic interpretation of the beds. Considering all up to now available facts, not only fauna study but also physical-chemical properties of the sediments, we can assume their origin during warmer and more humid climate. It would be consistent with the uncomplete development of the soil complex PK II of the interstadial W1/2.

Bed No. 10 (samples 24 - 28: 5.4 - 6.8 m):

The identified fauna in the loess bed No. 10 has a varied species and environmental composition. The loess species, varying from index species to the species occasionally occurring in loesses, are represented here. The fauna has a mixtured character. On one side there are species of a cool loess deposition as European species *Vitrea crystallina,* Boreoalpine species *Columella columella*, the representants of Pupilla fauna. On the other side there are species of warmer, arianta fauna containing the Central-North European species *Clausilia pumila,* Alpine-Central European species *Semilimax semilimax* and East-European species *Perforatella bidentata.* The last one is typical for a marginal phase of glacials and indicates a close neighbouring of interglacial horizons or their hiatuses. Comparing to the former beds, the forest environment is more conspicuous in the bed. The absence of the species Helicopsis striata and frequent occurrence of Euro-Sibirian species *Succinea oblonga* indicates increased humidity of climate. This interpretation is strengthen by the presence of the holoarctic species *Lymnaea trunculata,* even though only one individual, which shows the increased humidity and watering of the depositional environment. The fauna, similarly to the fauna of bed No. 11, can be assigned as a marginal fauna of Würm glacial (we are speaking about early development of the stadial W1).

Bed No. 12 (samples 31 - 35: 7.4 - 8.9 m):

The more humid ariant fauna occurs only in the upper part of the bed. The fauna is represented by species as Arianta arbustorum, East-European species *Perforatella bidentata*, East-Central European species *Clausilia pumila*, palaeoarctic species *Punctum pygmaeum* and others. They indicate humid and warmer climate. The part of the soil sediment in the depth 8.3 - 8.9 m could be an analogue of the described motley soil found in the Mnešice brick kiln (Ložek and Tyráček 1960). It comprises the most important horizon of soil complex PK III. Considering all available information we can assume that at least a part of this sediment originated during the last R/W interglacial and it is a part of the Stillfried complex A.

The underlying loess beds without fauna content and only occasional fragments is difficult to interpret stratigraphicaly. The entire underlying complex is strongly decalcified and it has an acid soil reaction. The increased amount of clay fraction as well as presence of Mn oxides shows possible redeposition of the sediments. They can be rests of the loess deposits from the Riss glacial. The beds No. 14 and 15 with indications of initial soil could suggest warmer fluctuation of R1/2 Treene interglacial. This would be consistent with soil horizon PK-IV.

Conclusion

On the basis of the obtained data it is possible to state that the studied outcrop confirmed a complexity of the Dolnø Váh valley development during the Middle and Late Pleistocene. The complexity reflects the erosive and depositional activity of water and wind. The fauna development points to climatic changes as well as to finer climatic oscillation during the time of the origin of the studied deposits. It enables to recognize two major types of fauna: cold fauna of stadials (glacials) with prevailing species of pupilla and columella fauna and mixtured faun of interstadials (interglacials) and transitional periods with prevailing species of tridens and ariant fauna. This renders a stratigraphic correlation with another loess profiles of Dolný Váh river area.

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Tab. I

Fig. 1a, b, c *Trichia hispida*	width: 3.9 mm
Mnešice, sample No. 28: 6.6–6,8 m	hight: 2.1 mm
Fig. 2a, b, c *Helicopsis striata*	width: 4.0 mm
Mnešice, sample No. 14: 3.2–3.5 m	hight: 5.7 mm

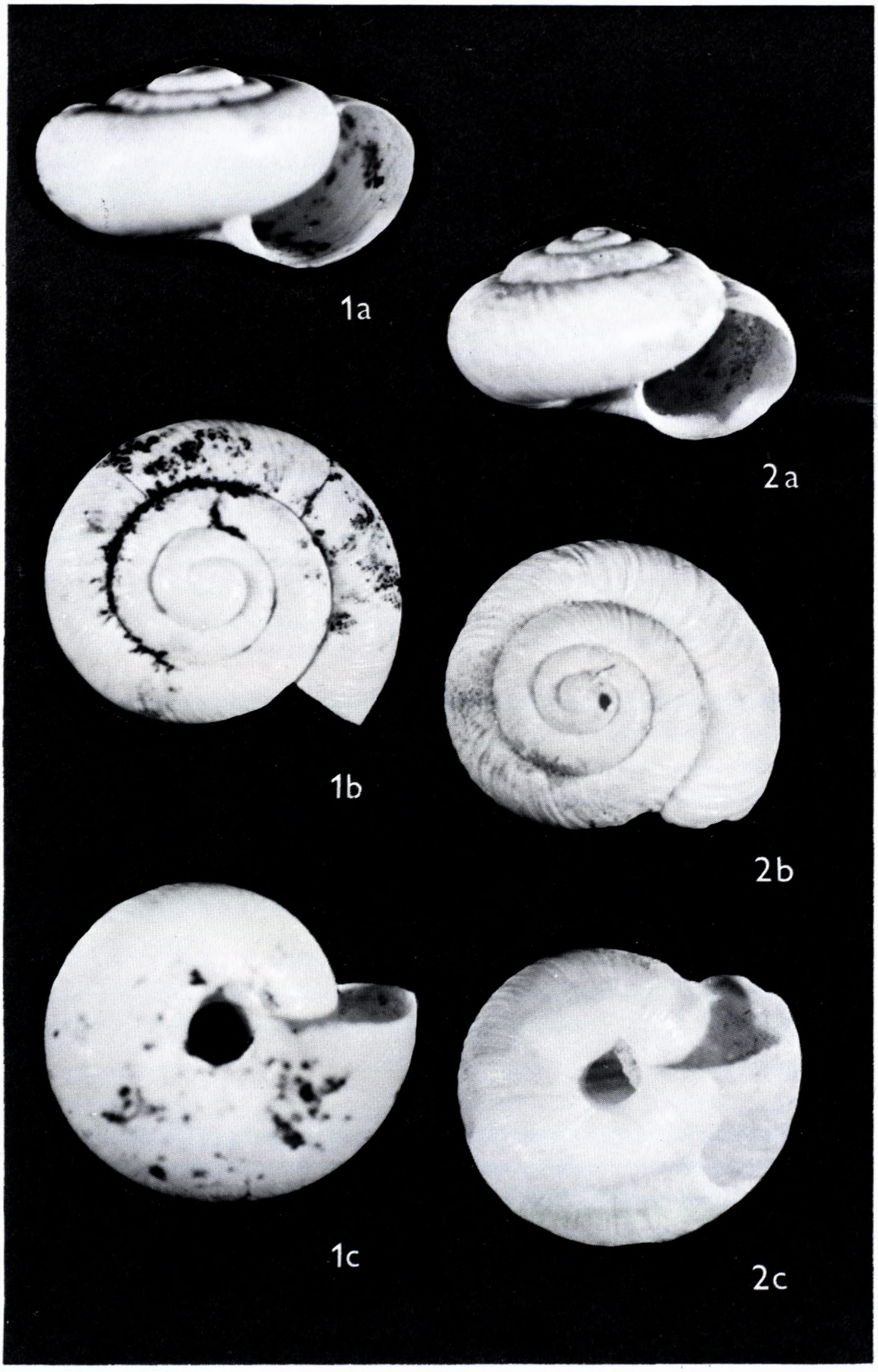
Tab. II

Fig. 3a, b, c *Vitra crystallina*	width: 1.5 mm
Mnešice, sample No. 28: 6.6–6,8 m	hight: 3.0 mm
Fig. 4a, b *Vallonia tenuilabris*	width: 1.4 mm
Mnešice, sample No. 11: 2.3–2.6 m	hight: 3.0 mm
Fig. 5a, b, b *Vallonia pulchella*	width: 1.1 mm
Mnešice, sample No. 20: 4.6–4.8 m	hight: 2.1 mm

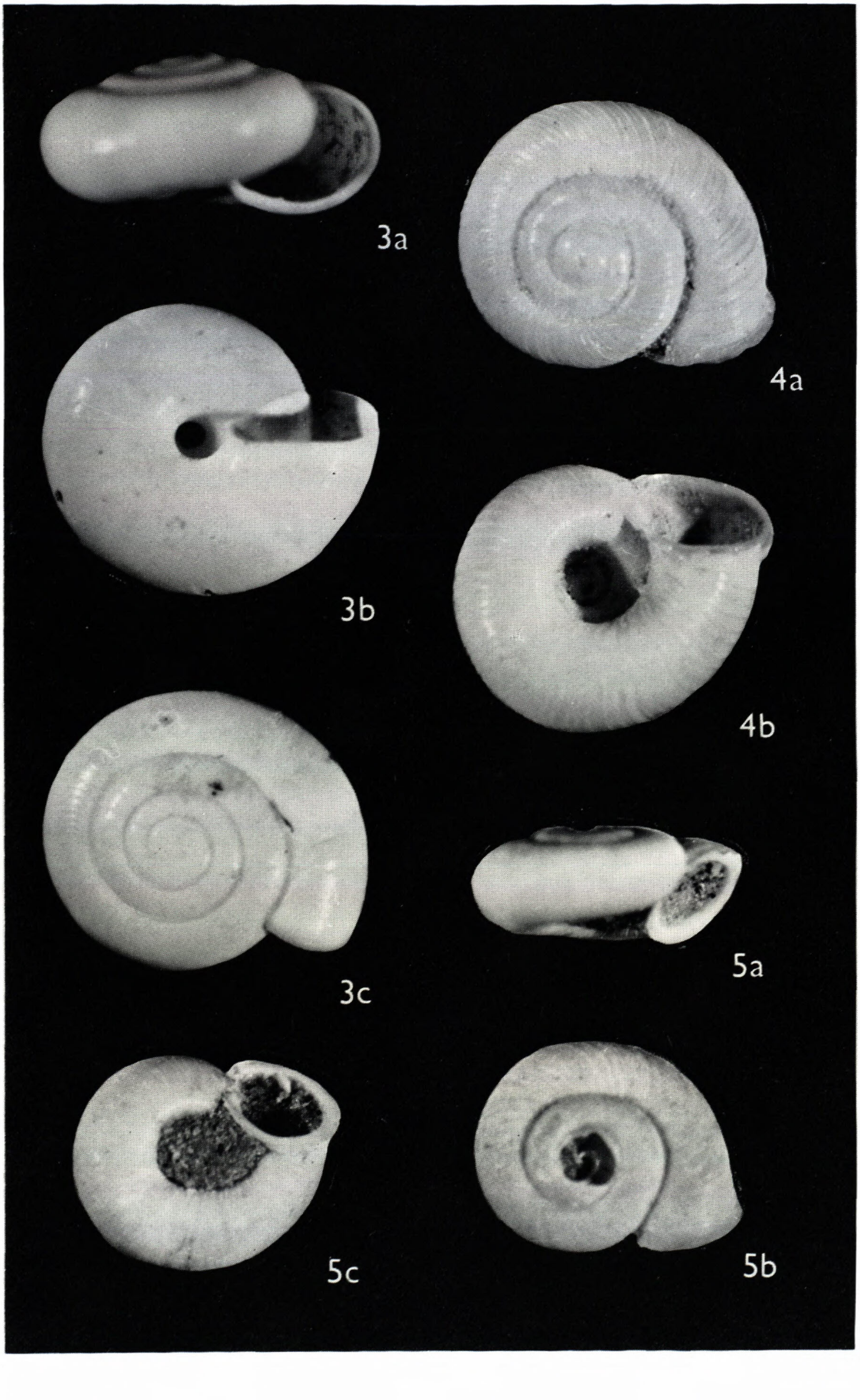
Tab. III

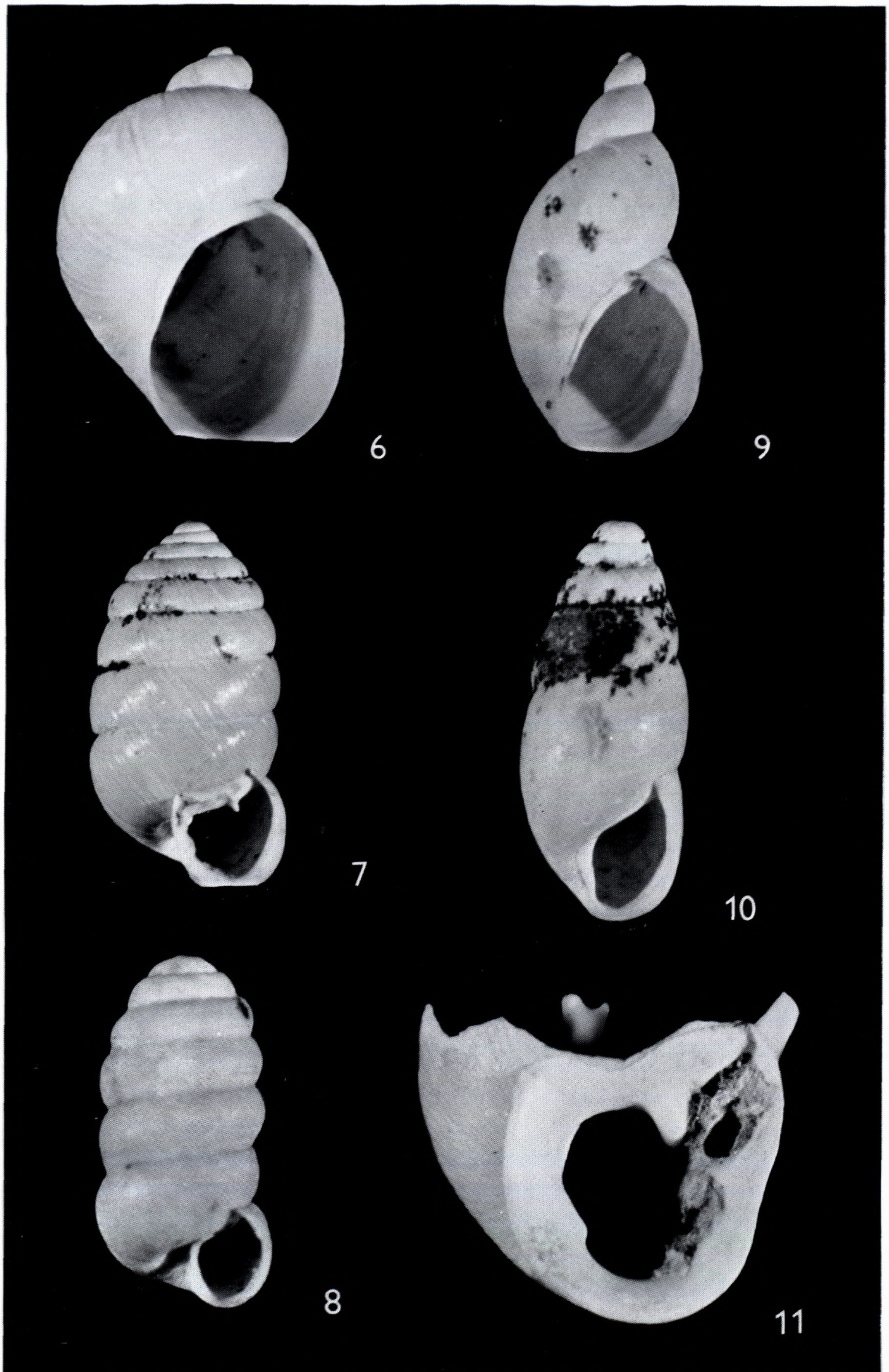
Fig. 6 *Catinella arenaria*	width: 7.0 mm
Mnešice, sample No. 13: 2.9–3.2 m	hight: 4.3 mm
Fig. 7 *Orcula dolium*	width: 6.8 mm
Mnešice, sample No. 29: 6.8–7.1 m	hight: 3.1 mm
Fig. 8 *Columella columella*	width: 3.0 mm
Mnešice, sample No. 28: 6.6–6.8 m	hight: 1.2 mm
Fig. 9 *Succinea oblonga*	width: 9.0 mm
Mnešice, sample No. 28: 6.6–6.8 m	hight: 4.0 mm
Fig. 10 *Cochlicopa lubrica*	width: 6.0 mm
Mnešice, sample No. 29: 6.8–7.1 m	hight: 2.1 mm
Fig. 11 *Chondrula tridens*	
Mnešice, sample No. 15: 3.5–3.8 m	

Tab. I



Tab. II

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Molluscs (gastropoda, bivalvia) from the Pannonian deposits of the western part of Danube Basin (Pezinok-clay pit)

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Abstract: Rich assemblages of molluscs were found in deposits of a clay pit, which is a part of the brick kiln facility located near the town of Pezinok on the western margin of the Danube lowland. The evaluation of molluscs suggested the assignment of fossil bearing deposits to the Pannonian zone E. Thirty species (subspecies) of gastropods were described; one of them was described as cf. and one only as genus. Seventeen species (subspecies) of bivalvia were described; one of them as cf., one as a possible new subspecies and one only as a genus.

Key words: Danube Basin, Pannonian, Gastropoda, Bivalvia, Systematics

Introduction

Pannonian deposits of the Danube lowland are mostly known only from boreholes. Outcrops are very scarce due to the great thickness of Pliocene and Quaternary deposits. One of the most important outcrops is at the clay pit of brick kiln in Pezinok. This outcrop is located in the Trnava - Dubnica Basin (a part of Danube Basin), more precisely, in Blatna depression (Vasss and others, 1988).

The clay pit of the brick kiln is located about 1 km southeast of the railway station Pezinok (Fig. 1). Recently the outcrop was studied by Fordinal (1986) and Holec and others (1987). The molluscs (gastropods and bivalves) were described by Holec and others (1987) and are also the objective of this paper revised. These molluscs are the objective of this paper.

Review of previous researches

The oldest report on mollusc occurrence from the Pezinok surroundings was given by Horusitzky (1907). He reported a rich mollusc assemblage from the base of the pit at the brick kiln near the road to Schweinsbach (Viničné). He found the following species: *Congeria neumayri* Andrusov, *Congeria* sp., *Dreissensia auricularis* Fuchs, *Unio atavus* Partsch, *U. matyasovzkyi* Halav., *U. neumayri* Penecke, *Anodonta* cfr. *pontica* Lörenthey, *Limnocardium conjungens* Partsch, *Valvata variabilis* Fuchs, *V. kupensis* Fuchs, *Pyrgula (Micromelania) schwabenaui* Fuchs, *Melanopsis sturii* Fuchs, *M. entzi* Brusina, *M. pygmaea* Partsch, *M. (Lyrcaea)* cfr. *vindobonensis* Fuchs, a transition form between *M. vindobonensis* and *M. impressa*, *Planorbis* cfr. *cornu* (Brougn.), *Helix* cfr. *baconicus* Halavats, *Limnaea* sp.

Horusitzky (1907) assigned the fossiliferous deposits sensu Halavats to the uppermost part of the horizon with the *Congeria balatonica,* which passes upward into horizon with *C. rhomboidea* (Middle Pontian) According to Lörenthey he put these deposits after horizon characterized by the species *Congeria triangularis* and *C. balatonica* (Upper Pannonian). He explained the mixtured character of mollusc fauna by the existence of a creek flowing into a brackish lake nearby Pezinok.

Pokorný (1946) reports the following occurrence of species from the old clay pit: *Congeria subglobosa* Partsch and *C. ungulacaprae* Münster.

At the same sites palynomorphs in the Pannonian clays were studied by Sitár (1958). He found that the basal layers of the clay pit contain temperate plant forms (*Ginkgo, Magnolia* and *Podocarpus*) buttle in these upper layers do not. Genera typical of cooler climate started to occur and in hidnest beds (immediately underlying loess) genera of todays types occurr (*Betula* sp., *Tilia* sp., *Alnus* sp.).

Cílek (1960) assigned the deposits in the clay pit of the brick kiln to the Lower and Middle Pannonian. He found the following mollusc species: *Congeria subglobosa* Partsch, *Melanopsis bouei* Fér., *M. pygmaea*

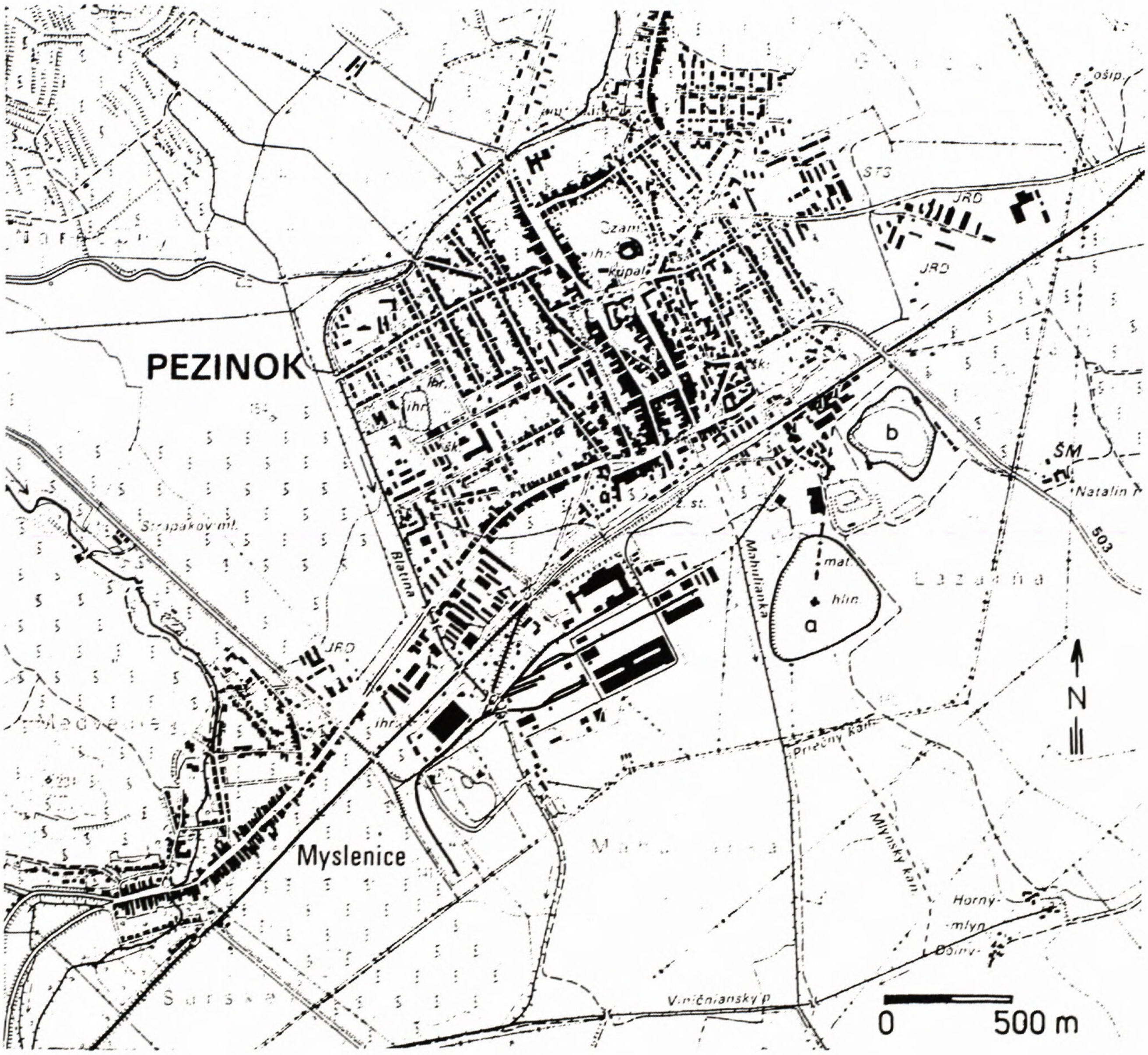

Fig. 1: Location of the clay pit for the brick kiln in Pezinok. a - "new" clay pit b - "old" clay pit (present covered)

Partsch, *Cardium* sp. and ostracods: *Cyprideis heterostigma sublitoralis* Pok., *C. pannonica* (Meh.), *Candona unguiculus* (Reuss), *C. multipora* Pok., *Candona* sp., *Erpetocypris recta* (Rss.), *E. abcissa* (Rss.), *Hemicythere* cf. *lörenthey* (Meh.) and *Hemicythere* sp..

From the "new" clay pit of the Pezinok brick kiln (Fig. 1) Holec (1981) reports finding a tooth belonging to the species *Hipparion primigenium* (H.v. Meyer).

The palaeoecology of the Pannonian - Pontian transition period was reconstructed from the palynologe mollusc fauna and clay Rtg analyses (Holec et al. 1987).

The species *Congeria doderleini* Brusina from this deposits was biometrically evaluated (Fordinál 1991).

Description of the clay pit deposits

The deposits consisting mostly of clays and same sands beds. A seguence of 48 petrographically distinct beds were described by Fordinál (1986) and Holec and others (1987). A molluscan fauna was found in four beds 26, 34, 36 and 42 (Fig. 2).

Bed 26 (Fig. 4) - consists of sand. Among the abundant molluscan fragments and the following species: *Theodoxus soceni* Jekelius, *T. postcrenulatus* Papp, *Valvata obtusaeformis* Lörenthey, *Melanopsis pygmaea mucronata* Handmann, *Congeria neumayri* Andrusov etc.

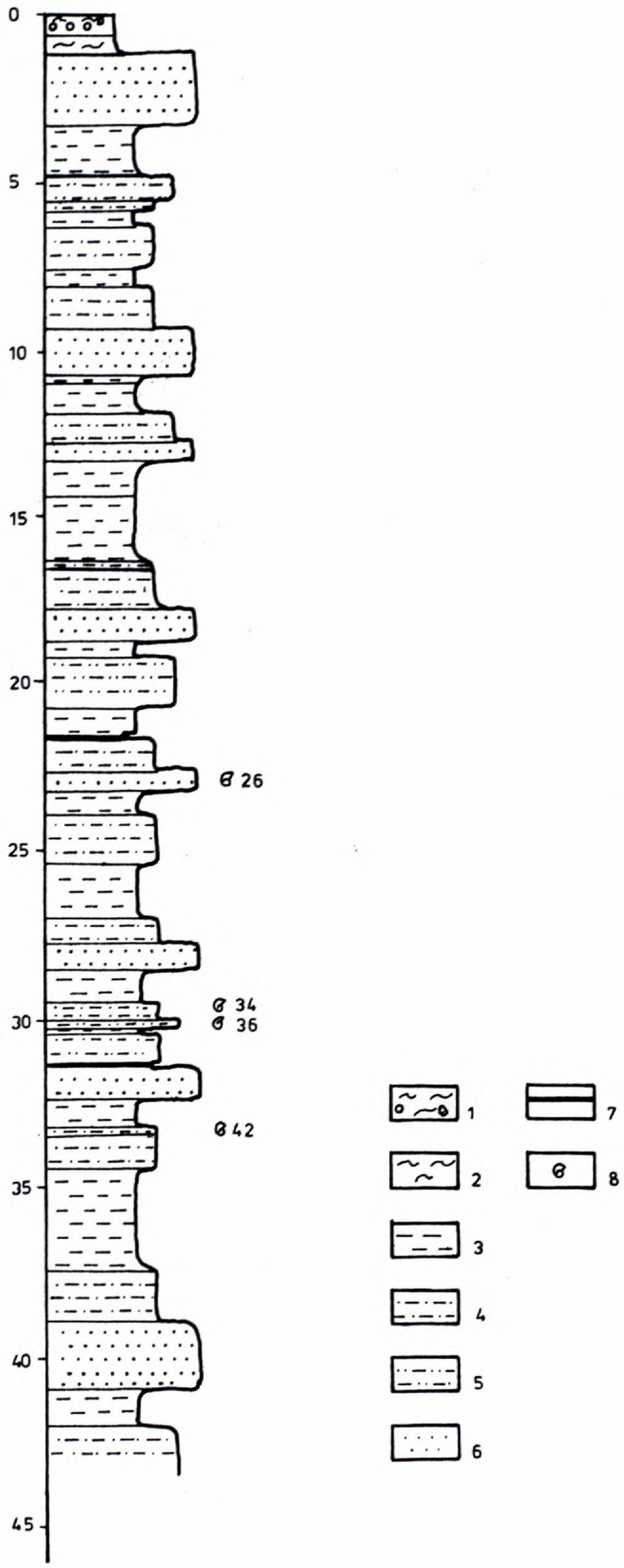

Fig. 2: Schematic lithologic profile through the clay pit in Pezinok. 1 - loam with clasts, 2- loam, 3- clay, 4 - sandy clay, 5 -clayey sand, 6 - sand, 7-lignite, 8- mollusc occurrence

Bed 34 consist of sandy clay containing abundant of bivalvia shells *Congeria ungulacaprae* Münster, *C. subglobosa subglobosa* Partsch, *C. spathulata* n. ssp.?. It also contains the gastropods: *Micromelania loczyi* Lörenthey, *Melanopsis affinis* Handmann, *Stenothyrella ovoidea* (Pavlovic) etc.

Bed 36 (Fig. 5) - comprises clayey sand containing abundant shell fragments and the following gastropods were: Subfacies *Melanopsis impressa* Krauss, *M. pygmaea pygmaea* M. Hoernes, *M.pygmaea mucronata* Handmann, *Pyrgula hungarica* Lörenthey and bivalvia *Congeria ungulacaprae* Münster, *C. doderleini* Brusina, *Dreissena bipartita* Brusina, *Lymnocardium conjungens* (Hoernes) etc.

Bed 42 is a sandy clay containing a poor molluscan assemblage of the gastropods *Melanopsis sturii* Fuchs and *Valvata obtusaeformis* Lörenthey.

Biostratigraphic assignment

The biostratigraphic assignment of the Pezinok clay pit deposits was made on the basis of the mollusc assemblages. I used the division of the Pannonian sensu Papp (1951) and Rögl et al. (1993) (Tab. 2). A total of 47 species and subspecies of mollusc, a 30 were gastropods and were bivalves (Tab. 1).

The mollusc assemblages contained species known from the entire Pannonian age. These species are only of minor biostratigraphic importance. They include: *Theodoxus intracarpaticus* Jekelius, *Micromelania variabilis* Lörenthey, *Melanopsis bouei affinis* Handmann, *M. bouei sturii* Fuchs, *M. pygmaea pygmaea* M. Hoernes, *Congeria neumayri* Andrusov etc.

Species *Dreissenomya primiformis* Papp, *Congeria subglobosa subglobosa* Partsch, *C. subglobosa longitesta* Papp, *Lymnocardium edlaueri* Papp, *L. conjungens* (Hoernes), *Monodacna viennensis* Papp and *Didacna deserta* (Stoliczka), had a great importance as to stratigraphic assignment of the sediment studied. They enabled to assign the fosiliferous beds to the Pannonnian E zone. Stratotype locality of the Pannonian E zone is Karagac (Stevanovic, 1985).

Nine of forty seven molluscs found in the Pezinok clay pit are identical to the mollusc of stratotype locality. They are: *Stenothyrella ovoidea* (Pavlovic), *Pyrgula hungarica* Lörenthey, *Bithynia jurinaci* (Brusina), *Melanopsis impressa* Krauss, *M. pygmaea* M. Hoernes, *M. vindobonensis* Fuchs *Congeria ungulacaprae* (Münster), *Dreissena bipartita* (Brusina) and *Didacna deserta* (Stoliczka).

Fig. 3: View of the southern part of the clay pit. Photo M. Horník

Fig. 4: Close-up of bed 26. Photo M. Horník

Fig. 5: Close-up of bed 36. Photo M. Horník

Tab. 1: The occurrence of species in the individual beds of the Pezinok clay pit

Species	Number of layers			
	26	34	36	42
GASTROPODA				
Theodoxus postcrenulatus	+			
Theodoxus soceni	+			
Theodoxus intracarpaticus		+		
Theodoxus leobersdorfensis dacicus	+			
Theodoxus turislavicus turislavicus	+		+	
Valvata obtusaeformis	+			+
Valvata gradata globulosa		+		
Stenothyrella ovoidea		+	+	
Prososthenia cf. *serbica*		+		
Pyrgula hungarica			+	
Pyrgula unicarinata			+	
Pyrgula incisa			+	
Bithynia jurinaci			+	+
Micromelania loczyi		+		
Micromelania banatica fuchsi			+	
Micromelania variabilis	+		+	
Micromelania bielzi		+		
Caspia sp.	+			
Melanopsis impressa impressa			+	
Melanopsis impressa carinatissima			+	
Melanopsis impressa pseudonarzolina			+	
Melanopsis impressa posterior			+	
Melanopsis vindobonensis		+		
Melanopsis affinis		+	+	
Melanopsis sturii				+
Melanopsis bouei multicostata			+	
Melanopsis pygmaea pygmaea			+	
Melanopsis pygmaea mucronata	+		+	
Melanopsis pygmaea turrita	+		+	
Melanopsis handmanni			+	
Gyraulus chaenostomus			+	
BIVALVIA				
Congeria neumayri	+		+	
Congeria spathulata nov. ssp.?		+		
Congeria doderleini			+	
Congeria ringeiseni		+		
Congeria gitneri			+	
Congeria ungulacaprae			+	
Congeria croatica			+	
Congeria subglobosa subglobosa		+		
Congeria subglobosa longitesta		+		
Dreissena bipartita			+	
Dreissena cf. turislavica			+	
Dreissenomya primiformis			+	
Psilunio atavus			+	
Lymnocardium edlaueri	+			
Lymnocardium conjungens		+		
Didacna deserta			+	
Monodacna viennensis		+		
Pisidium sp.	+			

Tab. 2 Opinions of the stratigraphic ranging of the Pannonian zones into individual stages

Papp, 1951		Papp, 1985	Bartha, 1971			Rogl et al., 1993
PANNONIAN	H	PONTIAN	PANNONIAN	Upper	middle part	PANNONIAN
	G					
	F				lower part	
	E	PANNONIAN		Lower		
	D					
	C					
	B					
	A					

Systematic part

Classis *GASTROPODA*
Subclassis *PROSOBRANCHIA*
Ordo *ARCHAEOGASTROPODA*
Familia *NERITIDAE*
Subfamilia *NERITINAE*
Genus *Theodoxus* Monfort, 1810
Typical species *Theodoxus fluviatilis* (Linnaeus)

Theodoxus (Theodoxus) postcrenulatus **Papp, 1953**

(Tab. I , Fig. 1)

1953 *Theodoxus (Theodoxus) postcrenulatus* n.sp. - Papp: p. 96, Tab. 2, Fig. 1-3

Sample: 5 individuals
Description: Papp (1953) p. 96
Size: Tab. I, Fig. 1 hight = 3,6 mm width = 5,4 mm
Occurrence: Pezinok, bed 26
Stratigraphic and geographic extent: The species known only from the Pannonian zone F of Austria (Götzendorf).

Theodoxus (Theodoxus) soceni **Jekelius, 1944**

(Tab. I, Fig. 5)

1944 *Theodoxus soceni* n.sp. - Jekelius: p. 51, Tab. 5, Fig. 7-26, p.113, Tab. 41, Fig. 25-26
1953 *Theodoxus (Theodoxus) soceni* Jekelius - Papp: p. 96, Tab. 2, Fig. 12-15
1979 *Theodoxus (Theodoxus) pilari soceni* (Jekelius)-Jurašic-Polšak: p. 20, Tab. 4, Fig. 3-6

Sample: 32 individuals
Description: Jekelius (1944) p. 51, 113
Size: Tab. I, Fig. 5 hight = 4,0 mm width = 5,8 mm
Occurrence: Pezinok, bed 26
Stratigraphic and geographic extent: The species is known from the Sarmatian and Pannonian of Romania and from the Pannonian D-E zone of Austria (Vösendorf, Gaja).

***Theodoxus (Theodoxus) intracarpaticus* Jekelius, 1944**
(Tab. I, Fig. 3)

1944 *Theodoxus intracapaticus* n.sp. - Jekelius: p. 112, Tab. 41, Fig. 1-24
1953 *Theodoxus (Theodoxus) intracarpaticus* Jekelius - Papp: p. 97, Tab. 2, Fig. 4-11
1992 *Theodoxus intracarpaticus* Jekelius - Magyar: p.297, Tab. 4, Fig. 1-3

Sample: 1 individual
Description: Jekelius (1944) p. 112
Size: Tab. I, Fig. 3 hight = 2,0 mm width = 3,0 mm
Occurrence: Pezinok, bed 34
Stratigraphic and geographic extent: The species is known from the Pannonian C-E zone of Austria (Vösendorf, Leobersdorf, Siegendorf, Regelsbrunn, Laaerberg), the Pannonian C-D zone of Romania (Turislav) and in the Upper Pannonian of Hungary.

***Theodoxus (Theodoxus) leobersdorfensis dacicus* Jekelius, 1944**
(Tab. I, Fig. 4)

1944 *Theodoxus dacicus* n.sp. - Jekelius: p. 114, Tab. 42, Fig. 8-11
1953 *Theodoxus (Theodoxus) leobersdorfensis dacicus* Jekelius - Papp: p. 99, Tab. 2, Fig. 32
1979 *Theodoxus (Theodoxus) leobersdorfensis dacicus* (Jekelius) - Jurišic - Polšak: p. 20, Tab. 4, Figs. 3-6

Sample: 1 individual
Description: Jekelius (1944) p.114
Size: Tab. I, Fig. 4 hight = 2,5 mm width = 3,5 mm
Occurrence: Pezinok, bed 26
Stratigraphic and geographic extent: This subspecies is known from the Pannonian D/E zone of Austria (Vösendorf, Gaja) and in the Pannonian C-D zone of Romania (Turislav).

***Theodoxus turislavicus turislavicus* Jekelius, 1944**
(Tab. I. Fig. 2)

1944 *Theodoxus turislavicus* n. sp. - Jekelius: p. 114, Tab. 42, Figs. 17-19
1953 *Theodoxus (Theodoxus) turislavicus turislavicus* Jekelius - Papp: p. 100, Tab. 2, Fig. 16-18

Sample: 16 individuals
Description: Jekelius (1944) p. 114
Size: Tab. I, Fig. 2 hight = 2,8 mm width = 3,4 mm
Occurrence: Pezinok, beds 26 and 36
Stratigraphic and geographic extent: This taxon is known from the Pannonian C zone of Austria (Leobersdorf) and the Pannonian C-D zone of Romania (Turislav).

Ordo *MESOGASTROPODA*
Familia *VALVATIDAE*
Genus *VALVATA* Müller, 1774
Subgenus *CINCINNA* Ferussac, 1821
Typical species *Valvata piscinalis* Müller

***Valvata (Cincinna) obtusaeformis* Lörenthey, 1911**

1911 *Valvata (Cincinna) obtusaeformis* nov. sp. - Lörenthey: p. 147, Tab. 3, Fig. 20
1953 *Valvata (Cincinna) obtusaeformis* Lörenthey - Papp: p. 110, Tab. 3, Figs. 20-22, Tab. 5, Fig. 2

Sample: 462 individuals
Description: Lörenthey (1911) p. 174
Occurrence: Pezinok, beds 26 and 42
Stratigraphic and geographic extent: This species occurs in the Pannonian F/G zone of Austria (Moosbrunn) and in the Upper Pannonian of Hungary (Öcs).

***Valvata (Cincinna) gradata globulosa* Jekelius, 1944**
(Tab. I, Fig. 6)

1944 *Valvata (Cincinna) gradata globulosa* n.var. - Jekelius: p. 117, Tab. 43, Fig. 18-20

Sample: 5 individuals
Description: Jekelius (1944) p. 117
Size: Tab. I, Fig. 6 hight = 2,2 mm, size = 2,5 mm
Occurrence: Pezinok, bed 34
Stratigraphic and geographic extent: The subspecies is known only from the Pannonian C-D zone of Romania (Turislav).

Familia *STENOTHYRIDAE*
Genus *STENOTHYRELLA* Wenz, 1939
Typical species *Stenothyrella lubricella* (Sandberger)

***Stenothyrella ovoidea* (Pavlovic, 1927)**
(Tab. I, Fig. 7)

1927 *Nematurella? ovoidea* nov. spec. - Pavlovic: p. 103, Tab. 14, Figs. 22-23
1944 *Stenothyrella ovoidea* Pavlovic - Jekelius: p. 122, Tab. 45, Figs. 6-8
1953 *Stenothyrella ovoidea* (Pavlovic) - Papp: p. 115, Tab. 7, Figs. 5-6

Sample: 15 individuals
Description: Pavlovic (1927) p. 103
Size: Tab. I, Fig. 7 hight = 2,9 mm, width = 1,5 mm
Occurrence: Pezinok, beds 34 and 36
Stratigraphic and geographic extent: This species is known from the Pannonian of Serbia, from the Pannonian C-D zone of Romania (Turislav) and from the Pannonian C zone of Austria (Leobersdorf).

Genus *PROSOSTHENIA* Neumayr, 1869
Typical species: *Prososthenia schwartzi* Neumayr

***Prososthenia* cf. *serbica* Brusina**
(Tab. II Fig. 7)

1902 *Prososthenia serbica* Brusina- Brusina: Tab. 8, Figs. 21-23

Sample: 3 individuals
Size: Tab. II, Fig. 7 hight = 4,0 mm width = 1,5 mm
Occurrence: Pezinok, beds 34
Stratigraphic and geographic extent: This species is known from the Pannonian of Serbia.

Famila *TRUNCATELLIDAE*
Genus *PYRGULA* Christoferi et Jan, 1832
Typical species *Paludina annulata* Linnaeus

***Pyrgula hungarica Lörenthey*, 1894**
(Tab. II, Fig. 5)

1894 *Pyrgula hungarica* nov. form. - Lörenthey: p. 86, Tab. 2, Fig. 9
1927 *Pyrgula hungarica* Lörenth. - Pavlovic. p. 100

Sample: 5 individuals
Description: Lörenthey (1894) p. 86
Size: Tab. II, Fig. 5 hight = 3,37mm,width = 1,26mm
Occurrence: Pezinok, bed 36
Stratigraphic and geographic extent: This species is known only from the Upper Pannonian of Hungaria (Kurd) and the Pannonian of Serbia.

***Pyrgula unicarinata* Brusina, 1902**
(Tab. II, Fig. 1)

1902 *Pyrgula unicarinata* Brus. - Brusina: Tab. 7, Fig. 83-85
1944 *Pyrgula unicarinata* Brus. var. - Jekelius: p. 122

Sample: 4 individuals
Size: Tab. II, Fig. 1 high t = 3,6 mm, width =?
Occurrence: Pezinok, bed 36
Stratigraphic and geographic extent: The species known only from the Pannonian C-D zone of Romania.

***Pyrgula incisa* Fuchs 1870**
(Tab.II, Fig.4)

1870 *Pyrgula incisa* Fuchs - Fuchs: p. 351, Tab. 14, Fig. 20-23
1902 *Pyrgula incisa* Fuchs - Lörenthey: p. 276
1911 *Pyrgula incisa* Fucs - Lörenthey: p. 142

Sample: 20 individuals
Description: Fuchs (1870) p. 351
Size: Tab. II, Fig. 4 hight = 3,6 mm width = 1,6 mm
Occurrence: Pezinok, bed 36
Stratigraphic and geographic extent: The subfacies is known from the Pannonian of Hungaria (Tihany, Fonyod) and Romania (Radmanest).

Familia *BITHYNIIDAE*
Genus *BITHYNIA* Risso, 1826
Typical species *Paludina tentaculata* Linnaeus

***Bithynia jurinaci* Brusina, 1884**
(Tab. III, Fig.10)

1884 *Bythinia Jurinaci* Brus. - Brusina: p. 31, 37
1902 *Bythinia Jurinaci* - Lörenthey: p. 243, Tab. 14, Fig. 5, Tab. 16, Fig. 6
1907 *Bithynia Jurinaci* Brus. - Troll: p. 52
1921 *Bithynia Jurinaci* Brusina - Wenz: p. 78
1927 *Bythinia Jurinaci* Brus. - Pavlovic: p.102
1953 *Bulimus (Bulimus) jurinaci* (Brusina) - Papp: p. 119, Tab. 3, Fig. 24, 25

Sample: 11 individuals
Description: Brusina (1884) p. 31
Size: Tab. III, Fig. 10 hight = 6,5 mm width = 4,0 mm
Occurrence: Pezinok, beds 36 and 42
Stratigraphic and geographic extent: The species occurs in the Pannonian zones C (Leobersdorf), E (Vösendorf), F (Götzendorf) and H (Eichkogel) of Austria and in the Pannonian of Hungaria (Tinnye).

Famila *MICROMELANIINAE*
Genus *MICROMELANIA* Brusina, 1874
Typical species *Micromelania cerithioides* Brusina

***Micromelania loczyi* Lörenthey, 1894**
(Tab. II, Fig. 9)

1894 *Micromelania* Lóczyi Nov. Form. - Lörenthey: p.84, Tab. 2, Figs. 6-8, 10

Sample: 10 individuals
Description: Lörenthey (1894) p. 84
Size: Tab. II, Fig. 9 hight = 3,0 mm , width = ?
Occurrence: Pezinok, bed 34
Stratigraphic and geographic extent: The species is only known from the Upper Pannonian of Hungary (Kurd).

***Micromelania banatica fuchsi* Papp, 1953**
(Tab. II, Fig. 2)

1928 *Goniochilus croaticus* (Brusina) - Wenz: p. 7, Abb. 1
1953 *Micromelania (Goniochilus) banatica fuchsi* n. ssp. - Papp: p. 122, Tab. 6, Fig. 9

Sample: 70 individuals
Description: app (1953) p. 122
Size: ab. II, Fig. 2 hight = 4,0 mm , width = 1,4 mm
Occurrence: Pezinok, bed 36
Stratigraphic and geographic extent: The subfacies known only from the Pannonian C zone of Austria (Leobersdorf).

***Micromelania variabilis* Lörenthey, 1902**
(Tab. II, Fig. 8)

1902 *Micromelania variabilis* nov. sp. - Lörenthey: p. 237, Tab. 18, Figs. 20, 23, 25
1944 *Micromelania variabilis* Lörenthey - Jekelius: p. 123, Tab. 45, Figs. 14-23
1953 *Micromelania (Goniochilus) variabilis* Lörenthey - Papp: p. 123, Tab. 6, Figs. 5-6

Sample: 400 individuals
Description: Lörenthey (1902)

Size: Tab. II, Fig. 8 hight = 3,0 mm width = 1,25 mm
Occurrence: Pezinok, beds 26 and 36
Stratigraphic and geographic extent: The species is known from the Pannonian D-F zone of Austria (Simmering, Stammersdorf), the Pannonian C-D zone of Romania (Turislav) and from the Pannonian in Hungaria (Tinnye).

Micromelania bielzi Brusina
(Tab. II, Fig. 6)

1902 *Prososthenia? Bielzi* Brus. - Brusina: Tab. 8, Figs. 39-41
1911 *Pyrgula (Prososthenia?) Bielzi* Brusina - Halavats: p. 47, Tab. 2, Fig. 11
1911 *Micromelania Bielzi* Brusina sp. - Lörenthey: p. 149, Tab. 2, Figs. 2-5

Sample: 1 individual
Description: Halavats (1911) p. 47
Size: Tab. II Fig. 6 hight = 2,8 mm width = 1,0 mm
Occurrence: Pezinok, bed 34
Stratigraphic and geographic extent: The species is known from the Pannonian of Hungary.

Genus *CASPIA* W. Dybowski, 1888
Typical species *Caspia baerii* Dybowski

Caspia sp.
(Tab. III, Fig. 9)

Sample: 1900 individuals
Size: Tab. III, Fig. 9 hight = 4,0 mm width = 1,5 mm
Occurrence: Pezinok, bed 26
Notes: In bed 26 abundant of individuals of this genera occurs. We were not able to identify them.

Familia *THIARIDAE*
Subfamilia *MELANOPSINAE*
Genus *MELANOPSIS* Ferussac, 1807
Typical species *Melanopsis praerosa* (Linnaeus))

Melanopsis impressa impressa Krauss, 1852
(Tab. III, Fig. 1)

1852 *Melanopsis impressa* n. sp. - Krauss: p. 143, Tab. 3, Fig. 3
1856 *Melanopsis impressa* Kraus - Hoernes: 596, Tab. 49, Fig. 10
1902 *Melanopsis impressa* Krauss - Brusina: Tab. 5, Figs. 33-36
1902 *Melanopsis impressa* Krauss - Lörenthey: p. 219, Tab. 15, Fig. 7
1944 *Melanopsis impressa* Krauss - Jekelius: p. 73, Tab. 16, Figs. 1-13
1953 *Melanopsis impressa impressa* Krauss - Papp: p. 130, Tab. 9, Figs. 1-4

Sample: 40 individuals
Description: Krauss (1852) p. 143
Size: Tab. III, Fig. 1 hight = 14,5 mm width = 8,5 mm
Occurrence: Pezinok, bed 36
Stratigraphic and geographic extent: The species occurs in the Sarmatian of Romania (Politioana) of the Pannonian in Hungaria (Tinnye) and of Austria (Rückersdorf, Gundersdorf).

Melanopsis impressa carinatissima Sacco, 1889
(Tab. III, Fig. 2)

1953 *Melanopsis impressa carinatissima* Sacco - Papp: p. 131, Tab. 9, Figs. 12-13

Sample: 7 individuals
Description: Papp (1953) p. 131
Size: Tab. III, Fig. 2 hight = 20,0 mm width = 10,7 mm
Occurrence: Pezinok, bed 36
Stratigraphic and geographic extent: The subspecies is known from the Pannonian B zone of Austria (Heiligenberg, Zehmendor) and from the Pannonian of Hungary (Tinnye).

Melanopsis impressa pseudonarzolina Papp, 1953
(Tab. III, Fig.5)

1953 *Melanopsis impressa pseudonarzolina* n. ssp. - Papp: p. 132, Tab. 9, Figs. 14-18

Sample: 75 individuals
Description: Papp (1953) p. 132
Size: Tab. III, Fig. 5 hight = 27,3 mm width =14,0 mm
Occurrence: Pezinok, bed 36
Stratigraphic and geographic extent: The species is known from the Sarmatian (Wiesen) and the Pannonian B-C zone of Austria.

Melanopsis impressa posterior Papp, 1953
(Tab. III, Fig. 4)

1953 *Melanopsis impressa posterior* n. ssp. - Papp: p. 133, Tab. 9, Fig. 19-23

Sample: 130 individuals
Description: Papp (1953) p. 133
Size: Tab. III, Fig. 4 hight = 21,3 mm width = 12,7 mm
Occurrence: Pezinok, bed 36
Stratigraphic and geographic extent: The taxon is known only from the Pannonian B zone of Austria (Heiligenberg).

Melanopsis vindobonensis Fuchs, 1870
(Tab. III, Fig. 3)

1870 *Melanopsis Vindobonensis* - Fuchs-Karrer: p. 139, Fig. 5
1887 *Melanopsis Vindobonensis* Fuchs - Handmann: p. Tab. 5, Figs. 8 - 13
1902 *Melanopsis vindobonensis* Fuchs - Lörenthey: p. 222, Tab. 15, Fig. 6

1927 *Melanopsis (Lyrcaea) Vindobonensis* Fuchs - Pavlovic: p. 82, Tab. 11, Figs. 1-6
1944 *Melanopsis vindobonensis* Fuchs - Jekelius: p. 135, Tab. 53, Fig. 1-17
1953 *Melanopsis vindobonensis vindobonensis* Fuchs - Papp: p. 137, Tab. 11, Figs. 13-16

Sample: 20 individuals
Description: Fuchs-Karrer (1870) p. 139
Size: Tab. III, Fig. 3 hight = 20,5 mm width = 14,0 mm
Occurrence: Pezinok, bed 34
Stratigraphic and geographic extent: The species is known from the Pannonian B-E zone of Austria ,from the Pannonian C-D zone of Romania and in the Upper Pannonian of Hungary.

***Melanopsis affinis* Handmann, 1882**
(Tab. III, Fig. 13)

1882 *Melanopsis affinis* n.f. - Handmann: p. 558
1887 *Mel. Canthidomus affinis* Handm. - Handmann: p. 32, Tab. 7, Figs. 9-12
1902 *Melanopsis affinis* Handmann - Lörenthey: p. 214, Tab. 17, Figs. 1-15
1944 *Melanopsis bouei affinis* Handmann - Jekelius: p. 129, Tab. 48, Figs. 14-17
1953 *Melanopsis bouéi affinis* Handmann - Papp: p. 146, Tab. 12, Figs. 9-11
1955 *Melanopsis bouéi affinis* Handmann - Bartha: p. 299
1955 *Melanopsis bouéi affinis* Handmann - Bartha-Soós: p. 62, Tab. 4, Figs. 1-3
1971 *Melanopsis affinis* Handmann: Švagrovský: p.324, Tab. 55, Figs. 8-9
1976 *Melanopsis bouei affinis* Handmann - Čtyroký-Knobloch: p. 110, Tab. 4, Figs. 19-20
1993 *Melanopsis bouei affinis* Handmann, 1882 - Fordinál: p. 61, Tab 12, Fig. 3.

Sample: 120 individuals
Description: Handmann (1882) p. 558
Size: Tab. III, Fig. 13 hight = 13,3 mm width = 6,3 mm
Occurrence: Pezinok, beds 34 and 36
Stratigraphic and geographic extent: The species is known from the Sarmatian of Austria and Bohemia, from the Pannonian of Slovakia, Austria, Hungary and Romania.

***Melanopsis sturii* Fuchs, 1873**
(Tab. III, Fig. 14)

1873 *Melanopsis Sturii* nov. sp. - Fuchs: p. 21, Tab. 4, Figs. 18-19
1902 *Melanopsis Sturii* Fuchs - Lörenthey: p. 211, Tab. 17, Figs. 16-17
1911 *Melanopsis Sturii* Fuchs - Lörenthey: p. 130
1944 *Melanopsis sturii* Fuchs - Jekelius: p. 74, Tab. 17, Figs. 1-17
1953 *Melanopsis bouéi sturii* Fuchs - Papp: p. 146, Tab. 12, Figs. 15-17
1955 *Melanopsis bouéi sturii* (Fuchs) - Bartha: p. 298, Tab. 1, Figs. 2-3
1993 *Melanopsis bouei sturii* Fuchs - Fordinál: p.62, Tab. 12, Figs. 4-5

Sample: 140 individuals
Description: Fuchs (1873) p. 21
Size: Tab. III, Fig. 14 hight = 14,5 mm width = 6,6 mm
Occurrence: Pezinok, bed 42
Stratigraphic and geographic extent: It occurs in the Pannonian of Austria, Hungary, Slovakia and Romania.

***Melanopsis bouei multicostata* Handmann, 1882**
(Tab. III, Fig. 7)

1882 *Melanopsis Bouéi* Fér. var. multicostata - Handmann: p. 557
1887 *Mel. Canthidomus Bouéi* Fér. var. *multicostata* - Handmann: p. 36, Tab. 8, Figs. 10-12
1902 *Melanopsis Bouéi Fér.* var. *multicostata* Handm. - Lörenthey: p.211
1944 *Melanopsis bouei multicostata* Handmann - Jekelius: p. 75, 130, Tab. 48, Figs. 18-22
1953 *Melanopsis bouéi multicostata* Handmann - Papp: p. 146, Tab.12, Figs. 12-14
1969 *Melanopsis (Canthidomus) bouei multicostata* Handmann, 1887 - Kojumdgieva: p. 98, Tab. 34, Figs. 3-6
1976 *Melanopsis bouei multicostata* Handmann - Čtyroký - Knobloch: p. 110

Sample: 3 individuals
Description: Handmann (1882) p.557
Size: Tab. III, Fig. 7 hight = 6,8 mm width = 4,0 mm
Occurrence: Pezinok, bed 36
Stratigraphic and geographic extent: The subfacies occurs in the Middle Sarmatian of Bulgaria, in the Pannonian C zone of Austria ,the Pannonian C-D zone of Romania (Turislav) and the Pannonian B zone of Bohemia.

***Melanopsis pygmaea pygmaea* M. Hoernes, 1856**
(Tab. III, Fig. 12)

1856 *Melanopsis pygmaea* Partsch - Hoernes: p. 599, Tab. 49, Fig. 13
1870 *Melanopsis pygmaea* Partsch - Fuchs: p. 545, Tab. 22, Figs. 9-10
1887 *Mel. Homalia pygmaea* Partsch - Handmann: p. 12, Tab. 1, Figs. 2-3 (non 1, 4-5)
1892 *Melanopsis pygmaea* Partsch - Brusina: p. 140
1942 *Melanopsis pygmaea* Partsch - Strausz: p. 88, Tab. 5, Figs. 25-28
1953 *Melanopsis pygmaea pygmaea* M. Hoernes - Papp: p. 149, Tab. 12, Figs. 28-30, 33-34
1976 *Melanopsis pygmaea pygmaea* M. Hörnes - Čtyroký-Knobloch: p. 111
1993 *Melanopsis pygmaea pygmaea* M. Hoernes, 1856 - Fordinál: p. 64, Tab. 13, Fig. 5

Sample: 260 individuals
Description: M. Hoernes (1856) p. 599
Size: Tab. III, Fig. 12 hight = 11,5 mm width = 4,8 mm
Occurrence: Pezinok, bed 36
Stratigraphic and geographic extent: The subspecies is known from the Pannonian of Austria, Moravia, Hungary and Slovakia.

***Melanopsis pygmaea mucronata* Handmann, 1887**
(Tab. III, Fig.11)

1887 *Mel. Homalia pygmaea* Partsch var. *mucronata* - Handmann: p. 13, Tab. 1, Fig. 1
1902 *Melanopsis eulimopsis* Brus. - Brusina: Tab. 5, Figs. 42-44
1953 *Melanopsis pygmaea mucronata* Handmann - Papp: p. 150, Tab. 12, Figs. 31-32
1980 *Melanopsis pygmaea mucronata* Handmann, 1887 - Lueger: p. 105, Tab. 1, Figs. 12-13
1993 *Melanopsis pygmaea mucronata* Handmann, 1887 - Fordinál: p. 65,

Sample: 670 individuals
Description: Handmann (1887) p. 13
Size: Tab. III, Fig. 11 hight = 10,8 mm width = 4,0 mm
Occurrence: Pezinok, beds 26 and 36
Stratigraphic and geographic extent: The subspecies occurs in the Pannonian of Austria, Hungary and Slovakia.

***Melanopsis pygmaea turrita* Handmann, 1887**
(Tab. III, Fig. 8)

1887 *Mel. Canthidomus turritus* Handm. - Handmann: p. 32, Tab. 7, Fig. 13
1953 *Melanopsis pygmaea turrita* Handmann - Papp: p. 150, Tab. 12, Figs. 24-27

Sample: 18 individuals
Description: Handmann (1887) p. 32
Size: Tab. III, Fig. 8 hight =10 mm width = 5 mm
Occurrence: Pezinok, bed 36
Stratigraphic and geographic extent: The subspecies is known only from the Pannonian C zone of Austria (Leobersdorf).

***Melanopsis handmanni* Brusina, 1892**
(Tab. III, Fig. 6)

1892 *Melanopsis Handmanni* Brusina - Brusina: p. 28
1894 *Melanopsis Handmanni* Brusina - Lörenthey: p. 154, Tab. 2, Fig. 23
1902 *Melanopsis Handmanni* Brus. - Brusina: Tab. 6, Fig. 26-29
1944 *Melanopsis handmanni* Brusina - Jekelius: p. 133, Tab. 50, Figs. 18-22
1953 *Melanopsis handmanni* Brusina - Papp: p. 150, Tab. 12, Figs. 35-37

Sample: 50 individuals
Description: Brusina (1892) p. 28
Size: Tab. III, Fig. 6 hight = 8,3 mm width = 4,0 mm
Occurrence: Pezinok, bed 36
Stratigraphic and geographic extent: The species occurs in the Pannonian B (Heiligenberg) and C (Leobersdorf) zones of Austria, in the Pannonian C-D zones of Romania (Turislav) and in the Pannonian of Hungary (Kurd).

Subclassis *PULMONATA*
Ordo *BASOMMATOPHORA*
Familia *PLANORBIDAE*
Genus *GYRAULUS* Charpentier, 1837

Typical species *Planorbis albus* Müller

***Gyraulus chaenostomus* Brusina, 1902**

1902 *Planorbis chaenostomus* Brus.-Brusina: Tab. 3, Figs. 4-6
1907 *Planorbis chaenostomus* Brus. - Wenz: p. 76

Sample: 6 individuals
Occurrence: Pezinok, bed 36
Stratigraphic and geographic extent: The species is known from the Pannonian of Hungary (Kúp) and of Austria (Leobersdorf).

Classis *BIVALVIA*
Ordo *VENEROIDEA*
Familia *DREISSENIDAE*
Genus *CONGERIA* Partsch, 1836
Typical species *Congeria subglobosa* Partsch

MYTILIFORMES

***Congeria neumayri* Andrusov, 1897**
(Tab. IV, Fig. 5)

1897 *Congeria Neumayri* nov. sp. - Andrusov: p. 83, Tab. 1, Figs. 8-14
1942 *Congeria Neumayri* Andr.. - Strausz: p. 75
1944 *Congeria neumayri* Andrusov - Jekelius: p. 142, Tab. 59, Fig. 17
1953 *Congeria neumayri* Andrusov - Papp: p. 156, Tab. 13, Figs. 1-4
1955 *Congeria neumayri* Andrusov - Bartha: p. 313, Tab. 1, Figs. 11, 14, 16
1968 *Congeria neumayri neumayri* Andrusov - Kojumdjieva: p. 192, Tab. 1, Figs. 1-3
1995 *Congeria neumayri* Andrusov, 1897 - Fordinál: p. 28, Tab. 1, Fig. 1

Sample: 4 individuals
Description: Kojumdjieva (1968) p. 192
Size: Tab.IV, Fig. 5 length = 19 mm, hight = 10 mm
Occurrence: Pezinok, beds 26 and 36
Stratigraphic and geographic extent: The species is known from the Karpatian of Austria, Middle Sarmatian of Bulgaria, from the Pannonian of Austria, Hungary, Romania and Slovakia.

***Congeria spathulata* nov. ssp.?**
(Tab. VI, Fig. 5)

Sample: 2 individuals
Size: Tab. VI, Fig. 7 length = 80 mm hight = 45 mm
Occurrence: Pezinok, bed 34
Note: Only two individuals have been found. The shells resemble subfacies *C. spathulata antulae* Pavlovic. They

differ by their narrower and longer frontal part of the shell.Because of the small amount of material I do not divide it intoa new subspecies.

***Congeria doderleini* Brusina, 1892**
(Tab. IV, Fig. 3)

1892 *Congeria Doderleini* Brusina n.sp. - Brusina: p. 71
1897 *Congeria Doderleini* Brus. - Andrusov: p. 126, Tab. 3, Figs. 23-30
1902 *Congeria Doderleini* Brus. - Lörenthey: p. 150, Tab. 10, Figs. 16-18
1911 *Congeria Doderleini* Brusina - Lörenthey: p. 56
1927 *Congeria Doderleini* Brusina - Pavlovic: p. 9
1944 *Congeria doderleini* Brusina - Jekelius: p.142, Tab. 59, Figs. 11-16
1953 *Congeria doderleini* Brusina - Papp: p. 164, Tab. 13, Figs. 8-12, Tab. 25, Figs. 6-7
1991 *Congeria doderleini* Brusina - Fordinál: p. 72, Tab. 61 Figs. 1-6, Tab. 62, Figs. 1-4

Sample: 80 individuals
Description: Brusina (1892) p. 71
Size: Tab. IV, Fig. 3 length =10 mm hight = 5,4 mm
Occurrence: Pezinok, bed 36
Stratigraphic and geographic extent: The subspecies is known from the Pannonian of Austria, Hungary, Romania and Slovakia.

***Congeria ringeiseni* Jekelius, 1944**
(Tab. IV, Fig. 4)

1944 *Congeria ringeiseni* n. sp. - Jekelius: p. 93, Tab. 27, Figs. 17-18

Sample: 1 individual
Description: Jekelius (1944) p. 93
Size: Tab.IV Fig. 4 length = 6,8 mm hight = 3,0 mm
Occurrence: Pezinok, bed 34
Stratigraphic and geographic extent: The species is known only from the Sarmatian of Romania (Politioana).

MODIOLAEFORMIS

***Congeria gitneri* Brusina, 1892**
(Tab. IV, Fig. 2)

1892 *Congeria Gitneri* Brusina n.sp. - Brusina: p. 72
1897 *Congeria Gitneri* Brus. - Andrusov: p. 189, Tab. 8, Figs. 33-36
1902 *Congeria Gitneri* Brus. - Brusina: Tab. 19, Figs. 18-21
1902 *Congeria Gitneri* Brus. - Lörenthey: p. 158, Tab. 10, Figs. 11, 14
1927 Congeria Gitneri Brus. - Pavlovic: p. 18
1944 *Congeria gitneri* Brusina - Jekelius: p. 143, Tab. 59, Figs. 24-26
1953 *Congeria gitneri* Brusina-Papp: p.166, Tab.13, Figs. 18-21

Sample: 1 individual
Description: Brusina (1892) p. 72
Size: Tab. IV, Fig. 2 length = 5,0 mm hight = 2,5 mm
Occurrence: Pezinok, bed 36
Stratigraphic and geographic extent: The species occurs in the Pannonian C-E zones of Austria (Stammersdorf, Regelsbrunn, Leobersdorf), in the Pannonian C-D zones of Romania (Turislav) and in the Pannonian of Hungary.

***Congeria ungulacaprae* (Muenster, 1839)**
(Tab. IV, Fig. 6)

1870 *Congeria Balatonica* Partsch var. *crassitesta* - Fuchs: p. 548, Tab. 22, Figs. 15-16
1892 *Congeria ungula caprae* Münst. - Brusina: p. 196
1897 *Congeria ungula caprae* Mu. - Andrusov: p. 158, Tab. 5, Figs. 18-22
1902 *Congeria ungula caprae* (Münster) - Brusina: Tab. 18, Figs. 32-35
1902 *Congeria ungula-caprae* Münster - Lörenthey: p. 257, Tab. 19, Figs. 1-2, 4, Tab. 20, Fig. 1
1951 *Congeria ungula-caprae* Münst. - Stevanovic: p. 209
1953 *Congeria ungula-caprae* (Muenster) - Papp: p. 169, Tab. 15, Figs. 8-9

Sample: 2 individuals
Description: Stevanovic (1951) p. 209
Size: Tab.IV, Fig. 6, length = 65 mm hight = 44 mm
Occurrence: Pezinok, bed 36
Stratigraphic and geographic extent: The species occurs in the Pannonian of Hungary (Budapest-Köbánya) and Serbia (Konoplište).

***Congeria croatica* (Brusina, 1874)**
(Tab.IV, Fig.7)

1884 *Dreissena croatica* Brusina - Brusina: p. 181, Tab. 27, Figs. 53-54
1897 *Congeria croatica* Brus. - Andrusov: p. 163, Tab. 6, Figs. 4-5, 8-11
1944 *Congeria croatica* Brusina - Jekelius: p. Tab. 60, Fig. 3
1951 *Congeria croatica* Brus. - Stevanovic: p. 208, Tab. 3, Figs. 2-6, Tab. 11, Fig. 5
1953 *Congeria croatica* Brusina - Papp: Tab. 18, Figs. 4,6
1992 *Congeria croatica* (Brusina) - Basch-Zakar-Sakač: p. 37, Tab. 9, Figs. 5-6, Tab. 10, Figs. 1-5,Tab. 11, Fig. 1

Sample: 2 individuals
Description: Brusina (1884) p. 181
Size: Tab. IV Fig. 7 length = 65 mm hight = 55 mm
Note: Individuals from Pezinok do not have the sharp keel as it has the holotyp (Basch-Zagar-Sakač, 1992, Tab.10, Fig. 1
Occurrence: Pezinok, bed 36
Stratigraphic and geographic extent: The species is known from the Pannonian of Hungary and Croatia.

SUBGLOBOSAE

***Congeria subglobosa subglobosa* Partsch, 1836**
(Tab. V, Fig. 1)

1836 *Congeria subglobosa subglobosa* Nobis - Partsch: p. 97, Tab. 11, Figs. 1-8, 10

1870 *Congeria subglobosa* Partsch - Hoernes: p. 362, Tab. 47, Figs. 1, 3
1884 *Dreissena subglobosa* Partsch - Brusina: p. 134
1897 *Congeria subglobosa* Partsch - Andrusov: p. 220, Tab. 12, Figs. 12-16
1907 *Congeria subglobosa* Partsch - Troll: p. 42
1927 *Congeria subglobosa* Partsch - Pavlovic: p. 19
1953 *Congeria subglobosa subglobosa* Partsch - Papp: p. 179, Tab. 19, Fig. 4

Sample: 5 individuals
Description: Partsch (1836) p. 97
Size: Tab. V, Fig. 1 length = 70 mm hight = 52 mm
Occurrence: Pezinok, bed 34
Stratigraphic and geographic extent: The species has been known from the Pannonian E zone of Austria (Vösendorf, Inzersdorf, Hennersdorf, Leobersdorf).

***Congeria subglobosa longitesta* Papp, 1953**
(Tab. V, Fig. 2)

1870 *Congeria subglobosa* Partsch - Hoernes: p. 362, Tab. 47, Fig. 2
1953 *Congeria subglobosa longitesta* n. ssp. - Papp: p. 177, Tab. 19, Fig. 2

Sample: 3 individuals
Description: Papp (1953) p. 177
Size: Tab. V, Fig. 2 length = 69 mm hight = 40 mm
Occurrence: Pezinok, bed 34
Stratigraphic and geographic extent: The subspecies occurs in the Pannonian D-E zones of Austria (Matzleinsdorf, Vösendorf, Siegendorf).

Genus *DREISSENA* van Beneden, 1835
Typical species *Dreissena polymorpha* (Pallas)

***Dreissena bipartita* Brusina**
(Tab. VI, Figs. 1-2)

1897 *Dreissensia bipartita* Brus. - Andrusov: p. 301, Tab. 16, Figs. 31-32
1902 *Congeria bipartita* Brus. - Brusina: Tab. 20, Fig. 36
1902 *Dreissensia bipartita* Brusina - Lörenthey: p. 263
1911 *Congeria bipartita* Brusina - Lörenthey: p. 56
1927 *Dreissensia bipartita* Brus. - Pavlovic: p. 24

Sample: 4 individuals
Description: Andrusov (1897) p. 301
Size: Tab. VI Fig. 1 length = 1,9 mm hight = 0,9 mm; Tab. VI Fig. 2 length = 2,7 mm hight = 1,3 mm
Occurrence: Pezinok, bed 36
Stratigraphic and geographic extent: The species is known from the Pannonian of Hungary (Kup, Fehérpart, Budapest-Köbánya) and from the Pannonian E zone of Serbia (Karagac).

***Dreissena cf. turislavica* Jekelius, 1944**
(Tab. IV, Fig. 1)

1944 *Dreissena turislavica* n. sp. - Jekelius: p. 141, Tab. 59, Figs. 1-10
1953 *Dreissena turislavica* Jekelius - Papp: p. 186, Tab. 21, Figs. 1-4

Sample: 6 individuals
Description: Jekelius (1944) p. 141
Size: Tab. IV, Fig. 1 length = 4,8 mm hight = 1,0 mm
Occurrence: Pezinok, bed 36
Stratigraphic and geographic extent: The species occurs in the Pannonian C-D zone of Romania and Austria.

Genus *DREISSENOMYA* Fuchs, 1870
Subgenus *SINUCONGERIA* Lörenthey, 1894
Typical species *Congeria arcuata* Fuchs

***Dreissenomya primiformis* Papp, 1949**
(Tab. VI, Fig. 3)

1953 *Dreissenomya primiformis* PAPP - Papp: p. 189, Tab. 21, Figs. 9-13
1977 *Dreissenomya (Sinucongeria) primiformis* Papp, 1949 - Marinescu: p. 92, Tab. 6, Fig. 1-2, (in text) Fig. 17

Sample: 2 individuals
Description: Marinescu (1977) p. 92
Size: Tab. VI, Fig. 3, length = 3,0 mm hight = 1,5 mm
Occurrence: Pezinok, bed 36
Stratigraphic and geographic extent: The species is known from the Pannonian E zone of Austria (Vösendorf, Leobersdorf, Inzensdorf, Simmering, Mannersdorf, Regelsbrunn) and Romania (Mermesti).

Familia *UNIONIDAE*
Genus *PSILUNIO* Stefanescu, 1896
Typical species *Psilunio littoralis* Lamarck

***Psilunio (Psilunio) atavus* (M. Hoernes, 1870)**

1837 *Unio atavus* - Hauer: p. 424 (nom. nud.)
1870 *Unio atavus* - Hoernes: p. 286, Tab. 37, Fig. 2
1953 *Psilunio (Psilunio) atavus* (Partsch, M.Hoernes) - Papp: p. 189, Tab. 17, Fig. 3

Sample: 1 individual
Description: Hoernes (1870) p. 286
Occurrence: Pezinok, beds 36
Stratigraphic and geographic extent: The species is known from the Pannonian E zone in Austria (Vösendorf).

Familia *CARDIIDAE*
Subfamilia *LYMNOCARDIINAE*
Genus *LYMNOCARDIUM* Stoliczka, 1871
Typical species *Cardium haueri* M. Hörnes

Lymnocardium edlaueri Papp, 1953

1953 *Limnocardium edlaueri* nov. sp. - Papp: p. 194, Tab. 23, Figs. 7-9
1967 *Limnocardium edlaueri* Papp - Spajic: p. 114, Tab. 2, Figs. 11-12
1995 *Lymnocardium edlaueri* Papp, 1953 - Fordinál: p. 31

Sample: 38 individuals
Description: Papp (1953) p. 194
Occurrence: Pezinok, bed 26
Stratigraphic and geographic extent: The species occurs in the Pannonian D-E zones of Austria (Laaerberg, Vösendorf, Stammersdorf), in the Pannonian D zone of Slovakia (Bratislava), in the Pannonian E zone of Serbia (Topolovnik) and Moravia (Kyjov, Czech Republic) (Čtyroký, 1975)

Lymnocardium conjungens (Hoernes, 1870)

(Tab. VI, Fig. 4)

1837 *Cardium conjungens* Partsch - Hauer: p. 423
1870 *Cardium conjungens* - Hörnes: p. 206, Tab. 30, Fig. 4
1892 *Limnocardium conjungens* (Partsch, 1837)) - Brusina: p. 185
1953 *Limnocardium conjungens* (Partsch) - Papp: p. 196, Tab. 23, Figs. 5-6, 10-12
1959 *Limnocardium conjungens* Partsch - Miletic-Spajic: Tab. 8, Fig. 4
1964 *Limnocardium conjungens* Partsch - Andrusov: p. 467, Tab. 3, Figs.16-18
1967 *Limnocardium conjungens* Partsch - Spajic: p. 115, Tab. 1, Figs. 1-9
1995 *Lymnocardium conjungens* (Hoernes) - Fordinál: p. 31, Tab. 5, Fig. 1

Sample: 1 individual
Description: Hornes (1870) p. 206
Occurrence: Pezinok, bed 34
Stratigraphic and geographic extent: The species is known from the Pannonian D-E zones of Austria (Vösendorf, Regelsbrunn, Hennersdorf, Stegersbach), from the Pannonian D zone of Slovakia (Bratislava), E zone of Croatia (Markuševec), Serbia (Topolovnik), Moravia (Kyjov, Czech Republic) (Čtyroký, 1975) and from the Upper Pannonian of Hungaria (Lázi) (Bartha, 1963).

Subfamilia *DIDACNINAE*
Genus *DIDACNA* Eichwald, 1838
Typical species *Cardium trigonoides* Pallas

Didacna deserta (Stoliczka, 1862)

1862 *Cardium desertum* Stol. - Stoliczka: p. 538, Tab. 17, Fig. 10
1892 *Limnocardium desertum* (Stoliczka, 1862) - Brusina: p. 187,
1902 *Limnocardium desertum* (Stol.) - Brusina: Tab. 28, Figs. 24-25
1907 *Limnocardium desertum* Stol. - Troll: p. 44
1921 *Limnocardium desertum* (Stoliczka) - Wenz: p. 84
1927 *Limnocardium desertum* Stoliczka sp. - Pavlovic: p. 40
1953 *Didacna deserta deserta* (Stoliczka) - Papp: p. 201, Tab. 23, Figs. 15-16
1959 *Didacna deserta* (Stoliczka) - Miletic - Spajic: Tab. 7, Figs. 7-8
1967 *Didacna deserta* (Stoliczka) - Spajic: p. 117, Tab. 2, Figs. 15-16
1980 *Didacna deserta* (Stoliczka, 1862) - Lueger: p. 114, Tab. 3, Fig. 3
1990 *Didacna deserta* (Stoliczka) - Basch: p. 73
1995 *Didacna deserta* (Stoliczka) - Fordinál: p. 32, Tab. 6, Figs. 2-3

Sample: 1 individual
Description: Papp (1953) p. 201
Occurrence: Pezinok, bed 36
Stratigraphic and geographic extent: The species is known from the Pannonian of Croatia, Serbia, Austria and Slovakia.

Subfamilia *ADACNINAE*
Genus *MONODACNA* Eichwald, 1838
Typical species *Corbula caspia* Eichwald

Monodacna vienensis Papp, 1953

1953 *Monodacna vienneinsis* n. sp. - Papp: p. 200, Tab. 22, Figs. 19-21
1995 *Monodacna viennensis* Papp, 1953 - Fordinál: p. 34,

Sample: 1 individual
Description: Papp (1953) p. 200
Occurrence: Pezinok, bed
Stratigraphic and geographic extent: The species is known from the Pannonian D (Föllig) and E (Vösendorf) zones of Austria and from the Pannonian D zone of Slovakia (Bratislava).

Familia *SPHAERIIDAE*
Genus *PISIDIUM* Pfeiffer, 1821
Typical species *Tellina amnica* Müller

Pisidium sp.

Sample: 7 individuals
Occurrence: Pezinok, bed 26
Notes: Small shells of genus Pisidium were found in the sand of the bed 26. I was not able to identify them more precisely.

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The captions to the photographs

Tab. I
Fig. 1 *Theodoxus postcrenulatus* Papp, bed 26, enlarged 6x
Fig. 2 *Theodoxus turislavicus* Jekelius, bed 26, enlarged 10x
Fig. 3 *Theodoxus intracarpaticus* Jekelius, bed 34, enlarged 10x
Fig. 4 *Theodoxus leobersdorfensis dacicus* Jekelius, bed 26, enlarged 10x
Fig. 5 *Theodoxus soceni* Jekelius, bed 26, enlarged 6x
Fig. 6 *Valvata gradata globulosa* Jekelius, bed 34
Fig 7 *Stenothyrella ovoidea* (Pavlovic), bed 34

Tab. II
Fig. 1 *Pyrgula unicarinata* Brusina, bed 36
Fig. 2 *Micromelania banatica fuchsi* Papp , bed 36
Fig. 3 *Micromelania* sp., bed 36
Fig. 4 *Pyrgula incisa* Fuchs, bed 36
Fig. 5 *Pyrgula hungarica* Lörenthey, bed 36
Fig. 6 *Micromelania bielzi* Brusina, beds 34
Fig. 7 *Prososthenia serbica* Brusina, bed 34
Fig. 8 *Micromelania variabilis* Lörenthey, bed 36
Fig. 9 *Micromelania loczyi* Lörenthey, bed 34

Tab. III
Fig. 1 *Melanopsis impressa impressa* Krauss, bed 36, enlarged 1,5x
Fig. 2 *Melanopsis impressa carinitissima* Sacco, bed 36, enlarged 1,5 x
Fig. 3 *Melanopsis vindobonensis* Fuchs, bed 36, enlarged 1,5x
Fig. 4 *Melanopsis impressa posterior* Papp, bed 36, enlarged 1,5x
Fig. 5 *Melanopsis impressa pseudonarzolina* Papp, bed 36, enlarged 1,5x
Fig. 6 *Melanopsis handmanni* Brusina, bed 36, enlarged 4x
Fig. 7 *Melanopsis bouei multicostata* Handmann, bed 36, enlarged 5x
Fig. 8 *Melanopsis pygmaea turrita* Handmann, bed 36, enlarged 4x
Fig. 9 *Caspia* sp. bed 26, enlarged 10x
Fig. 10 *Bithynia jurinaci* (Brusina), bed 42, enlarged 5x
Fig. 11 *Melanopsis pygmaea mucronata* Handmann, bed 36, enlarged 4x
Fig. 12 *Melanopsis pygmaea pygmaea* Handmann, bed 36, enlarged 4x
Fig. 13 *Melanopsis affinis* Handmann, bed 36, enlarged 4x
Fig. 14 *Melanopsis sturii* Fuchs, bed 42, enlarged 4x

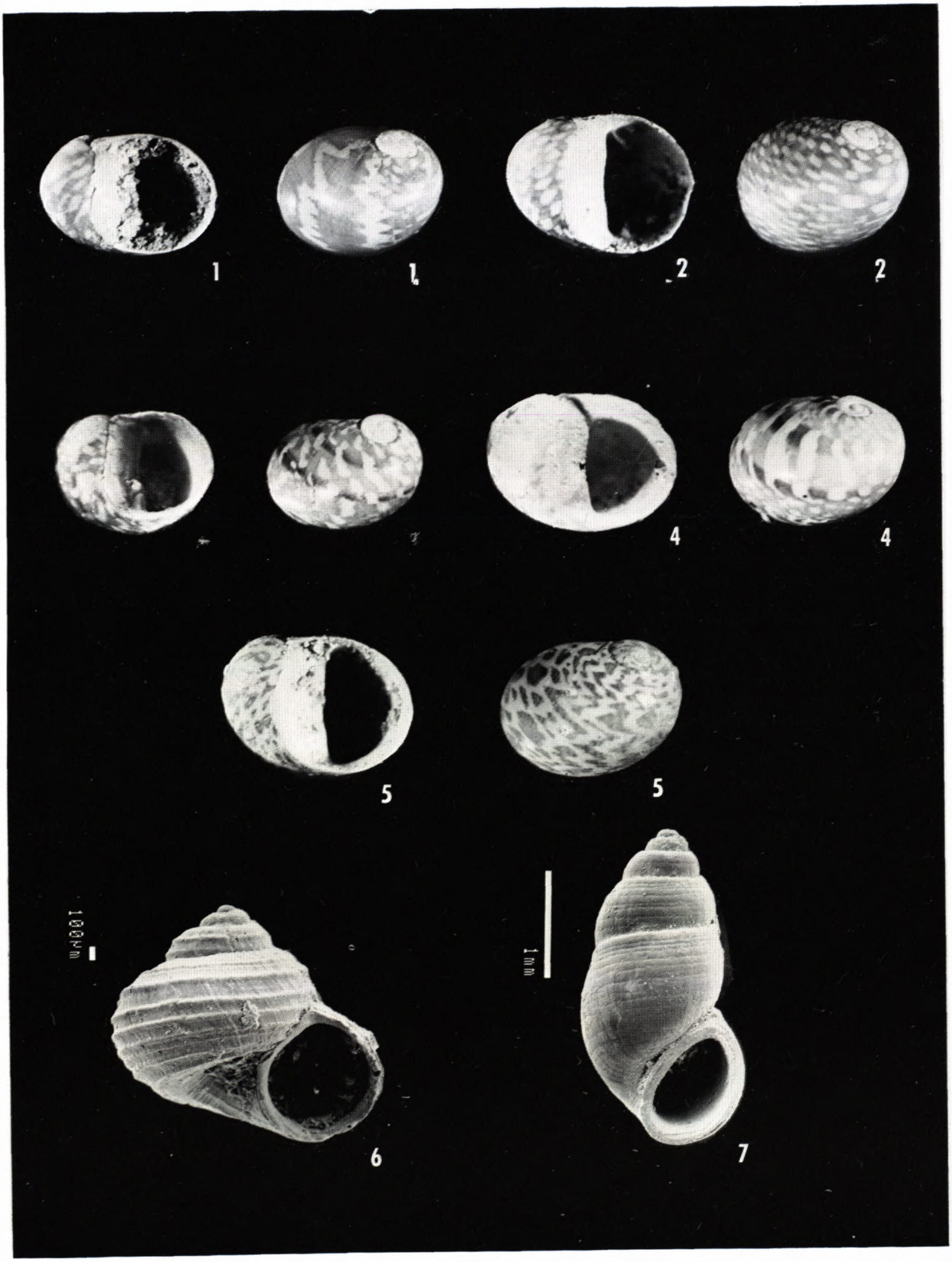
Tab. IV
Fig. 1 *Dreissena cf. turislavica* Jekelius, bed 36, enlarged 7, 8x
Fig. 2 *Congeria gitneri* Brusina, bed 36, enlarged 7,8x
Fig. 3 *Congeria doderleini* Brusina, bed 36, enlarged 4x
Fig. 4 *Congeria ringeiseni* Jekelius, bed 34, enlarged 6,2x
Fig. 5 *Congeria neumayri* Andrusov, bed 26, enlarged 2,6x
Fig. 6 *Congeria ungulacaprae* Münster, bed 36, natural size
Fig. 7. *Congeria croatica* Brusina, bed 36 natural size

Tab. V
Fig. 1 *Congeria subglobosa subglobosa* Partsch, bed 34, natural size
Fig. 2 *Congeria subglobosa longitesta* Papp, bed 34, natural size

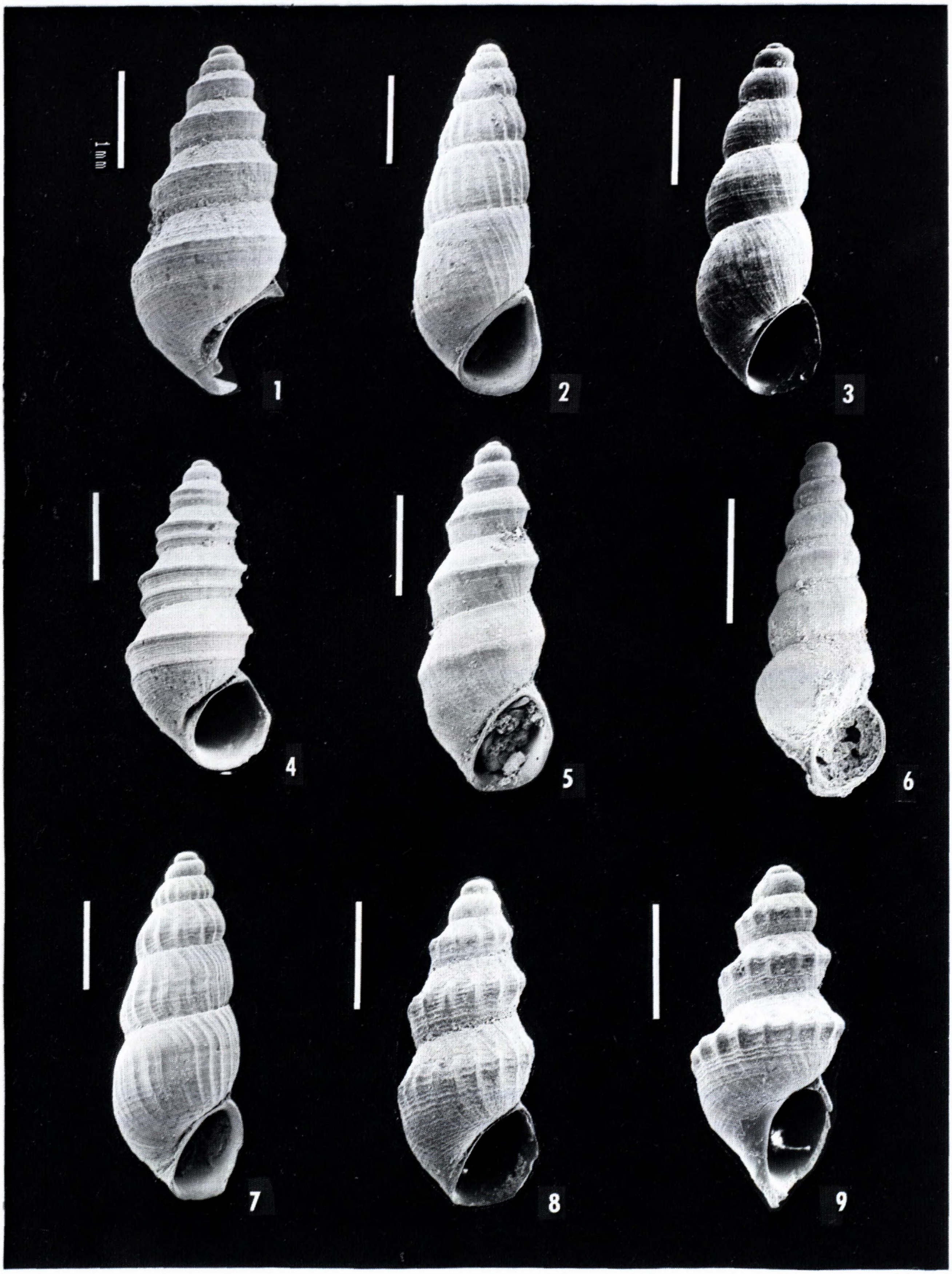
Tab. VI
Fig. 1-2 *Dreisena bipartita* Brusina, bed 36
Fig. 3 *Dreissenomya primiformis* Papp,bed 36
Fig. 4 *Lymnocardium conjungens* (M.Hoernes), beds 34, enlarged 2,7x
Fig. 5 *Congeria spathulata* nov. ssp.? bed 34, natural size

Fossils on the Tab. I, Figs. 6-7, Tab. III and Tab. VI, Figs.1-3 were photographed on the SEM Jeol-840 at the Geological Survey of Slovak Republic (operator J. Stankovič); other photographs were taken by L. Osvald.

Tab. I



Tab. II



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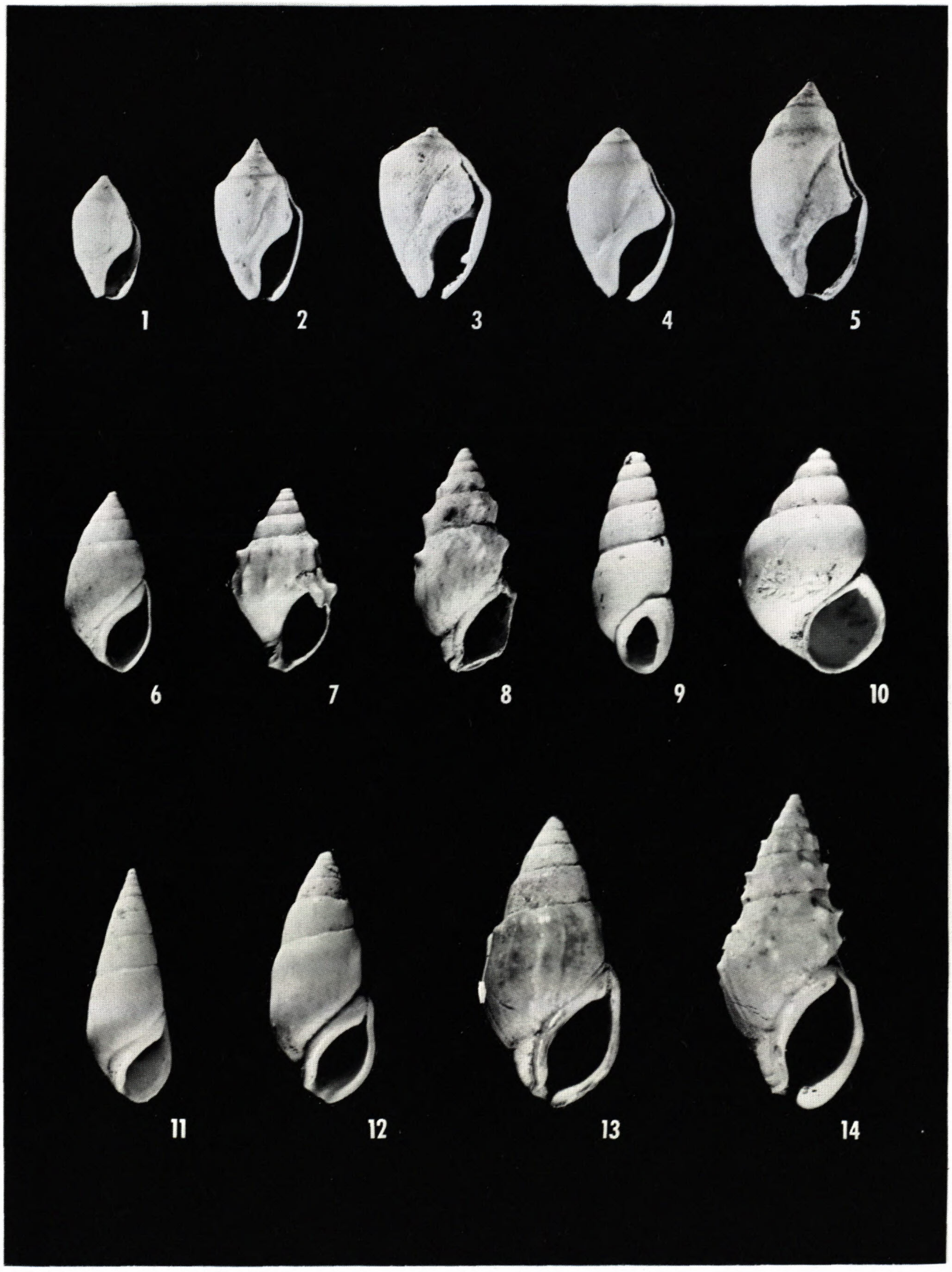
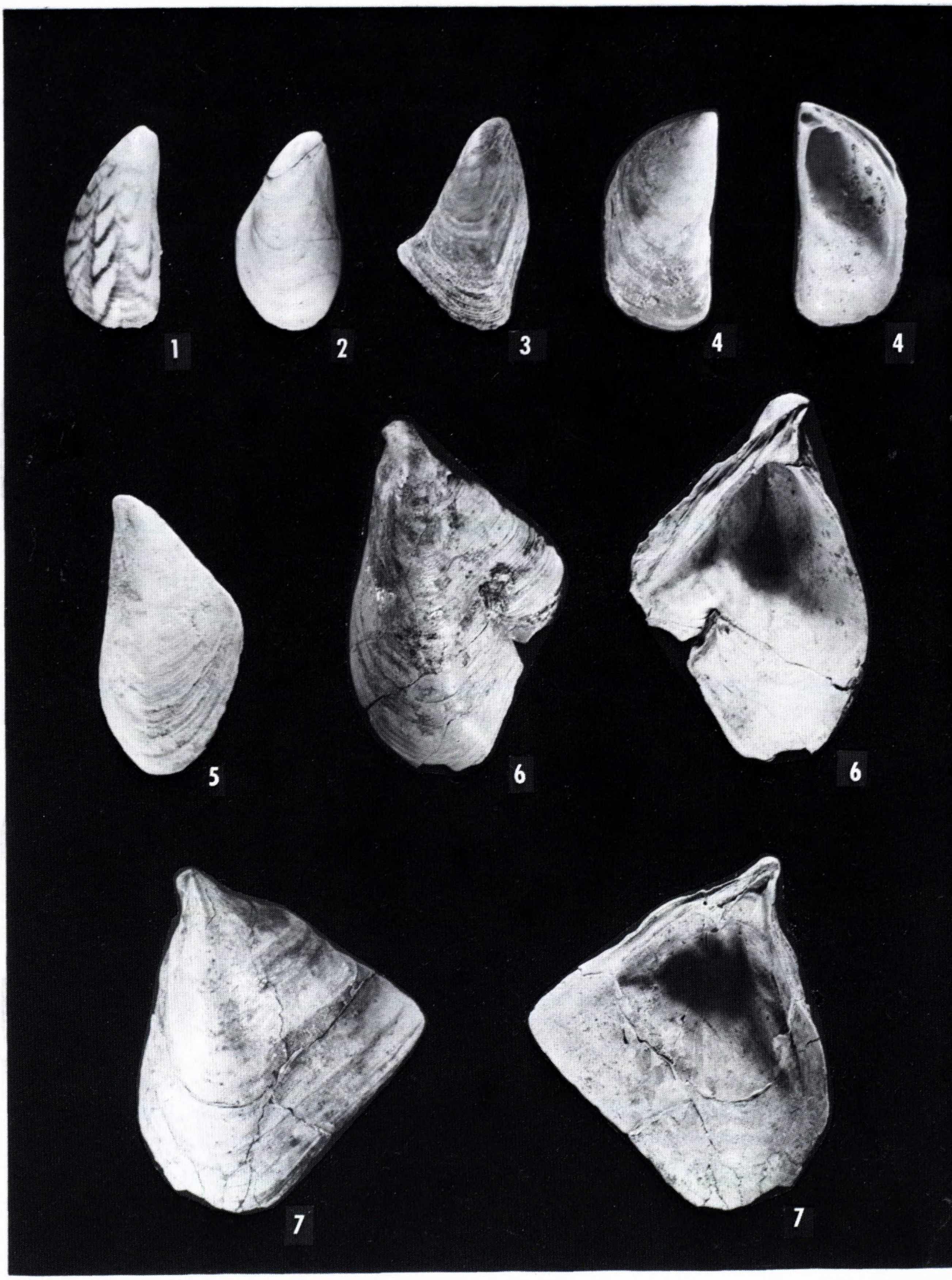
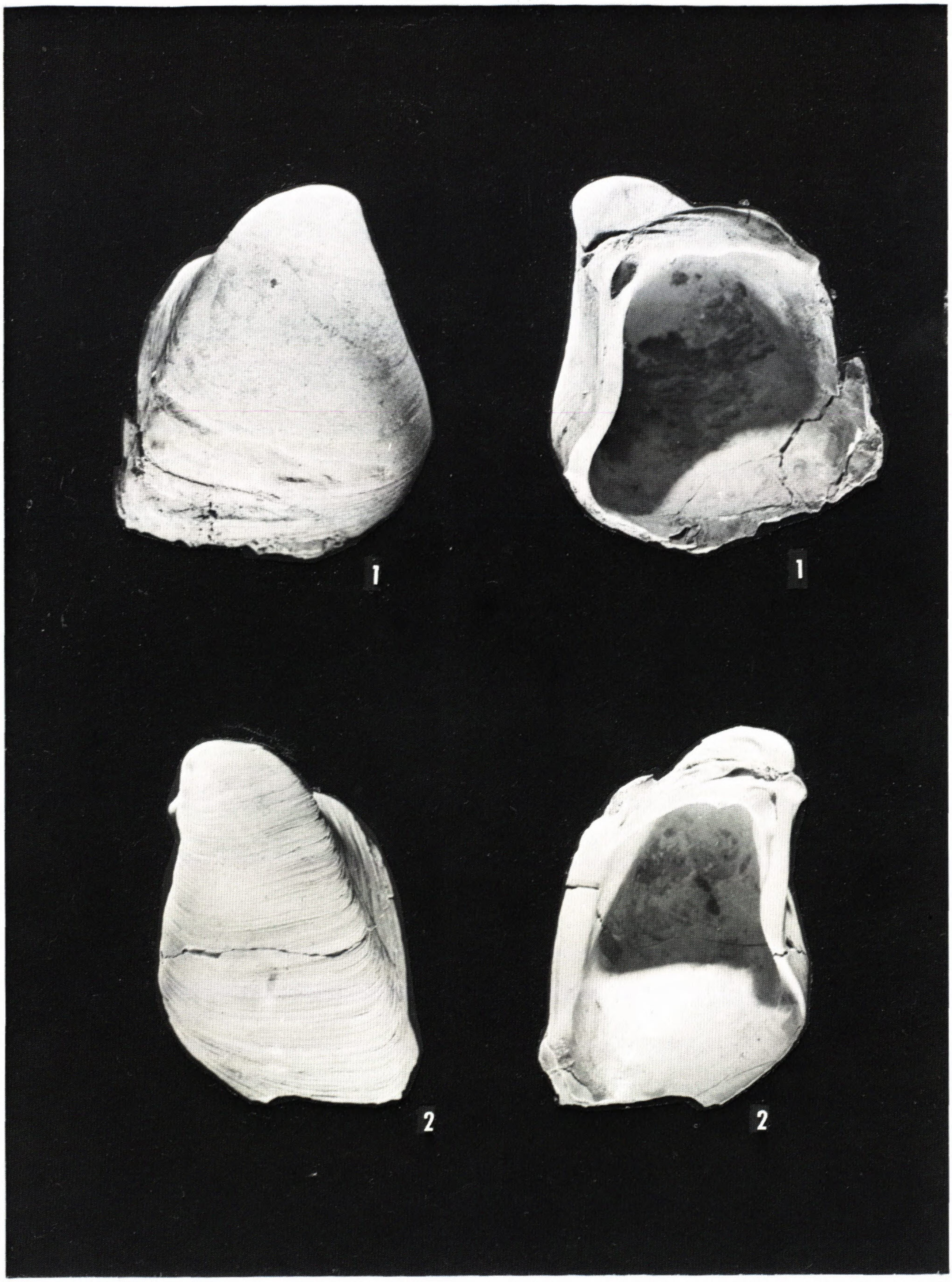


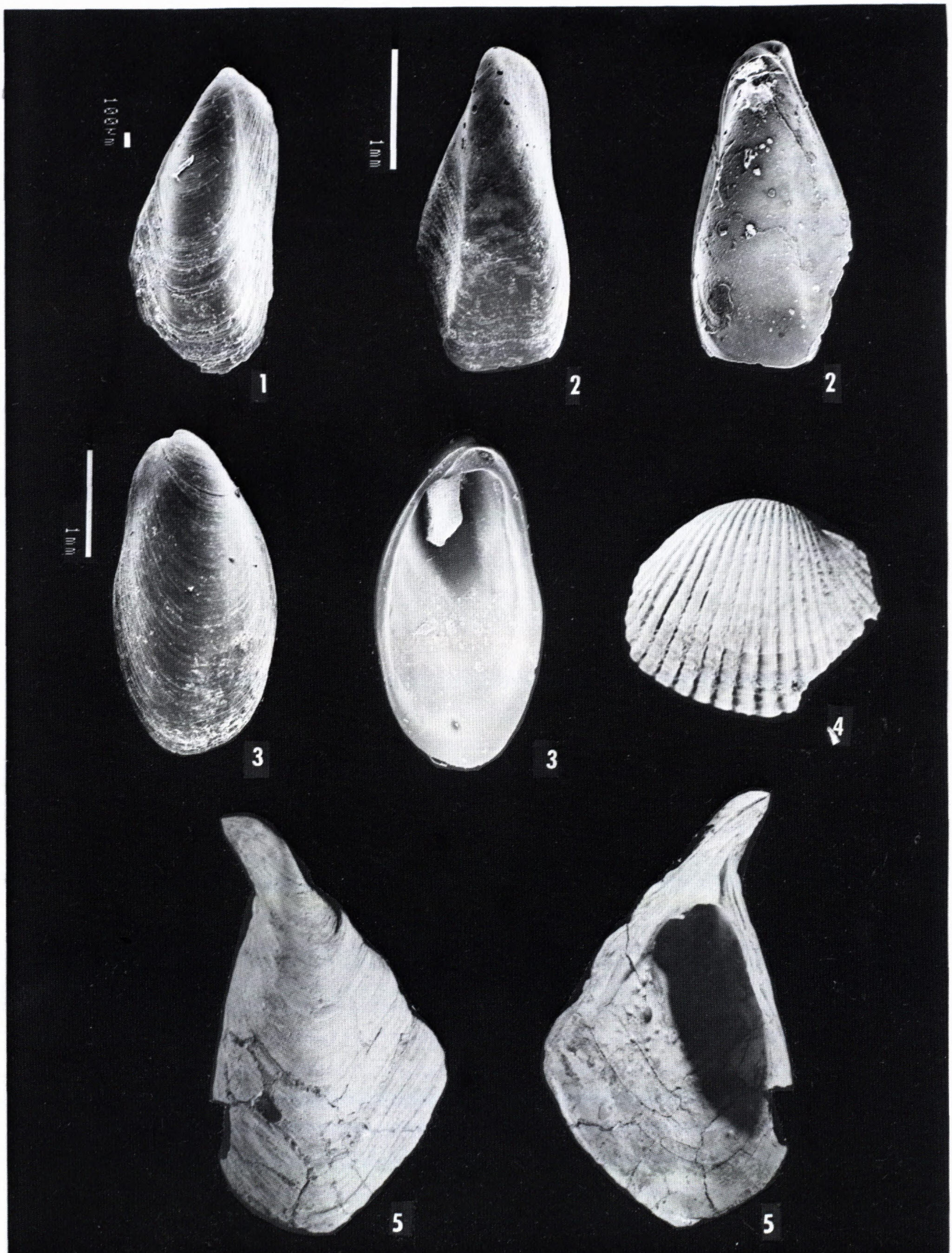
Tab. IV



Tab. V



Tab. VI



Biostratigraphy of Sarmatian Sediments from the Košická kotlina depression on the basis of Foraminifers

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Abstract. The article is dealing with distribution of foraminifers in the individual litostratigraphical units of the Sarmatian from the Košická kotlina depression, their correlation with foraminifer biozones and taxonomy of forms typical of this stage. The results of study may by summarized as follows :

1. In the Upper Badenian there was lowering salinity and gradual shallowing of the sedimentation area. The Klčov Formation (Upper Badenian to lowermost Sarmatian) contains a marine and marine-brackish microfauna of the Bulimina-Bolivina and Ammonia biozones.

2. The Stretava Formation (Lower to Middle Sarmatian) is characterized by shallow-water brackish foraminifers (mainly of the genus *Elphidium*) belonging in microfauna to the *Elphidium reginum* and *Elphidium hauerinum* biozones. In the area under study, however, *E. hauerinum* (Orb.) appears untypically already in the Lower Sarmatian, indicating the possibility of stratigraphic limitation of this formation to the Lower Sarmatian. The molluscs in the Stretava Formation correspond to the microfaunistic Zone (Lower Sarmatian).

3. Kochanovce Formation (Middle to Upper Sarmatian) contains only freshwater ostracodes of the ostracode D_3 Zone from the original microfauna.

Key words: foraminifers, Sarmatian, Košická kotlina depression

Introduction

The goal of the article is to establish the composition and character of foraminifer associations in the individual lithostratigraphical units of the Sarmatian in the Košická kotlina depession, their correlation with foraminifer biozones and taxonomy of typical Sarmatian species.

Biozonation was based upon foraminifer zonation according to Grill (1941) in the Vienna Basin. The litostratigraphical units are identical with the units worked out by Vass and Čverčko for the Sarmatian of the East Slovakian Lowland (1985).

The total number of microfaunistic samples, from which we set out in the work, varies around 250. Some samples contained, besides foraminifers, also ostracodes, Bryozoa and Dasycladaceae.

A particular part is devoted to the system of foraminifers typical of the Sarmatian. It includes synonyms, remarks, stratigraphic range, occurrence in the Košická kotlina depression and ecology of 16 foraminifer species belonging to 8 genera and 6 families. In this part the foraminifer system of Loeblich and Tappan (1988) was used. A part of this system is the table of distribution of the individual foraminifer species in the Neogene of the East Slovakian Basin (Tab. 13) and photographic plates.

Delimitation of the Sarmatian stage

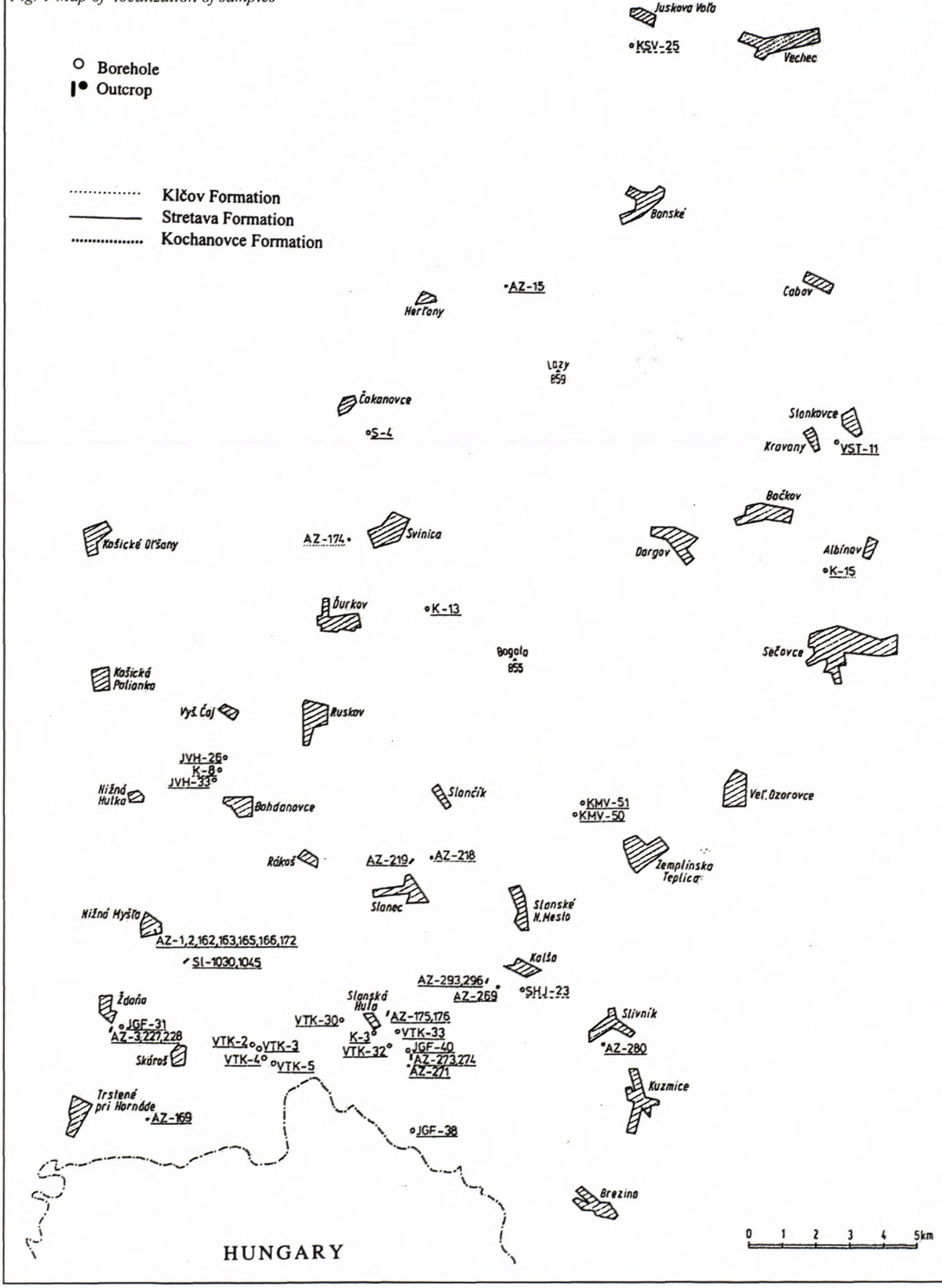
According to up to present knowledge we may establish the absolute age to 10-11m.y. for the upper boundary and ± 14 m.y. for the lower boundary (Vass et al. 1974).

The denomination "Sarmatische Stufe" was published first by Suess in the year 1866. He designated so the beds, which are overlying the marine beds and underlying the Congeria Member, the latter were previously designated as the Cerithium Member (Ceritien-Schichten or Brakische Stufe) in the Vienna Basin.

Barbot de Margny (1867,1869) mantioned under the denomination Sarmatian beds a similar brackish development in the Euxinian-Caspian region. Already originally a difference in the range of age of brackish beds in both regions was assumed. The range of age of the Sarmatian in the Vienna Basin is essentially less than the range of the Sarmatian in the Euxinian-Caspian region.

On the basis of the agreement of the Subcommision for Paratethys Stratigraphy at the "Committee of Medi-

Fig. 1 Map of localization of samples



terranean Neogene Stratigraphy" the question was solved provisionally in a way that "Suess Sarmatian" will be designated as s.s. whilst that of "Barbot" as s.l., the latter designation also includes the Volhynian, Bessarabian and Chersonian substages, established later (Simonescu, 1903, Papp-Marinescu-Seneš et al. 1974).

In the Eastern Paratethys where after the Sarmatian the Meotian stage follows, corresponding only to the uppermost Pannonian of the Central Paratethys, the Sarmatian is used in the sense of Barbot de Margny ´s definition.

The Sarmatian s.s. of Suess corresponds to the Volhynian and Lower Bessarabian, to the Sarmatian of the Central Paratethys (Tab.10).

The Upper Bessarabian, Chersonian and Meotian correspond in fulle extent to the Pannonian of the Central Paratethys.

The Sarmatian s.s. in the sense of Suess was divided on the basis of paleontological criteria in various ways in the Western Carpathians. Essential is in the first place the division of Grill (1941) according to foraminifers, of Papp (1954) according to molluscs and Jiříček (1972, 1983) according to ostracodes (Tab.10,11).

The lowermost Sarmatian is characterized in microfauna by brackish fauna with *Ammonia beccarii* (L.). In its higher part the so called lager elphidia appear, e.g. *Elphidium reginum* (Orb.), *E. aculeatum* (Orb.) (*Elphidium reginum* Zone, Grill, 1941).

The Middle Sarmatian belongs microfaunistically to the *Elphidium hauerinum Zone* (Grill, 1941).

The Upper Sarmatian belongs in microfauna to the *Nonion granosum* Zone (Grill, 1941) and is defined by the Pannonian base in the Central Paratethys. For the basal A Zone of the Pannonian s.s. onset of the foraminifer *Silicoplacentina hungarica* Koev. and onset of ostracode genera *Erpetocypris* and *Hungarocypris* and of the species *Hemicytheria loerentheyi* (Meh.) is characteristic.

The Sarmatian vertebrate fauna is of Miocene character. Only in the Pannonian younger elements of fauna occur as hipparions with developing autochthonous forms, for instance *Bunolophodon longirostris* (Kaup.) (Thenius, 1959).

The holostratotype of the Sarmatian is the locality Nexing in Lower Austria. As faciostratotype localities for the Sarmatian s.s. in the Western Carpathians of Slovakia were determined: Nižná Myšľa, Mochovce, Hontianska Vrbica and Močiar.

From the survey of up to present microbiostratigrapgical investigations of the sarmatian in East

In the frame of the geological investigation of the Neogene in eastern Slovakia Bystrická (1954) evaluated micropaleontologically several samples from the area east of the Slanské vrchy Mts. She found Lower Sarmatian sediments in the vicinity of the villages Veľaty, Byšta, Dvor Mária, Brezina (Kolbaš), Veľký Kazimír. In the upper part of the Lower Badenian she observed alternation of horizons of stenohaline fauna with brackish.

The Sarmatian with a typical brackish microassociation is mentioned by Bystrická (l.c.) from a brook near Kuzmice, from the right bank of the Olšava river, north of the village Olšovany, from the southern outskirts of Kalša, from the brook near Bohdanovce, from the brook Roňva between the farmstead Gender and the viaduct, west of Kuzmice, near Slivník and Slanská Huta, near the railway station in Slanec, east and northwest of the lake Izra.

From samples taken at the borehole Michaľany-1 from the depth of 140-283,7m Jendrejáková (1957) determined the Upper Badenian. At the profile of the borehole there is alternation of brackish and marine microfauna. With its comparison she has come to the conclusion that it mostly approaches foraminifer associations from the borehole near Veľaty.

The Sarmatian microfauna was studied by Bystrická (1959) from the vicinity of the villages Nižná Myšľa, Slanec, Nové Mesto Slančík, Skároš, Rákoš Trstené on Hornád, Kalša a Rankovce. According to predominating forms of foraminifers she delimited 5 types of associations.

Prokšová (1959, in Brodňan et al.(1959) evaluated micropaleontologically boreholes in the Podvihorlat coal basin. From the boreholes Hažín-1,2 and Blatné Revište-1 she determined the brackish Lower Sarmatian.

Sarmatian microfauna in eastern Slovakia was also dealt with by Kudláčková (1959, in Janáček, 1959).

Sarmatian sediments encountered in borehole Bočiar-1 were divided by Brestenská (1960), in Brestenská and Priechodská, 1960) into 2 horizons: the lower - brackish and upper - freshwater horizons. From organic remnantes in the freshwater Sarmatian root concretions and carbonized or pyritized remnants of plants are present only. Autochthonous foraminifers are absent. These 2 Sarmatian developments are distinguishable by heavy mineral associations (Priechodská, 1960, in Brestenská and Priechodská, 1960).

The beds of the Upper Badenian Bulimina-Bolivina Zone are overlain by a transgressively deposited brackish to freshwater formation, with was pursued by drillings near Sečovce, Albínov, between Sečovce and Michalovce and between Bidovce and Herľany. As to microfauna the formation was studied in detail mainly at the borehole Sečovce-1 by Zapletalová (1960). As it results from her investigations the 1 500m thick brackish Badenian formation is characterized by sedimentation in freshwater to brachyhaline environment with freshening in overlying direction when sedimentation of the brackish Upper Badenian underlying the brackish Lower Sarmatian is terminated by beds with larger elphidia and Lower Sarmatian ostracodes.

Lower Sarmatian foraminifers of the zone of larger elphidia (*Elphidium reginum* Zone, Grill, 1941) from boreholes im the area of Belža, Trstené on Hornád, Nižná Myšľa, Ždaňa, Nižná Hutka and Nižný Čaj were investigated by Lehotayová (1960).

Cicha (1961) from microbiostratigraphical investigations near Brezina, Byšta, Veľký Kazimír, Michaľany, Veľaty, Černochov, Veľká Tŕňa and in boreholes near Trebišov has not proved beds of the brackish Upper Badenian, transgessively overlying the Bulimina-Bolivina Zone in the Sečovce-Albínov area, on the general map sheet Trebišov.

Development of the brackish and freshwater Sarmatian in the East Slovakian Neogene region was studied by Cicha and Kheil (1962).

Microfaunistic analyses from borehole Klečenov -1, 2 were carried out by Zapletalová (1962).

From borehole R-16 (Ruskov, depth 50,6m) Gašparíková (1963) mentioned foraminifer associations of the highest part of the Lower Sarmatian, belonging in microfauna to the Elphidium hauerinum Zone (Grill, 1941).

In the frame of hydrogeological investigation of artesian aquifers in eastern Slovakia, in the area of Dargov-Zemplínska Teplica, micropaleontological analyses of drilling samples AV-1a and AV-2 were carried out. The sediments in the area of Zemplínska Teplica were assigned to the freshwater higher Sarmatian by Gašparíková (1964) on the basis of microassociations.

Biostratigraphy of the Sarmatian and Pannonian and the problem of their boundaries in eastern Slovakia were studied by Jiříček (1972).

A detailed study of foraminifers from litostratigraphical units of the Sarmatian in the frame of regional geological investigation of the Košická kotlina depression and Slánske vrchy Mts. was performed by Zlinská (1984, 1986, 1987, 1988, 1989 a, b, 1990, 1990 a, 1991 a, b, 1992, 1992 a, b,1993 a, b, c,1994 a,b).

The correlation of the Sarmatian on the basis of foraminifers and molluscs may be found in the works by Zlinská and Fordinál (1988, 1989, 1995), Fordinál and Zlinská (1994) and Zlinská et al. 1996.

Correlation of sarmatian lithostratigraphic and biostratigraphical units in the Košická kotlina depression

In the frame of lithostratigraphical division of the Sarmatian in the Košická kotlina depression the units delimited by Vass and Čverčko (1985) for the Neogene of the East Slovakian Lowland were used. In biozonation the scale elaborated by Grill (1941) in the Vienna Basin served as the basis (Tab. 12).

In this chapter the results of the works by Zlinská (1984, 1986, 1987, 1989 a, 1990 a, 1991 a, b, 1992), Zlinská and Fordinál (1988,1989) and Zlinská et al.1996 were used.

Klčov formation

In the Upper Badenian-Kosovian was differentiation of microfauna into marine, which is represented in the lower part of the substage, lithologically belonging to the Lastomír Formation and brackish, in the upper part of the substage, represented by Klčov Formation reaching stratigraphically the lowermost Sarmatian (Tab.12).

From the mentioned formation together 31 samples were studied as to microfauna from boreholes: KSV-25 (Juskova Voľa, 1 sample from depth of 252,5-254m), K-8 (Nižný Čaj, 25 samples from depths of 294 - 648 m) and SHJ-23 (Kalša, 5 samples from depths of 75-100m) (Fig.1).

As visible from the attached table (Tab.1), the formation is characterized, besides redeposited marine microfauna, by mixed marine and marine-brackish foraminifers of the Bulimino-Bolivina and Ammonia biozones, of stratigraphic range Upper Badenian to lowermost Sarmatian. From the fauna of foraminifers mainly the genera were recorded: Globigerina, Bulimina, Bolivina, Uvigerina inclining to the Badenian and to the Sarmatian Elphidium, Nonion, miliolid forms (*Quinqueloculina, Triloculina*) and *Ammonia beccarii* (L.) as most abundant. The species *Elphidium flexuosum grilli* Papp is also known from the Lower Sarmatian of stratotype borehole Bč-1 (Bočiar) (Brestenská, 1974). Ostracodes are represented by diachronous species, only *Phlyctenophora farkasi* (Zal.) is bound to the Upper Badenian (NO-10 Zone, Jiříček, 1983) .

The obtained foraminifer associations point to salinity and depth of the sedimentation area gradually decreasing from marine to brackish and from the neritic to sublittoral.

The sediments of this formation prevailingly contained terrestrial gastropods (Zlinská et al. 1996) with prevalence of hydrophilous genera.

Stretava formation

From this formation 25 outcrop samples (AZ-1, 2, 3, AZ-15, 162, 163, 165, 166, 169, 172, 175, 176, 218, 219, 227, 228, 269, 271, 273, 274, 280, 293, 296, Sl-1030, 1045 and 138 drilling samples were studied microfaunistically, coming from boreholes: S-4 (Čakanovce, 2 samples from depth of 17,9-26,5 m), JGF-31 (Ždaňa, 1 sample from depth of 14,2 m), VST-11

(Kravany, 10 samples from depths of 57,8-240,5m), KMV-50 (Zemplínska Teplica,5 samples from depths of 21,5-49,6m), KMV-51 (Zemplínska Teplica, 12 samples from depths of 14,6-137,5m), VTK-2 (Skároš, 7 samples from depths of 24,2-48,2m), VTK-3 (Skároš, 5 samples from depths of 28,1-72,3m), VTK-4 (Skároš, 5 samples from depths of 17,2-46,5m), VTK-5 (Skároš, 4 samples from depths of 13,2-18,2m), JGF-38 (Izra, 1 sample from depth of 10,8m), JGF-40 (Slanská Huta, 1 sample from depth of 14,2m), VTK-30 (Slanská Huta, 2 samples from depths of 27-46,5m), VTK-32 (Slanská Huta, 4 samples from depths of 13,2-32,2m), VTK-33 (Slanská Huta, 4 samples from depths of 17,7-35,7m), JVH-26 (Nižný Čaj, 1 sample from depth of 19m), JVH-33 (Nižný Čaj, 1 sample from depth of 17m), K-3 (Slanská Huta, 29 samples from depths of 18-286m), K-8 (Nižný Čaj, 26 samples from depths of 7,3-242,5m), K-13 (Ďurkov, 8 samples from depths of 210,8-250m) and K-15 (Sečovce, 10 samples from depths of 236,4-275,2m) (Fig.1).

The formation contains shallow-water brackish foraminifers, according to up to present knowledge of the Elphidium reginum and *Elphidium hauerinum* biozones (Tab.12), or stratigraphically the Lower to Middle Sarmatian. The species *Elphidium hauerinum* (Orb.), which in basins of the Central Paratethys is found in the Middle Sarmatian, however, according to present-day results atypically appears already in the Lower Sarmatian in the Košická kotlina depression thus in the foraminiferal *Elphidium reginum* Zone (Grill, 1941).

To foraminifers characteristic of this formation (Tab. 2 - 8) mainly belong to the species: *Ammonia beccarii* (L.), *Elphidium reginum* (Orb.), *E. hauerinum* (Orb.), *E.* ex gr. *flexuosum* (Orb.), *E. macellum* (F.-M.), *E. aculeatum* (Orb.), *E. glabrum* Bystrická, *E. fichtelianum* (Orb.), *E. crispum* (L.), *E. microelegans* Serova, *Protelphidium bogdanowiczi* (Volosh.), *Elphidium granosum* (Orb.), the genera *Schackoinella, Nonion, Articulina* and other miliolid foraminifers. In the Košická kotlina depression, for instance, at the localities Nižná Myšľa and Skároš, in the Slanské vrchy Mts. in Slanská Huta and in the East Slovakian Lowland at the type locality of Kravany (borehole VST-11) the new species *Elphidium samueli* Zlinská (1993) was described in the Stretava Formation. It is a form transitional between *E. aculeatum* (Orb.) and *E. reginum* (Orb).

The obtained foraminifers characterize the shallow-water brackish environment (Zlinská, 1992b).

From other organic remains Lower Sarmatian Bryozoa were found: *Schizoporella* sp. (Slanská Huta) and *Crisiella carnuntina* Bobies (Trstenné on Hornád, Kravany), algae (*Dasycladaceae, Chlorophyta*): *Chalmasia morelleti* Pokorný (Sečovce), described by Pokorný (1948) from the Sarmatian of Moravia (Podivín). Further on, Sarmatian ostracodes were found, typical species of the NO-11 Zone (in the sense of Jiříček, 1983) (Tab.11). They are:

Aurila mehesi (Zal.) (Izra, Slanská Huta, Herľany, Sečovce, Nižná Myšľa, Čakanovce, Kravany, Zemplínska Teplica), *Senesia vadaszi* (Zal.) (Herľany, Kravany, Kalša), *Cytheridea hungarica* (Zal.) (Slanská Huta, Sečovce, Slanec, Herľany, Nižná Myšľa, Skároš, Izra, Nižný Čaj), *Loxoconcha hastata* (Rss.) (Herľany), *Hemicyprideis dacica* (Héjj.) (Ždaňa) and *Hemicytheria loerentheyi sarmatica* Jiř. (Zemplínska Teplica), which is described by Jiříček (1974) from the Lower Sarmatian (B Zone, Tab.10) of borehole 4 (Svinica, 35-40 m) in eastern Slovakia.

The studied formation contains gastropods, which permit to range it to Lower Sarmatian Rissoa beds in the sense Papp (1954) (Tab.10, Zlinská et al. 1996).

Kochanovce formation

The last studied lithostratigraphical unit of the Sarmatian is the Kochanovce Formation. A feature characteristic of this formation is the presense of freshwater molluscs and absence of brackish ones. In microfauna it corresponds to the *Elphidium hauerinum* and *Nonion granosum* biozones (Grill, 1941) (Tab.12) or to the stratigraphic range of the Middle to Upper Sarmatian.

From the Kochanovce Formation an outcrop sample from the locality Svinica (AZ-174) and 15 samples from borehole K-15 (Sečovce, from depths of 43,6-174,5m), were studied (Fig.1).

As it is a freshwater formation, it does not contain autochthonous associations of foraminifers (Tab. 9). Freshwater ostracodes were established only (Zlinská, 1992). The subspecies *Phlyctenophora farkasi sarmatica* Jiř. was described by its author from the Sarmatian D_3 Zone (Jiříček, 1974).

The sediments did not contain an autochthonous fauna of terrestrial gastropods and freshwater gastropods and bivalves (Zlinská et al. 1996).

Systematic part

Order *FORAMINIFERIDA* Eichwald 1830
Family *HAUERINIDAE* Schwager 1876
Genus *Cycloforina* Luczkowska 1972

Cycloforina hauerina (Orbigny 1846)

1846 *Quinqueloculina hauerina* Orbigny, p. 286, pl.17, fig. 25-27
1974 *Quinqueloculina hauerina* Orbigny - Brestenská, p. 249
1974 *Cycloforina hauerina* (Orbigny) - Luczkowska, p. 79, pl. 12, fig. 1a-c, text fig. 28/5

1985 *Cycloforina hauerina* (Orbigny) - Papp et Schmid, p. 97, pl. 91, fig. 5-8, textfig. 14/3

Remarks: The test is from outside similar to the species *Quinqueloculina akneriana* Orbigny. They are distinquished by cycloforine inner chambers.

Stratigraphic range: This form is found in the Badenian and Sarmatian in the Western Carpathians, mostly in association with elphidia and miliolids. In the East Slovakian basin it was established from the Kosovian to Lower Sarmatian.

Occurences: In the Sarmatian of the Košická kotlina depression in samples: K-8 (Nižný Čaj), K-3 (Slanská Huta), VTK-4 (Skároš), VST-11 (Kravany).

Genus *Sinuloculina* Luczkowska 1972

***Sinuloculina consobrina* (Orbigny 1846)**

(Pl. I, Fig. 1)

1846 *Triloculina consobrina* Orbigny, p.277, pl.17, fig. 10-12
1970 *Quinqueloculina consobrina consobrina* Orbigny-Didkovský et Satanovská, p.21, pl. 10, fig.2a-v
1974 *Sinuloculina consobrina* (Orbigny) - Luczkowska, p.123, pl. 25, fig.5a-c,6, 7a-c, textfig.40
1985 *Sinuloculina consobrina* (Orbigny) - Papp et Schmid, p.95, pl. 88, fig. 5-10, textfig. 14/2

Remarks: The initial chamber of this species is sinuloculoid, enabling Luczkowska (1972) re-assignment to the genus *Sinuloculina. S.consobrina* is similar to *S. nitens* (Reuss). It is, however, more slender and has a more oval test. From the species *Triloculina gibba* Orb. it differs in a more slender test, more rounded cross selection and insignificantly deepened sutures.

Stratigraphic range: In the East Slovakian Basin it was established from the Wieliczian to Lower Sarmatian.

Occurrences: In the Košická kotlina depression in samples: VTK-32,33,AZ-176, K-3 (Slanská Huta), AZ-169 (Trstené on Hornád), KMV-50 (Zemplínska Teplica), VTK-2,3,4 (Skároš), K-8 (Nižný Čaj), K-15 (Sečovce).

Genus *Articulina* Orbigny 1826

***Articulina articulinoides* Gerke et Issaeva 1952**

(Pl. I, Fig. 2)

1952 *Articulina articulinoides* Gerke et Issaeva, p. 211, pl.33, fig.6-8 (in Bogdanowicz 1952)
1974 *Articulina articulinoides* Gerke et Issaeva - Brestenská, p. 253, pl. 2, fig. 4,6

Remarks: Similar to the species *A. sarmatica* (Karrer), which in the initial stage reaches less dimensions and in the uniserial part are chambers with smaller length than in *A. articulinoides*. The initial part in both species is quinqueloculine.

Stratigraphic range: The species is endemic, bound in its occurrences with the Sarmatian of Paratethys.

Occurrences: In the Košická kotlina depression found in the Lower Sarmatian in samples: AZ-169 (Trstené on Hornád), VTK-32,33 (Slanská Huta).

Family *GLABRATELLIDAE* Loeblich et Tappan 1964
Genus *Schackoinella* Weinhandl 1958

***Schackoinella imperatoria* (Orbigny 1846)**

1846 *Rosalina imperatoria* Orbigny, p.176, pl.10, fig.16-18
1958 *Schackoinella sarmatica* Weinhandl, p. 141, textfig. 1 (nom.corr.)
1974 *Glabratella imperatoria* (Orbigny) - Brestenská, p. 258, pl. 4, fig.1-3
1985 *Schackoinella imperatoria* (Orbigny) - Papp et Schmid, p .66, pl. 60, fig. 1-5

Remarks: On the contrary to other species small spines on the dorsal side of chambers are typical of this species.

Ecology: The species belongs to representatives of the shallow neriticum. Murray (1973) mentions the lower boundary of extension of this species to 50m.

Stratigraphic range: In the central Paratethys found in the Early Sarmatian. In places it is prevalent in the zone of larger elphidia. In the eastern Paratethys it was already established in the Upper Badenian.

Occurrences: In the Košická kotlina depression it is found in the Lower Sarmatian in samples: VST-11 (Kravany) and AZ-169 (Trstené on Hornád).

Family *PARRELLOIDIDAE* Hofker 1956
Genus *Lobatula* Fleming 1828

***Lobatula lobatula* (Walker et Jacob 1798)**

1798 *Nautilus lobatulus* Walker et Jacob, p.642, pl.14, fig.36
1846 *Truncatulina lobatula* (Walker et Jacob) - Orbigny, p.168, pl.9, fig.18-23
1846 *Anomalina variolata* Orbigny, p.170, pl. 9, fig. 27-29
1960 *Cibicides lobatulus* (Walker et Jacob) - Cicha et Zapletalová, p.27, pl.7, fig.1-3
1985 *Cibicides lobatulus* (Walker et Jacob) - Papp et Schmid, p. 64, pl. 56, fig.1-5
1988 *Lobatula lobatula* (Walker et Jacob) - Loeblich et Tappan, p. 583, pl. 637, fig. 10-13

Remarks: Marks (1951) considers as synonym of this species the following species: *Truncatulina tuberculata* Orb., *Anomalina variolata* Orb., *Truncatulina communis* Reuss. As the variability of the studied taxon is considerably large, one may agree with his opinion.

Ecology: The species is a typical representative of shallow-neritic conditions.

Stratigraphic range: In the Tertiary of the central Paratethys it is common, in the Miocene abundant. In the East Slovakian Basin it was established from the Karpatian to Lower Sarmatian.

Occurrences: In the Košická kotlina depression in samples: AZ-69 (Trstené on Hornád), K-8, JVH-26 (Nižný Čaj), VTK-30, 32, 33 (Slanská Huta).

Family *NONIONIDAE* Schultze 1854
Genus *Nonion* de Montfort 1808

Nonion commune (Orbigny 1825)

(Pl.I, Fig. 3)

non 1791 *Nautilus scapha* Wulfen, p.242
1798 *Nautilus scapha* Fichtel et Moll, p. 105, pl. 19, fig. d-f
1825 *Nonionina communis* Orbigny, p.128, Nr. 20 (fide Ellis - Messina 1940)
1846 *Nonionina communis* Orbigny, p. 106, pl. 5, fig. 7-8
1939 *Nonion scaphum* (Fichtel et Moll) - Cushman, p. 20, pl. 5, fig. 18-21
1967 *Florilus communis* (Orbigny) - Cicha et Zapletalová, p. 136
1969 *Nonion scaphum* (Fichtel et Moll) - Roegl, p. 102, pl. 5, fig.19a-b
1984 *Nonion commune* (Orbigny) - Roegl et Hansen, p. 66, pl. 24, fig. 1-2,4-6
1985 *Nonion commune* (Orbigny) - Papp et Schmid, p. 45, pl. 34, fig.1-5

Remarks: According to revision of the original material of Orbigny by Papp and Schmid (1985) the species *Nonioni* na *Boueana* Orbigny is additionally ranged to the genus *Hanzawaia*. Nonion commune differs from the species *Hanzawaia boueana* mainly in less overlapping younger chambers and rounded periphery.

Stratigraphic range: In the Tertiary of the central Paratethys the species is common, in the Miocene abundant, bound to shallow-water facies. In the East Slovakian Basin it was established from the Karpatian to Lower Sarmatian.

Occurrence: In the Košická kotlina depression in samples: K-8, JVH-33 (Nižný Čaj), AZ-166 (Nižná Myšľa), K-13 (Ďurkov), K-3 (Slanská Huta), VTK-5 (Skároš), KMV-50 (Zemplínska Teplica).

Family *ROTALIIDAE* Ehrenberg 1839
Genus *Ammonia* Bruennich 1772

Ammonia beccarii (Linné 1758)

(Pl. I, Fig. 4, 5)

1758 *Nautilus Beccarii* Linné, p. 710
1846 *Rosalina vienensis* Orbigny, p. 177, pl. 10, fig. 22-24
1857 *Rosalina vienensis* Orbigny - Egger, p. 277, pl. 8, fig. 11-13
1959 *Rotalia beccarii* (Linné) - Dieci, p. 80, pl. 6, fig. 29a-c
1971 *Streblus beccarii* (Linné) - Hofker, p. 17, pl. 63, fig. 1-8, pl. 64, fig. 1-6
1973 *Ammonia beccarii* (Linné) - Cicha et al., p. 312, pl. 6, fig.32 a-b
1985 *Ammonia beccarii* (Linné) - Papp et Schmid, p. 67, pl. 61, fig.1-5
1987 *Ammonia beccarii* (Linné) - Wenger, p. 303, pl. 14, fig. 13-16

Remarks: The species is characterized by great variability, which is depending on ecological factors.

Ecology: It is a form characteristic of shallow waters (Poag, 1981,Walton 1964). According to Phleger (1960) it is ofter found at depths of 10-50m. Reaches maximally 80m. Endures strong freshening.

Stratigraphic range: In the Miocene of the central Paratethys it is common. In the East Slovakian Basin it was established from the Eggenburgian to Middle Sarmatian.

Occurrences: In the Košická kotlina depression found in all the studied samples except AZ-271.

Family *ELPHIDIIDAE* Galloway 1933
Genus *Elphidium* de Montfort 1808

Elpihidium aculeatum (Orbigny 1846)

(Pl. I, Fig. 6)

1846 *Polystomella aculeata* Orbigny, p.131, pl. 6, fig. 27-28
1932 *Elphidium aculeatum* (Orbigny) - Bogdanowicz et Fedorov, p. 14, textfig. 13-20, pl.1, fig. 4-7
1985 *Elphidium aculeatum* (Orbigny) - Papp et Schmid, p. 53, pl. 43, fig. 4-7

Remarks: This species characteristic of the Sarmatian is distinguished by bent septa which are running out into spines.

Ecology: The genus *Elphidium* is generally considered as indicator of little water depths. In larger amount it is found at depths less than 80-100m (Boltovskoy-Wright 1976, Walton 1964, Poag 1981).

Stratigraphic range: In the central Paratethys the species is found from the Karpatian. We may observe typical *E. aculeatum* in the Early Sarmatian. In the East Slovakian Basin it was established from the Moravian to Lower Sarmatian.

Occurrences: In the Košická kotlina depression in samples: AZ-162, 166, Sl-1030, 1045 (Nižná Myšľa), AZ-176, 271, 274, VTK-32, 33, K-3 (Slanská Huta), AZ-227, 228, vz.3 (Ždaňa), JVH-26, K-8 (Nižný Čaj), VST-11 (Kravany), VTK-2, 3,4 (Skároš), K-15 (Sečovce).

Elphidium crispum (Linné 1758)

1758 *Nautilus crispus* Linné, p. 709, No. 236
1798 *Nautilus crispus* Linné - Fichtel et Moll, p. 40 (partim), pl. 5, fig. a-b
1822 *Polystomella crispa* Lamarck, p. 624

1846 *Polystomella crispa* Lamarck - Orbigny, p. 125, pl. 6, fig. 9-14
1932 *Elphidium crispum* (Linné) - Bogdanowicz et Fedorov, p. 12, pl. 1, fig.3, textfig. 11
1971 *Elphidium crispum* (Linné) - Cicha et al., p. 270, pl. 17, fig. 6-8
1985 *Elphidium crispum* (Linné) - Papp et Schmid, p. 50, pl. 40, fig.5-8

Remarks: From *E. rugosum* (Orbigny) it differs in a very clear central pillar. From *E. flexuosum* subtypicum Papp it differs in a higher number of chambers, larger test and clearly bordered considerably smooth pillar.

Stratigraphic range: In the central Paratethys Miocene a common species from the Eggerburgian. In the East Slovakian Basin established from the Karpathian to Lower Sarmatian.

Occurrences: In the Sarmatian of the Košická kotlina depression in samples: S-4 (Čakanovce), AZ-163 (Nižná Myšľa), AZ-2712 73 (Slanská Huta), KMV-50 (Zemplínska Teplica), VTK-4 (Skároš), K-15 (Sečovce).

***Elphidium fichtelianum* (Orbigny 1846)**

1846 *Polystomella fichtelliana* Orbigny, p. 125, pl.6, fig. 7-8
1939 *Elphidium fichtellianum* (Orbigny) - Cushman, p. 42, pl.11, fig.12
1960 *Elphidium fichtellianum* (Orbigny) - Krasheninnikov, p.34, pl.2, fig.2, pl.3, fig.1
1985 *Elphidium fichtelianum* (Orbigny) - Papp et Schmid, p. 50, pl. 40, fig. 1-5

Remarks: From *E. ortenburgense* (Egger) in differs in flatter sharp, larger growth of chambers in the last whorl and more strongly bent septa. Both species are linked through transitional forms.

Stratigraphic range: E. fichtelianum (Orb.) is a species common in the central Paratethys, persisting from the Eggenburgian to the lower part of the Early Sarmatian where it is abundant in the zone of larger elphidia. In the East Slovakian Basin it was established from the Karpatian to Lower Sarmatian.

Occurrences: In the Košická kotlina depression in samples: K-8 (Nižný Čaj), AZ-163 (Nižná Myšľa), JGF-38 (Izra), K-3, VTK-32 (Slanská Huta), VTK-2, 4, 5 (Skároš), SHJ-23, AZ-269, 293, 296 (Kalša), AZ-219 (Slanec), K-15 (Sečovce).

***Elphidium flexuosum flexuosum* (Orbigny 1846)**
(Pl. I, Fig. 7)

1846 *Polystomella flexuosa* Orbigny, p.127, pl. 6, fig. 15-16
1857 *Polystomella flexuosa* Orbigny - Egger, p. 303, pl. 10, fig. 21-22
1963 *Elphidium flexuosum flexuosum* (Orbigny) - Papp, p. 271, pl. 12, fig. 5-6
1985 *Elphidium flexuosum flexuosum* (Orbigny) - Papp et Schmid, p.51, pl. 41, fig.1-4

Remarks: Similar to the species *E. crispum* (L.). The latter, however has a larger number of chambers and a flatter form.

Stratigraphic range: In the Miocene of the central Paratethys wide-spread from the Eggenburgian to Sarmatian. In the East Slovakian Basin it was established from the Karpatian to Lower Sarmatian.

Occurrences: In the Košická kotlina depression in samples: K-8 (Nižný Čaj), K-15 (Sečovce), AZ-166 (Nižná Myšľa), AZ-228 (Ždaňa), AZ-280 (Slivník), AZ-293, 296 (Kalša), VTK-2,5 (Skároš).

***Elphidium (Porosononion) granosum* (Orbigny 1846)**
(Pl. I, Fig. 8)

1826 *Nonionina granosa* Nob.- Orbigny, p. 294 (nomen nudum)
1846 *Nonionina granosa* Orbigny, p. 110, pl. 5, fig.19-20
1857 *Nonionina subgranosa* n. sp. - Egger, p. 299, pl. 14, fig. 16-18
1939 *Nonion granosum* (Orbigny) - Cushman, p. 11, pl. 2, fig. 17-18
1985 *Elphidium (Porosononion) granosum* (Orbigny)-Papp et Schmid, p. 47, pl. 37, fig. 1-6

Remarks: From *Protelphidium roemeri* (Cushman) it differs in being flatter, having many mouths and thick perforation. *P. roemeri* is fine perforated.

Stratigraphic range: In the East Slovakian Basis established in the Moravian to Middle Sarmatian.

Occurences: In the Košická kotlina depression in samples: AZ-175, VTK-33 (Slanská Huta),VTK-2, 3, 4, 5 (Skároš), K-8 (Nižný Čaj), AZ-162, vz.1, Sl-1030 (Nižná Myšľa), AZ-219 (Slanec), KMV-51 (Zemplínska Teplica), K-15 (Sečovce).

***Elphidium hauerinum* (Orbigny 1846)**
(Pl. II, Fig.1, 2)

1846 *Polystomella hauerina* Orbigny, p.122, pl.6, fig. 1-2
Polystomella antonina Orbigny, p.128, pl. 6, fig. 17-18
Polystomella listeri Orbigny, p.128, pl. 6, fig. 19-22
1932 *Elphidium hauerinum* (Orbigny) - Bogdanowicz et Fedorov, p. 21, pl. 1, fig. 19-21, textfig. 31-32
1939 *Elphidium hauerinum* (Orbigny) - Cushman, p. 42, pl. 11, fig. 9
Elphidium antoninum (Orbigny) - Cushman, p. 43, pl. 11, fig.14
1963 *Elphidium antoninum* (Orbigny) - Papp, p. 262, pl. 10, fig.3-5
Elphidium hauerinum (Orbigny) - Papp, p. 263, pl. 10, fig.6
Elphidium listeri (Orbigny) - Papp, p. 273, pl.12, fig. 9
1985 *Elphidium hauerinum* (Orbigny) - Papp et Schmid, p. 49, 51, pl. 38, fig. 5-10, pl. 41, fig. 5-10, pl. 42, fig.1-4

Remarks: Similar to the species *E. obtusum* (Orbigny), which however, has finer sutural pits. Papp (1963) and Brestenská (1974) ranged *E. hauerinum* to primitive elphidia.

Stratigraphic range: In the central Paratethys the species is widespread in the Middle Sarmatian only. Relatively small tests with large pores are found in the Košická kotlina depression already in the upper part of the Lower Sarmatian.

Occurrences: In the Košická kotlina depression it was establis hed in the higher part of the Lower and Middle Sarmatian in samples: S-4 (Čakanovce), AZ-15 (Herľany), VST-11 (Kravany), AZ-166 (Nižná Myšľa), AZ-227 (Ždaňa),VTK-2, 4, 5 (Skároš).

***Elphidium macellum* (Fichtel et Moll 1798)**

(Pl.II, Fig. 3, 4)

1798 *Nautilus macellus* var. beta - Fichtel et Moll, p.68, pl.10, fig. h-k

1939 *Elphidium macellum* (Fichtel et Moll) - Cushman, p. 51, pl.15, fig.9-10

1960 *Elphidium macellum* (Fichtel et Moll) - Krasheninnikov, p.32, pl.1, fig.2, pl.2, fig.1

1974 *Elphidium macellum* (Fichtel et Moll) - Brestenská, p. 263, pl. 6, fig. 4

1984 *Elphidium macellum* (Fichtel et Moll) - Roegl et Hansen, p. 50, textfig. 18B, pl. 14, fig. 2,5-6, pl. 15, fig.1-2

Remarks: From *E. fichtelianum* (Orbigny) it differs in wider form.

Stratigraphic range: In the Miocene of the central Paratethys it is found from the Egerian diachronously. In the East Slovakian Basin established from the Karpatian to Middle Sarmatian.

Occurrences: In the Košická kotlina depression it was established in the Sarmatian in samples: K-8 (Nižný Čaj), SHJ-23, AZ-269, 293, 296 (Kalša), AZ-15 (Herľany), VST-11(Kravany), AZ-227, 228, JGF-31 (Ždaňa), AZ-176, 271, 273, K-3, JGF-40, VTK-32, 33 (Slanská Huta), AZ-169 (Trstené on Hornád), AZ-218 (Slančík), AZ-162, 163, 166,172 (Nižná Myšľa), S-4 (Čakanovce), AZ-280 (Slivník), JGF-38 (Izra), KMV-50 (Zemplínska Teplica), VTK-2, 4, 5 (Skároš).

***Elpihidium reginum* (Orbigny 1846)**

(Pl.II, Fig. 5, 6)

1846 *Polystomella regina* Orbigny, p.129, pl.6, fig. 23-24

1960 *Elphidium regina* (Orbigny) - Krasheninnikov, p. 35, pl. 3, fig.3

1985 *Elphidium reginum* (Orbingy) - Papp et Schmid, p. 52, pl. 42, fig. 5-9, pl. 43, fig. 8

Remarks: This index fossil of the Sarmatian is considered by Papp and Schmid (1985) as an endemic species for the Paratethys. Assignment to the genus *Parrelina* Thalmann 1951 is based on accidental resemblance.

Stratigraphic range: The species is very variable. Mainly the number, length and massiveness of projections are changing. In the central Paratethys it is bound to the zone of larger elphidia. In the S part of the USSR it is still found in the Bessarabian. In the East Slovakian Basin it was established in the Lower Sarmatian.

Occurrences: In the Košická kotlina depression in samples: AZ-15 (Herľany), VST-11 (Kravany), K-8 (Nižný Čaj), AZ-163, SI-1030 (Nižná Myšľa), AZ-273, 274, VTK-32, 33, K-3 (Slanská Huta), K-15 (Sečovce).

***Elphidium samueli* Zlinská 1993**

(Pl. II, Fig. 7, 8)

1993 *Elphidium samueli* sp. n. - Zlinská, p. 85-87, pl. 19, fig. 4-9, pl. 20, fig. 1-8, pl. 21, fig. 1-8, pl. 22, fig. 1-8, pl. 23, fig. 2-9

Remarks: From *Elphidium aculeatum* (Orb.) it differs in a higher number of chambers, their shape, larger angle of sutures bending and irregular longer spines. From *Elphidium crispum* (L.) in less thickness. From *Elphidium reginum* (Orb.) in spines not overgrowing from the preceding whorl through the wall of the following whorl.

Stratigraphic range: The species was established in clayey-sandy facies of the lower brackish Sarmatian (*Elphidium reginum* Zone).

Occurrences: In the Košická kotlina depression in Lower Sarmatian samples: VST-11 (Kravany), VTK-3,5 (Skároš), AZ-165 (Nižná Myšľa), VTK-30, 32, K-3 (Slanská Huta), AZ-227 (Ždaňa), KMV-50 (Zemplínska Teplica).

Conclusion

The objective of the article was to find out the composition and character of foraminifer associations in the individual lithostratigraphical units of the Sarmatian in the Košická kotlina depression, their correlation with foraminifer biozones in the Vienna Basin and refinement of the taxonomy of foraminifers typical of the Sarmatian.

In the article the results of study of around 250 microfaunistic samples (foraminifers and ostracodes) are presented.

The Sarmatian is characterized by shallow-water forms of foraminifers, which are marked by a great variability of species. There are relatively few species having a narrow range of occurrence. Sometimes the stratigraphic assignment is very pretentious for the reasons of absence of these forms. Besides that the boundaries of litho- and biostratigraphical units are not equal. We place the microfaunistic boundary of the Klčov and Stretava Formations to the first occurrence og the species *Elphidium reginum* (Orb.), what represents as to microfauna the base of the equal-named zone and stratigraphically higher part of the Lower Sarmatian (Tab. 10). The boundary of the Stretava and Kochanovce Formations cannot be fixed microfaunistically because no species of foraminifers exists, the first occurrence of which would be recorded above the Middle Sarmatian base. In general the Middle Sarmatian base in the Central Paratethys is characterized by onset of the species *Elphidium hauerinum* (Orb.).This however appears in the Košická kotlina depression untypically already in the uppermost part of the Lower Sarmatian (Stretava Formation), testifying tocommunication af this area with the Eastern Paratethys region. Equally in the Sarmatian of the Košická kotlina depression species are relatiely largely represented, which were established first E of the East Slovakian Basin (Tab.2-8).

On the basis of the study of Sarmatian microfauna in the Košická kotlina depression it may be summarized briefly as follous:

1. In the Upper Badenian there was reduction of salinity and gradual shallowing of the sedimentation area. The Klčov Formation (Vass and Čverčko, 1985) (Upper Badenian to lowermost Sarmatian) contains a marine and marine-brackish microfauna with *Ammonia beccarii* (L.) and terrestrial gastropods with prevalence of hydrophilous genera. Only in one case the presence of brackish molluscs was established (Zlinská et al. 1996).

2. The Stretava Formation (Vass and Čverčko 1985) (Lower to Middle Sarmatian) is characterized by shallow-water brackish foraminifers (mainly of genus *Elphidium*) belonging as to microfauna to *Elphidium reginum* and *Elphidium hauerinum* Biozones (Grill 1941,Tab.12). In the area under study, however, *Elphidium hauerinum* (Orb.) appear untypically already in the Lower Sarmatian, indicating the possibility of restriction of this formation to the Lower Sarmatian. Gastropods of this formation correspond to the Lower Sarmatian Rissoa Member in the sense of division by Papp (1954, Tab.10), thus to the microfaunistic *Elphidium reginum* Zone (Zlinská et al. 1996).

3. The Kochanovce Formation contains from the original microfauna freshwater ostracode and fauna of terrestrial gastropods and freshwater gastropods and bivalves only (Zlinská et al.1996).

The biostratigraphical contribution of the article consists in:

1. summarization of the character of foraminifer associations in the individual lithostratigraphical units of the Sarmatian Košická kotlina depression

2. their correlation with Sarmatian foraminifer (Grill, 1941), or ostracode (Jiříček,1972,1983) and mollusc (Papp, 1954) (Tabs.10,11).

3. refinement of taxonomy of the individual foraminifers and of their stratigraphic range in the East Slovakian Basin (Tab. 13).

4. paleogeographical reconstruction of the environment: on the basis of stratigraphic range of the species *Elphidium hauerinum* (Orb.) in the upper part of the Lower Sarmatian in the East Slovakian Basin communication of this area with the Eastern Paratethys may be inferred.

5. refinement of the chronostratigraphicale scale of the Sarmatian in the Central and Eastern Paratethys.

It results from the above mentioned that it will be necessary to pay longer-termed attention to these problems also in future mainly in connection with phylo- and ontogeny, taxonomy, extension of individual taxa and their correlation with other groups and with the Eastern Paratethys.

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LIST OF LOCALITIES AND USED SAMPLES

Klčov Formation
Juskova Voľa : KSV-25
Nižný Čaj : K-8
Kalša : SHJ-23

Stretava Formation
Nižná Myšľa: AZ-1, 2, 162, 163, 165, 166, 172, Sl-1030,1045
Ždaňa: AZ-3, 227, 228, JGF-31
Herľany: AZ-15
Slanská Huta: AZ-175,176, 271, 273, 274, JGF-40, VTK-30, 32, 33, K-3
Slančík: AZ-218
Slanec: AZ-219
Kalša: AZ-269, 293, 296
Slivník: AZ-280
Kravany: VST-11
Zemplínska Teplica: KMV-50, 51
Skároš: VTK-2, 3, 4, 5
Izra: JGF-38
Nižný Čaj: JVH-26, JVH-33, K-8
Ďurkov: K-13
Trstené on Hornád: AZ-169
Čakanovce: S-4
Sečovce: K-15

Kochanovce Formation
Svinica : AZ-174
Sečovce : K-15

EXPLANATION TO PHOTOGRAPHIC PLATES

Plate I
Fig. 1 *Sinuloculina consobrina* (Orbigny), Slanská Huta
Fig. 2 *Articulina articulinoides* Gerke et Issaeva, Trstené on Hornád
Fig. 3 *Nonion commune* (Orbigny), Kalša
Fig. 4,5 *Ammonia beccarii* (Linné), 5 Skároš, 6 Kalša
Fig. 6 *Elphidium aculeatum* (Orbigny), Skároš
Fig. 7 *Elphidium flexuosum flexuosum* (Orbigny), Kalša
Fig. 8 *Elphidium granosum* (Orb.), Kalša

Plate II
Fig. 1,2 *Elphidium hauerinum* (Orbigny), Nižná Myšľa
Fig. 3,4 *Elphidium macellum* (F.-M.), 3 Slivník, 4 Kalša
Fig. 5,6 *Elphidium reginum* (Orbigny), 5 Ždaňa, 6 Nižný Čaj
Fig. 7,8 *Elphidium samueli* Zlinská, Kravany

The photographs are made by elektron microscope JSM-840, operators J. Stankovič and K. Horák, the length of abscissa corresponds to 100 µm.

Plate I

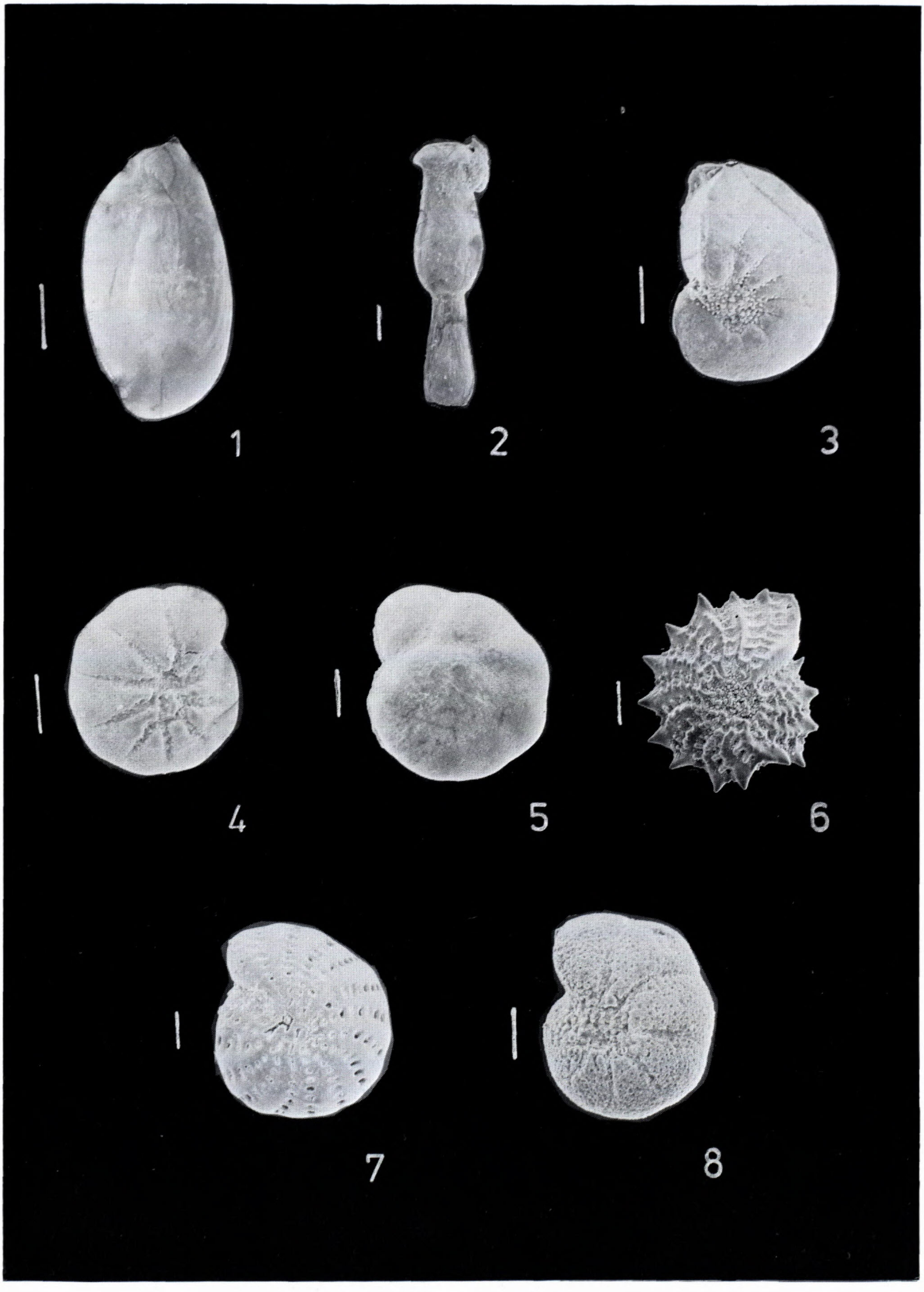
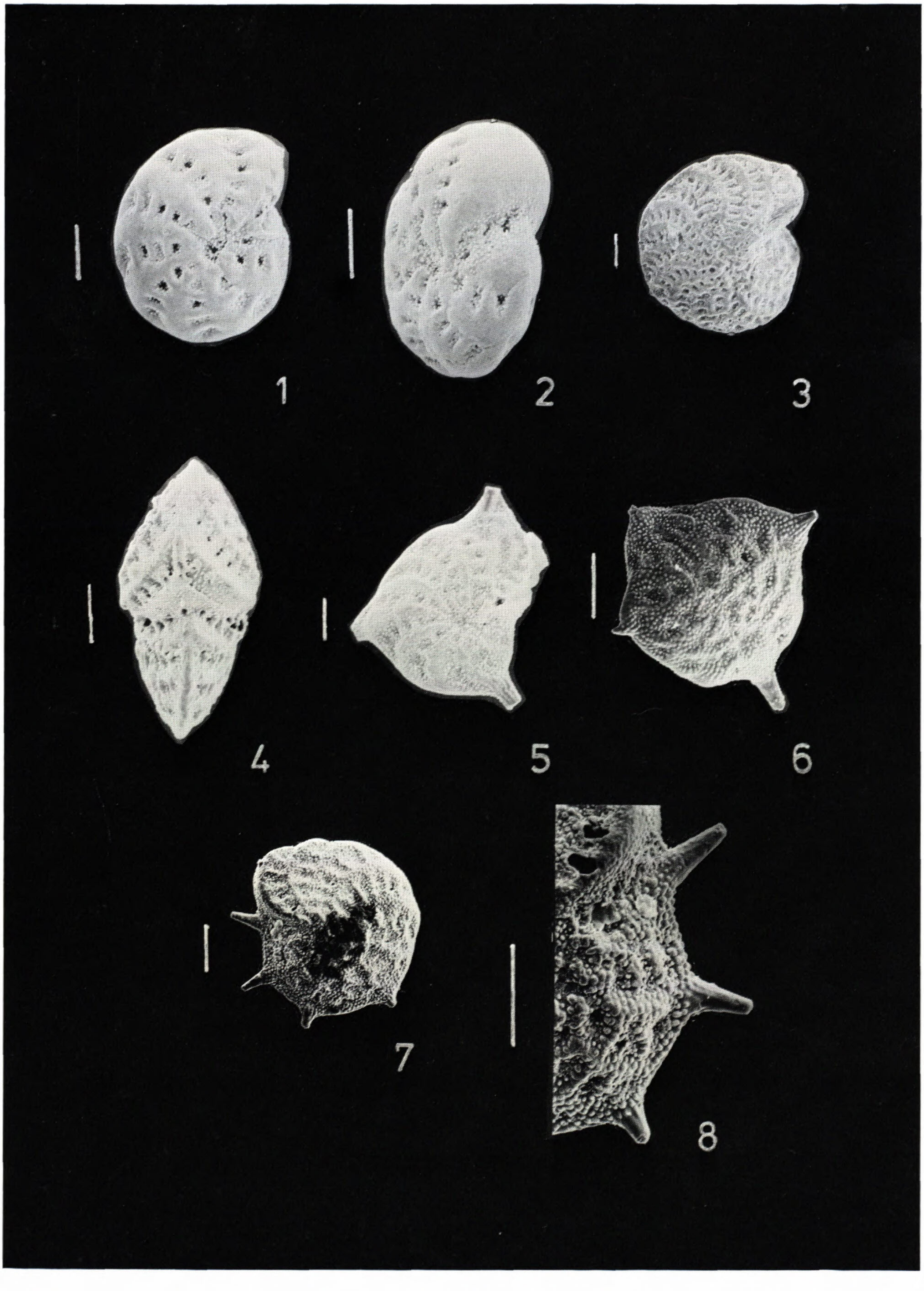


Plate II



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Paleoenvironmental controls and microfacies variability of the flowstone cover from the Zvonivá Cave in the Slovakian Karst

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Abstract: The almost 2 m thick flowstone cover in the Zvonivá Cave of the Slovakian Karst was studied for microfacies variability that are inferred to be influenced by environmental changes in the drainage area above the cave. The flowstone profile consists of three layers displaying different microfacies development. The lower player is composed of porous and clastic-rich, acicular calcite microfacies, it originated through fast $CaCO_3$-precipitation from supersaturated solutions. The intense growth of the flowstone resulted from a humid and warm climate which is confirmed by the stable isotopic data.

The middle layer of the section formed under a more stable hydrologic regime with pronounced seasonal rhythms that are reflected in varve-like microlaminations of the calcite increments.

The uppermost layer contrasts from the subjacent ones through a lack of detrital impurities and the frequent presence of corrosion horizons. As indicate stable isotopes contents, this layer of the flowstone developed in an arid cool climate which hindered growth of plant cover and weaker pedogenetic processes. A U/Th - date (116 Ka BP) was obtained from this layer of flowstone, which indicates its Eemian age and supports the environmental interpretation.

Keywords: speleothems, microfacies, stable isotopes, paleoenvironmental controls, Slovakian Karst

Introduction

Cave deposits are very useful tools of paleoenvironmental reconstructions since they record data lost in other continental sediments (e.g. fluvial or lacustrine).

Past studies on speleothems concern essentially two aspects: either they are descriptive analyses of speleothem sizes and forms or they are used in very advanced crystallographic and/or chemical plus radiometric investigations (Thompson et al., 1974; Harmon et al., 1975; Gascoyne et al., 1983; Gordon et al., 1989; Li et al., 1989). As a matter of fact, there are only few works dealing with crucial problem of sedimentary controls of speleothem formation (Folk and Assereto, 1976; Kendal and Broughton, 1978; Broughton, 1983a, 1983b, 1983c; Bar-Matthews et al., 1991; Dziadzio et al., 1993; Gonzá lez et al., 1993; Frisia et al., 1993; Railsbeck et al., 1994).

The present paper involves sedimentologic investigations on a flowstone profile from the Zvonivá Cave (Zvonivá diera) of the Slovakian Karst. This study was carried out in the frame of a more extended research programme focused on the main dynamic factors controlling Quaternary flowstones growth in Central Europe.

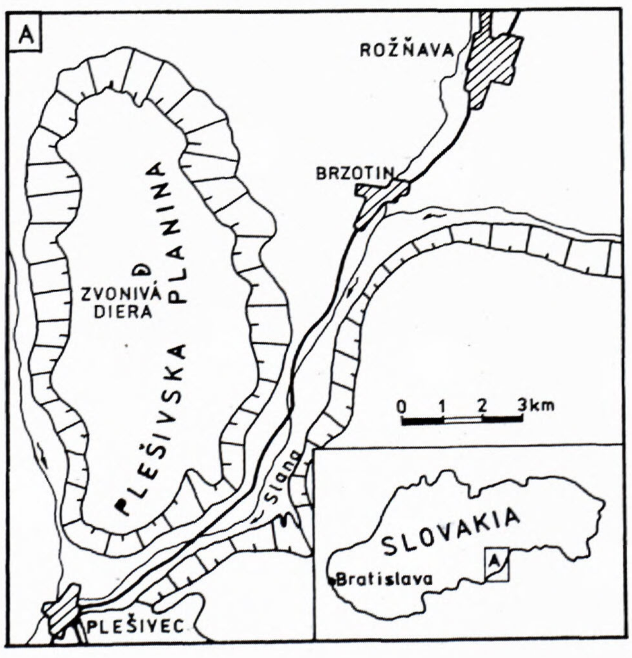

Fig. 1. Location map of the Zvonivá Cave

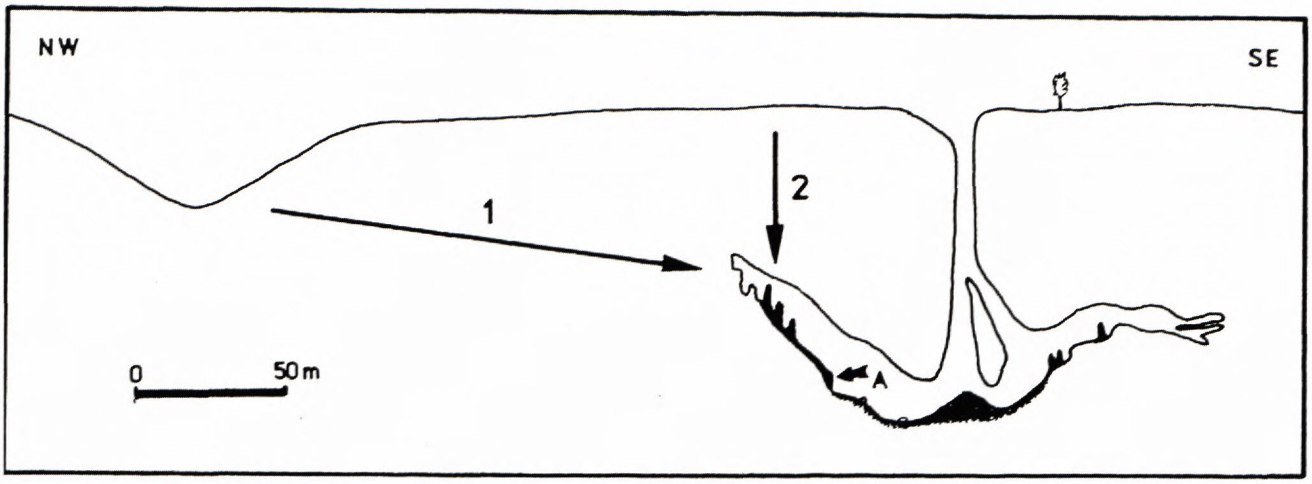

Fig. 2. Cross section of the Zvonivá Cave (after Benický, 1958) and the reconstructed drainage pathways: 1. During formation of the lower and middle part of the flowstone profile and 2. during formation of the upper part of the flowstone. Arrow indicates examined flowstone

Geology of the study area

The study area belongs to the major tectonic unit called the Silica Nappe. The Middle Triassic carbonate rocks are the dominant component of the nappe; they represent the lithofacies succession typical of the Anisian-Carnian transgressive sequence. This succession commences with shallow-water, massive Gutenstein-Steinalm Limestones, which pass gradually into deep-water, thin bedded, cherty Reifling Limestones and finally into massive to thick-bedded, organodetrital Wetterstein carbonates (Bystrický, 1964, 1972; Mello, 1975; Mello et al., 1996). The limestone-dominated lithology of the rocks enhanced ubiquitous, multiphase karstification during the Paleogene and Pliocene-Quaternary. The Triassic rocks are covered by Neogene and Quaternary clastic deposits which also form the sedimentary infill of the pre-Badenian karstic depressions (Bosák et al., 1989).

Speleological setting

The Zvonivá Cave is located in the central part of Plešivska planina, called the Mesač-na krajina (Fig. 1). The cave entrance lies at the altitude of 677 m (Droppa, 1958). The cave is 100 m deep and consists of a vertical entrance pitch and an huge chamber beneath it (Fig. 2). The tall stalagmites and thick flowstone covers occur in the chamber. One of the stalagmites reaches the hight of about 27 m (Droppa, 1958). At present the cave is dry and inactive. A hydrologic connection exists between this cave and the resurgence cave of Brzotínska vodná (Orvan, 1980).

The cave developed within the massive Wetterstein Limestones and is influenced by of N-S and ENE-WSW trending fissures (Kubíny, 1958).

Materials and methods

The flowstone section about 1.8 m thick was sampled layer-by-layer (Fig. 3). Standard polished thin sections were studied petrographically under an Axioskop Carl Zeiss Opton microscope and under an Olympus BHS microscope coupled with an BH2-RFC reflected light fluorescence attachment. The same specimens were examined by a scanning electron microscope (SEM) JEOL 5410 coupled with a microprobe Voyager 3100 (Noran). Some specimens were etched with an acetate buffer before making the SEM observations.

A set of samples for geochemical analyses was selected based on microscopy. About 20 g of the crushed samples were treated repeatedly with acetate buffer at about 80°C until the carbonates were removed. The insoluble residue was washed with water, centrifuged, dried and weighted. Powder X-ray diffractometry (XRD) was performed on this prepared material with a TUR M-62 diffractometer equipped with a horizontal goniometer HZG-4B. Cu-K_a radiation (Ni-filtered) was used. Such residue pressed with KBr (pellets technique) was used to obtain infrared spectra. The IR absorption spectrometry was accomplished with a single beam spectrometer FTS 135 (BioRad) operated with Win-IR Foundation software.

Elemental composition (Ca, Mg, Mn, Al, Fe) was analysed with AAS. Analyses of the organic carbon content were performed with a Culomat 702/SO/CS/E (Strolheim). The samples were twice HCl treated (carbonate removal) prior to the analyses. The instrument was calibrated on the available standards and natural samples.

Stable carbon and oxygen isotope ratios ($\delta^{13}C$, $\delta^{18}O$) were measured at the Mass Spectrometry Laboratory of the Institute of Geochemistry and Physics of Minerals, Ukrainian Academy of Sciences in Kiev by means of mass-spectrometer Mi 12-06 Sumy.

Description of the section

The section consists of three layers of which the lower two are more intesely coloured and relatively thick and the top layer is thinner and pale-coloured. In detail, the basal layer is about 160 cm thick and consists of moderate-reddish-brown (10 R4/6; all colours given according to Goddard et al. 1970) laminae, a few mm to a few cm thick, with faintly lighter ones alternating with faintly darker ones. These laminae are slightly gradational. and the darker ones are more porous than the lighter ones.

The medial layer is 160 cm thick and dark reddish brown (10 R3/4) It is a dense rock that forms a distinctly banded sheet.

The top layer is only as much as 3 cm thick and is very pale orange (10 YR 8/2). It is also very dense, and it has faint internal laminations marked by thin brown intercalations. This layer forms domes divided by fissures as much as 1 cm deep (Fig. 5).

Microscopic features

The three layers of the section also differ in their microfacies characteristics, such as calcite crystallography, internal lamination or abundance of non-carbonate material. Acicular, blocky, rhytmically laminated and columnar facies are distinguished.

Description of the acicular calcite microfacies (ACM)

An acicular microfacies occurs in the lower part of the section.

The ACM has a high intercrystalline porosity. The calcite crystals generally form long narrow needles grouped in fan-shaped bundles with elongated pores enclosed between the needles (Fig. 6). Where fully enclosed, the pores have liquid or gaseous inclusions within the speleothem. Parts of the pores are filled with blocky calcite and/or by micritic internal sediment. The needles are commonly overgrown by smaller crystallites growing obliquely to the needles and arranged in *en echelon* rows (Fig. 6).

The ACM displays faintly preserved internal lamination reflecting fluctuations in noncarbonate phases and in inclusion quantities (Fig. 6). Under polarized light the bundles show unit extinction. The length/width ratio of the acicular crystals ranges between 3:1 and 25:1. This ratio changes across the section but is fairly constant laterally. The longer crystals have acute terminations whereas the shorter crystals display flattened tips. As a rule, layers formed by the stumpy crystals are denser and have fewer inclusions. They make up the lighter coloured laminae of the lower layer of the section.

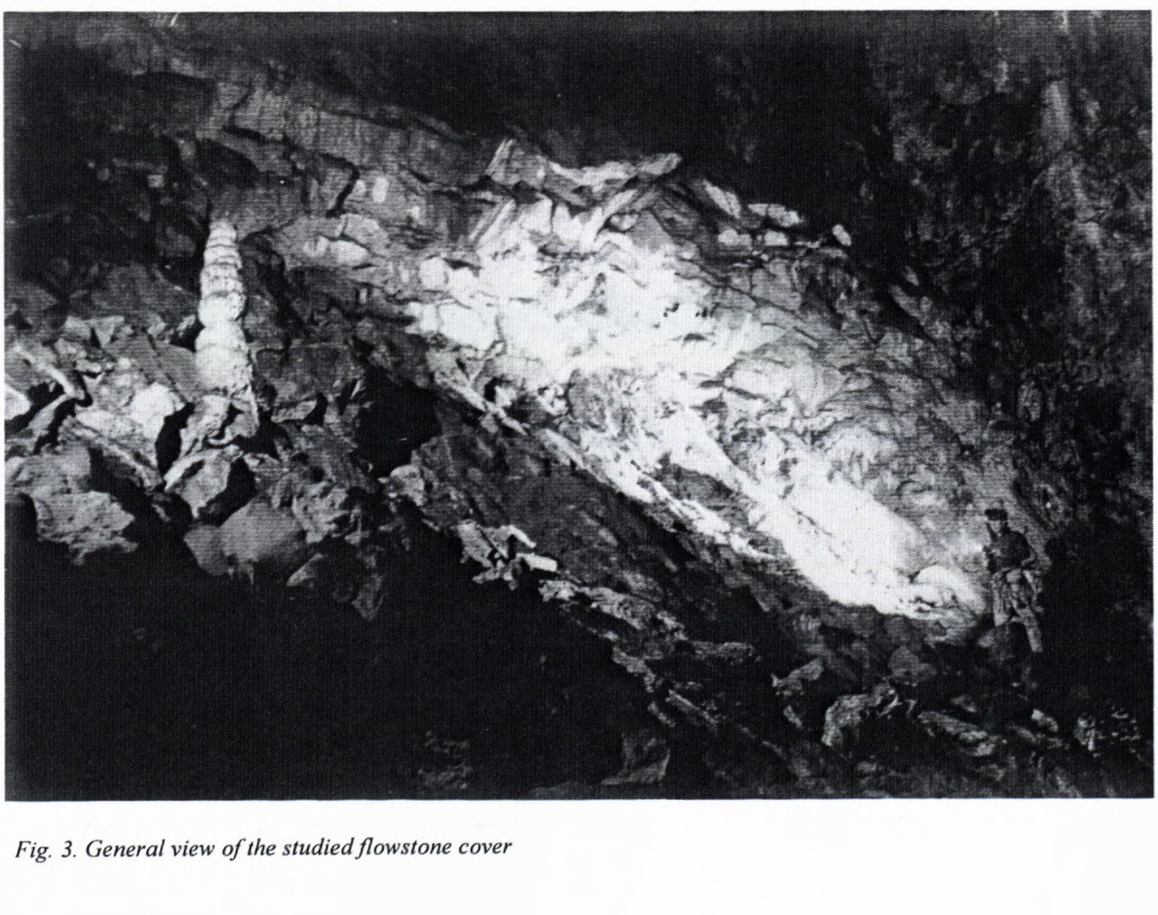

Fig. 3. General view of the studied flowstone cover

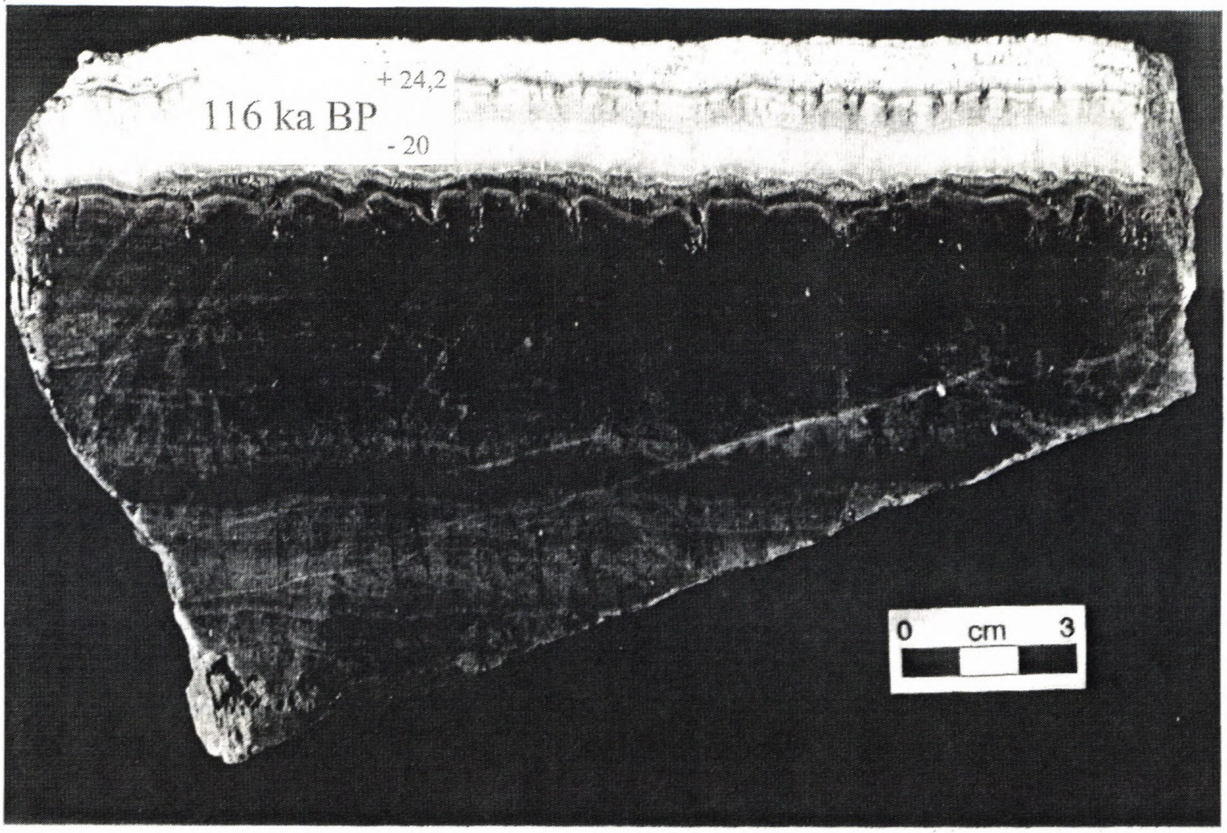

Fig. 4. Porous habit and irregular layering of the lower part of the flowstone; polished slab

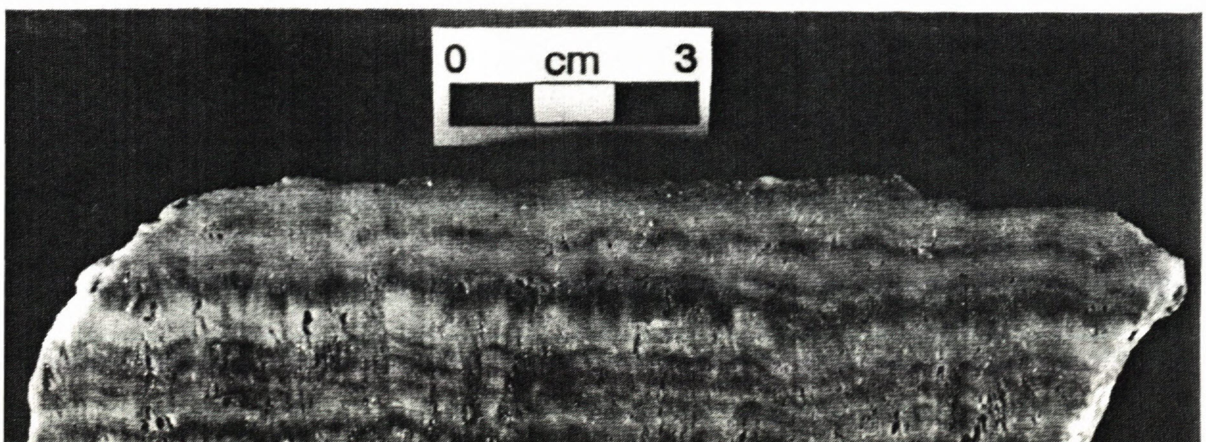

Fig. 5. Dense fabrics of the middle (RLM) and upper, light coloured (mainly ACM) parts of the flowstone. Iisotopic age of upper part is given. Polished slab

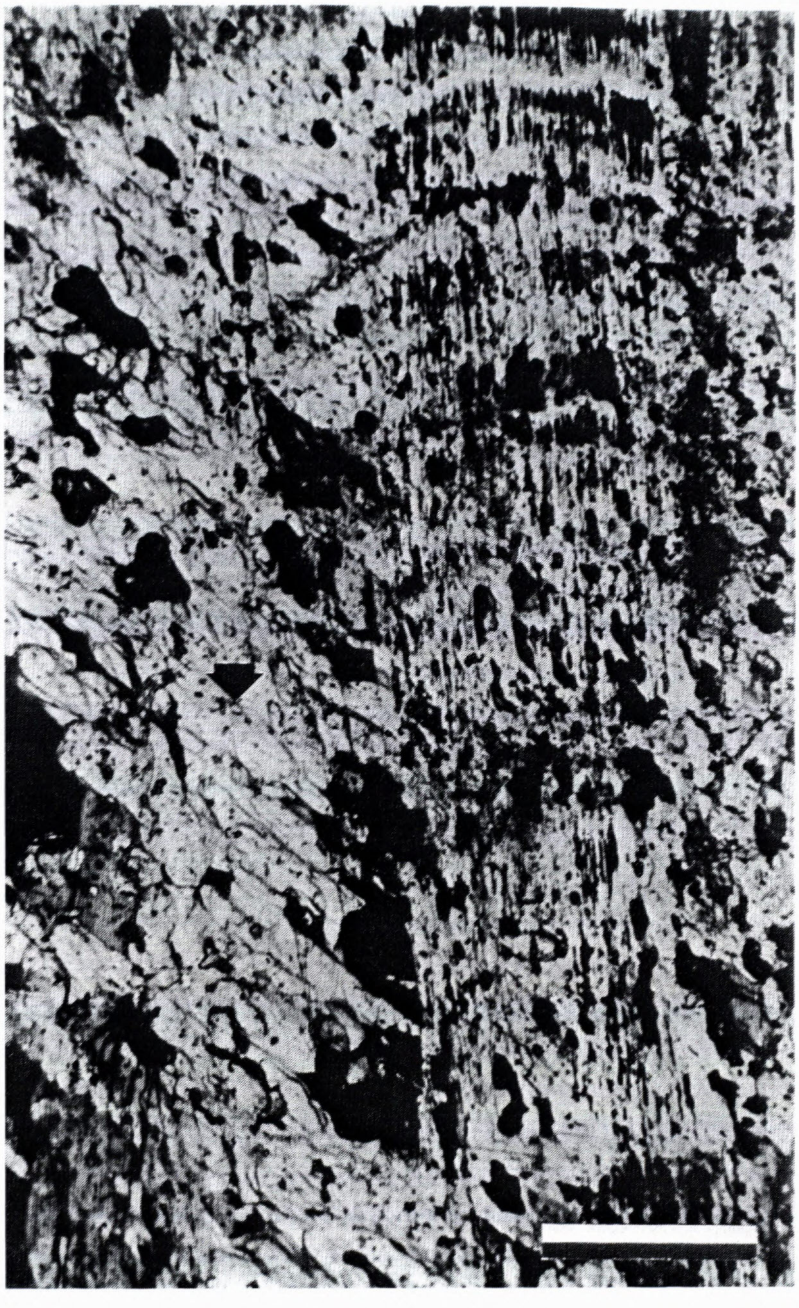

Fig. 6. Needle habit of the acicular calcite microfacies (ACM); note the high porosity of the ACM and the en echelon arranged crystal overgrowths (arrow). Thin section, light microscopy; scale bar - 400 μm

Origin of the ACM

The acicular microfacies is thought to be formed in a turbulent, thick water layer, supersaturated with respect to calcium carbonate, where needle calcite crystallisation proceeds very quickly (Broughton, 1983c; Given and Wilkinson, 1985; González et al, 1992; Jones and Kahle; 1993). Such a spontaneous crystallisation resulted in intense growth porosity of the speleothem. These pores are partly infilled by synchronously formed *en echelon* overgrowths and by late, blocky cement precipitated in a water-soaked flowstone cover.

Crystals size and termination types may be useful in reconstruction of the thickness of the water sheet. Tthe elongated crystals with acute tips indicate a relatively thick water layer in which the crystals grew unconstrained (Broughton, 1983c; Kostecka, 1993). A decrease in the water-film thickness limited the vertical growth of the crystals and forced a lateral progadation of the precipitates as one may inferr from the flattened termination of the stumpy crystallites.

Description of the blocky microfacies (BM)

The BM occurs as accesory microfacies within the lower part of the section. This kind of microfacies determines anhedral calcite fabrics composed of calcite grains ranging in size from micrite to spar (Fig. 7). The occurrence of the blocky microfacies is always related to an increase of detrital impurietes ("clastic dilution"). The size and form of the calcite crystals depends on the quantity and grain size of the detritus. Generally, micrite crystals dominate, however, isolated acicular bushes also occur. The composition of the clastic impurities are considered below.

Origin of the BM

The large quantity of the clastic material indicates a substantial water input to introduce the detrital particles (Ikeya, 1978; Dziadzio et al., 1983; Gradziński et al., 1996). Clastics cause lattice deformation of growing calcite crystals and hinder their euhedral growth (Broughton, 1983a). However, the presence of acicular calcite fans within the blocky microfacies is evidence of a high carbonate concentration in the solution. This suggests that the particles laid down from the water sheet were cemented simultaneously through calcite precipitation from the solution.

Description of the rhythmically laminated microfacies (RLM)

This calcitic microfacies dominates in the medial layer of the section. Through microscopic examination of

Fig. 7. BM (lower part of photo) and fan-shaped columnar calcite microfacies (CCM) (upper part of the photo); note the lamination preserved in the columnar calcite layer and competitive crystal growth pattern. Thin section, polarized light microscopy; scale bar - 800 µm

Fig. 7. BM (lower part of photo) and fan-shaped columnar calcite microfacies (CCM) (upper part of the photo); note the lamination preserved in the columnar calcite layer and competitive crystal growth pattern. Thin section, polarized light microscopy; scale bar - 800 µm
the layer its varved nature was recognized (Fig. 8). One varve couple comprises a more brownish impurer lamina and a more light-coloured purer one. Thicknesses of such couples are 2 - 20 µm. The thicknesses of dark lamina are more or less constant throughout the whole section, whereas that of the light-coloured lamina varies from varve to varve. Microscopic and geochemical investigations show that the dark laminae are enriched in Al, Si and Fe (Figs. 9, 10) and abound in minute inclusions while light-coloured increments are composed of compact calcite with negligible contribution of other components. The varves are grouped into the darker and lighter bands (Fig. 11)

Origin of the RLM

Lateral continuity of the laminae, lack of larger inclusions and scarcity of erosional and depositional breaks within the RLM suggest that this microfacies originated under a very stable hydrodynamic regime. However, flat termination of the crystals and micrometric thickness of the laminae suggest the presence of an extremely thin water film wherein the precipitation proceeded (Broughton, 1983c; Railsback et al., 1994).

These laminations reflect essentially changes of the non-carbonate contribution within spelean carbonates. The most common white-dark-coupled band may be attributed to seasonal changes during the year. White, pure calcite precipitates from a solution free of other components, while the coloured laminae originated from water rich in ultrathin detrital and organic components. The impurities caused a subtle splitting of the crystallites and the origin of the minute fluid inclusions (Fig. 10). A similar enrichment of dark speleothem laminae in fluid inclusions was also found by Folk and Assereto, (1976), Kendal and Broughton, (1978), Broughton, (1983c) and Frisia et al., (1993). We interpret the white laminae as dryer-season increments and the darker ones as deposited during wet periods.

The annually stratified bands were recognized as the most common climatic rhythm recorded in the laminated speleothems (Baker et al., 1993; Dziadzio et al., 1993; Shopov et al., 1994; Genty et al., 1996). Some suggest the presence of finer cycles that may reflect diurnal growth of speleothems (Shopov et al., 1994, 1996). However the lower-order cyclicity may be misinterpreted because of the limited lateral extent or the deformation of the laminae is commonplace in spelean calcite (Fig. 8).

Most of the fabrics studied of the above facies were studied with the aid of luminescence microscopy. The luminescence commonly is assumed to have been evoked by humic and fulvic activators encompassed in the dark

Fig. 8. Microscopic view of the RLM; note that the varve-like lamination may change laterally or vanish completely. Thin section, light microscopy; scale bar - 250 μm

laminae (White, 1989; Shopov et al, 1994; Baker et al., 1994; Van Beynen, 1996). We found, however, that the activators could be organic as well as inorganic contaminations in the calcite. The most common inorganic components in the dark laminae are clay minerals, siliciclastic ultrafine quartz and micas grains and amorphous ferrioxides (Figs. 13, 15). It is noteworthy that some of these impurities, such as kaolinite could give luminescence effect similar to fulvic/humic acids (Grant, 1962; Teichmüller and Wolf, 1977; Dravis and Yurevicz, 1985). Moreover, in some cases the dark laminae are the more fluorescent ones and in other cases the white laminae are the more luminescent as the darker ones (cf. Genty and Quinif, 1996; Gradziński et al., 1997).

Description of the calcite microfacies (CCM)

The CCM occurs sporadically among the BM of the flowstone profile. The CCM is characterized by elongated calcite crystals grouped in densely packed fans (Fig. 7). The fans grow competitively (Broughton 1983a; González et al, 1992; Dziadzio et al., 1993; Sunagawa, 1994) one by the other, giving them an undulated, compact layer. character. Subtle, internal, irregular laminations are also present and are related to thin clastic intercalations and/or to corrosion horizons.

Origin of the CCM

The CCM precipitates from a water layer thick enough to crystallise the elongated columnar calcite with acute terminations (cf. Broughton, 1983c; Kostecka, 1993). The euhedral habit of the crystals and the scarcity of inclusions indicate a progressive, moderate crystallisation rate from non-turbulent saturated ambient water. Inasmuch as the CCM occurs intermittently within the blocky microfacies, it could mark a decrease of clastic input.

Corrosion event records in the studied section

Ubiquitous corrosion horizons were found in all parts of the speleothem section from the Zvonivá Cave. The minor ones may be explained through changes in a very local hydrochemical regime. The major corrosion phenomena are commonly intepreted as the effects of cold climate and of limited plant cover in karstic regions. According to our results, we believe that the more pronounced corrosion events instead mark periods when the cave was invaded by water that was saturated by CO_2 in humus-rich soil, typical of humid and warm climate. A similar mechanism of chemical degradation of speleothems was also recognized in flowstones from Israel (Bar-Matthews et al., 1991), and Botswana (Railsback et al., 1994).

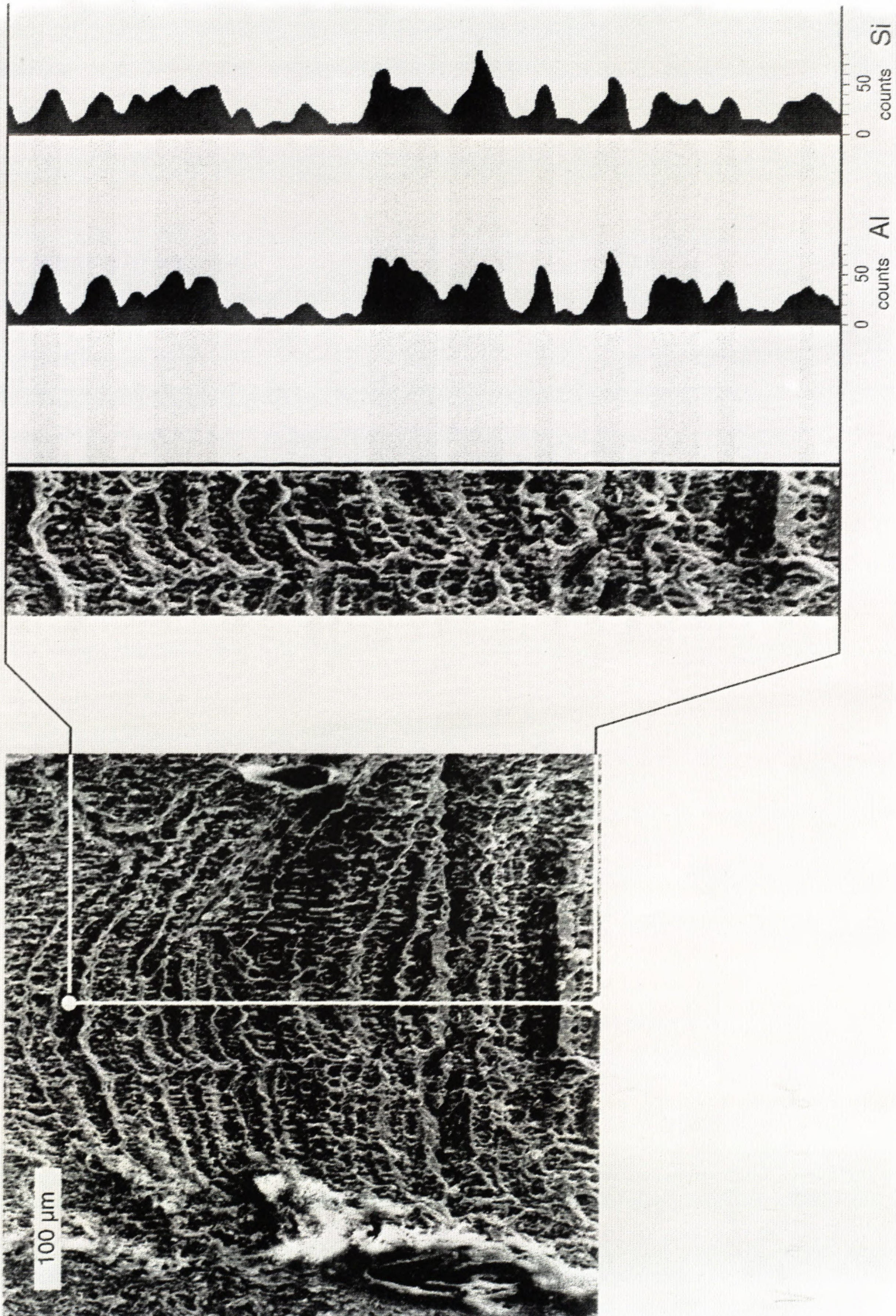

Fig. 9. SEM-view of the RLM and the plotted curves of Al and Si composition along the chosen profile. Note the correlation between porous laminae and the increasing contribution of Al and Si elements

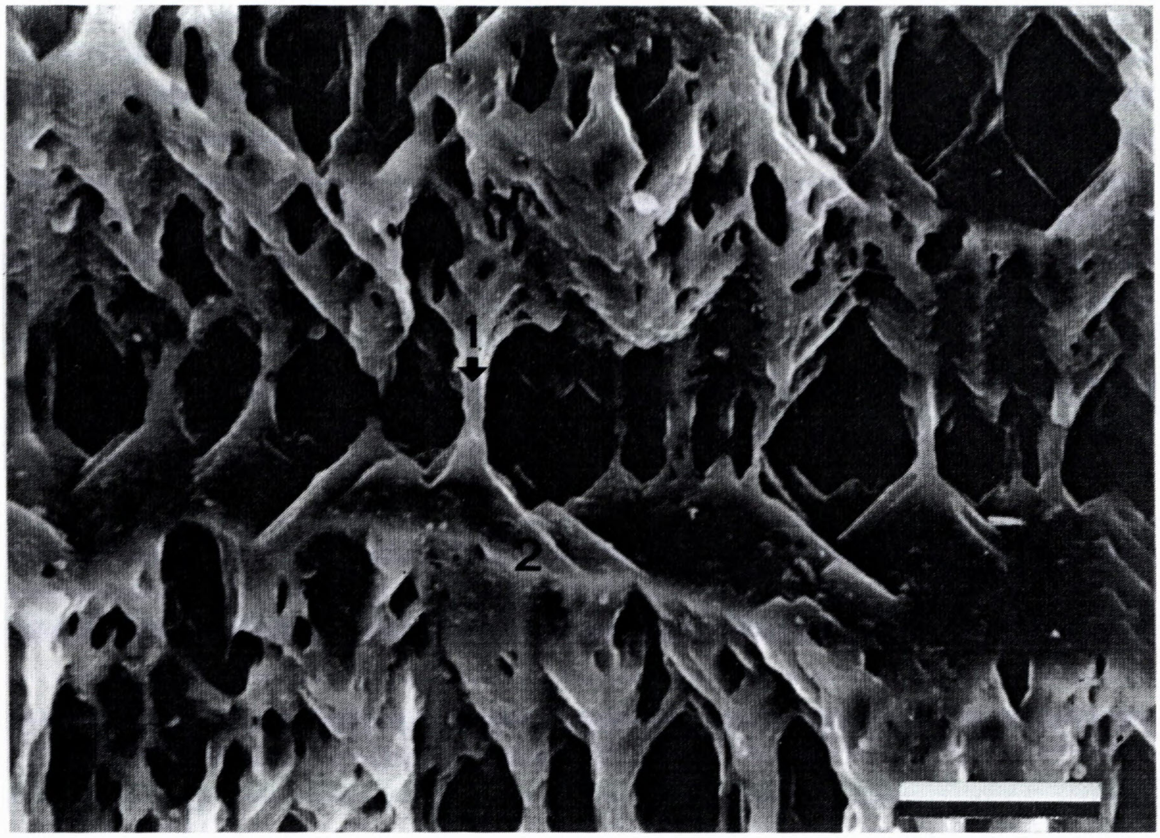

Fig. 10. Detail from the Fig. 10., with points of the examined elementary compositions: point 1 (from porous lamina) - composition: Al - 1,32%, Si - 1,03%, Ca - 67,19%, Fe - 0,90 %, point 2 (from dense lamina) - composition: Al - 0,48%, Si - 0,44%, Ca - 69,99 %, Fe - not detected; scale bar - 10 μm

Chemical and mineral compositions of the noncarbonate components of the studied speleothems

The mineral phases encountered in acetate buffered insoluble residua consist of kaolinite (base peak 7.19A, 3.48A), quartz (base peaks 3.34A, 4.25A), and traces of illite (base peak 1.10A). The high base grounds in the diffractograms are due to dispersed iron (hydro-)oxides, which dye the residue red (Figs. 13, 14). In addition to the prevailing kaolinite, the infrared spectroscopy reveals the presence of hydrargillite γ-$Al(OH)_3$ (Fig. 15). The mineral composition is similar in the macroscopic dark-brown calcite of the lower and middle layers and in the light-coloured upper most layer of the investigated section (Figs. 13, 14). Only hydroxylapatite (base peak 2.82Ĺ, 2.71A), which occurs in the middle layer of the section is absent in the lower and upper ones. It should be stressed that red-coloured lower and middle layers of the section differ completely from the pale-coloured upper layer in the Al, Fe, Si, Ti and Mn contents (Table 1). Organic carbon consists, at the most, 0.05 % by wt. of $C_{org.}$ of the speleothems but frequently is below the detection limit of the analytical method used.

Interpetation

The high contents of iron in the reddish parts of the flowstone is unusual for calcitic speleothems (Beck, 1978; Goede and Vogel, 1991; Bar-Matthews et al., 1991). A similar high iron contents, have been ascribed by González et al. (1992) to detrital impurities incorporated into the speleothem. We propose, too, that the iron oxides in the flowstones from the Zvonivá Cave were supplied by downward redeposition of infills of the sinkholes at the surface (Fig. 2) . The mineralogy of the examined residua is typical of the *terra rosa* or lateritic soils (Olier, 1969) and is very common for the other sites in the Slovakian Karst (Andrusov, 1958; Smoliková, 1963). Andrusov (1958) interpreted the *terra rosa* deposits from the Gombasek quarry, situated some 7 km from the Zvonivá Cave, as residual material of weathered Miocene volcanic rocks. However, comparing the composition of the speleothem residua with the noncarbonate components of the Triassic host limestones described by Demovič (1974), this limestone seems to be the source of the clastic impurietes encompassed in the discussed flowstones.

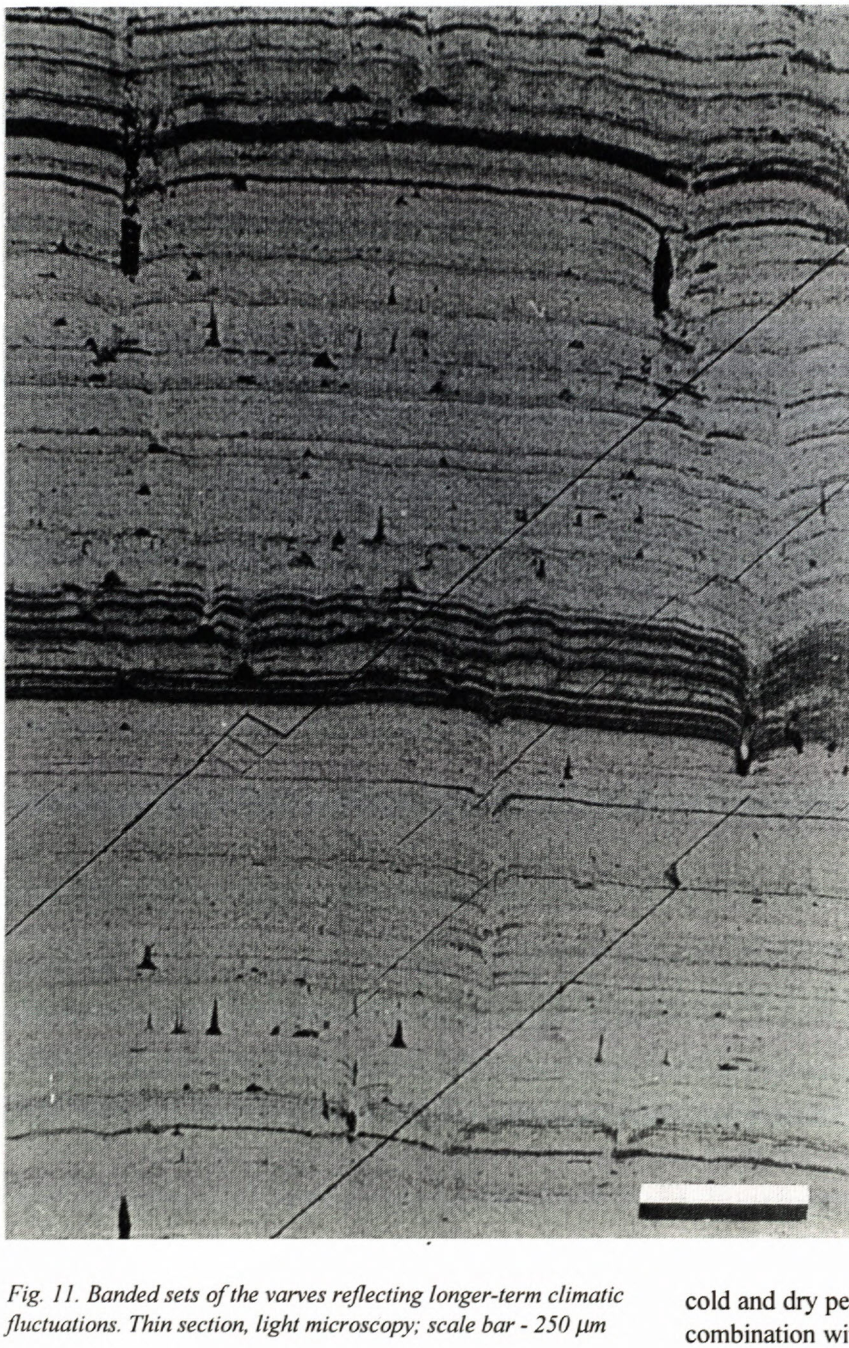

Fig. 11. Banded sets of the varves reflecting longer-term climatic fluctuations. Thin section, light microscopy; scale bar - 250 μm

The organic matter contents is very low, with a maximum of 0.05 % by wt. of $C_{org.}$ Therefore, we presume that organic components, if present at all, must have been concentrated within extremally limited areas of the speleothems. In the RLM organic matter may occure in pores of the dark coloured laminae rich in detritic components (Lauritzen et al., 1986). Thus, concentration of the organic matter, could affect increase of the UV luminiscence of these laminae.

Stable isotopes signals

The stable isotope ratios of $\delta^{13}C$ and $\delta^{18}O$ from the studied samples follow generally the recognized microfacies tripartition of the flowstone section (Fig. 16, 17). The difference is particularly visible in the fluctuation of the $\delta^{13}C$ values, which display a substantially positive trend in the upper pale layer. The middle part of the section (RLM) $\delta^{13}C$ shifts toward more negative range.

Interpretation

Interpretation of the isotopic signals must be done carefully inasmuch as the control measurements made along one layer gave different results and suggested disequilibrium precipitation of calcite (Hendy, 1969; Gascoyne, 1992). On the other hand, this phenomenon supports our interpretation of fast deposition of the flowstone calcite from carbonate-supersaturated solutions (Chafetz et al., 1991; Chafetz & Lawrance, 1994). The data obtained indicate that the lower and middle layer of the section originated from solutions enriched in isotopically light CO_2, in humus-rich soils settled by C3 plants (Cerling et al., 1989; Koch et al., 1992) typical of temperate climate zone.

In contrast to the lower layers, $\delta^{13}C$ from the uppermost pale layer indicates a decrease in the contribution of the soil-derived CO_2. This, in turn, suggests the presence of an arid climate with a scarce vegetation and a weak pedogenetic development. Two possible arid conditions may be assumed: a warm and dry (Mediterreanean) climate or a cold and dry periglacial climate with permafrost effects. In combination with the other chemical and sedimentological data as well as lack of drastic changes in $\delta^{18}O$, we propose the first model as more probable one. A decrease in the proportion of carbon derived from the soil CO_2 was compensated for by an increase in the contribution of isotopically heavier C derived from the substrate rocks (Zamarreńo et al., 1997).

Conclusions

The flowstone shows internal microfacies variability reflecting environmental changes in the drainage area. The lower layer of the flowstone, composed mainly of ACM originated in a humid warm climate favouring prolific vegetation. The middle layer, built by RLM, devel-

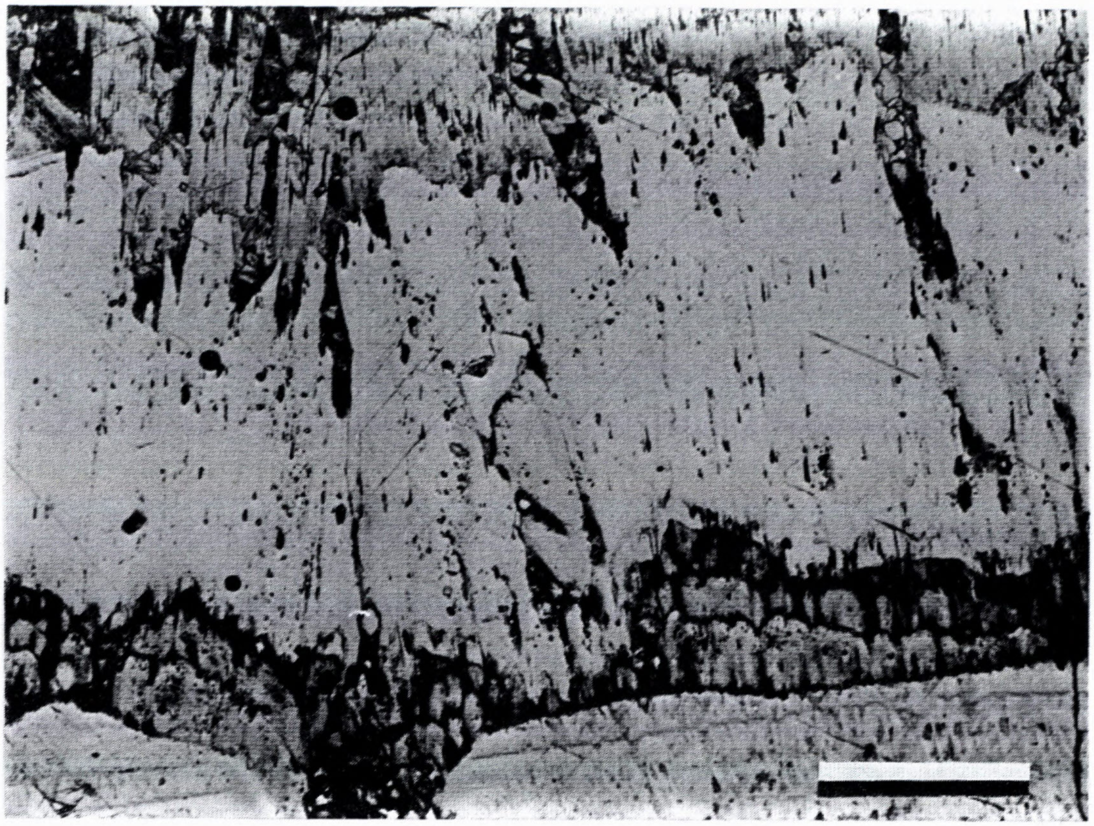

Fig. 12. Multiple corrosion events recorded in topmost part of the flowstone profile. Thin section, light microscopy; scale bar - 800 μm

Tab. 1. Comparison of the chemical analysis of hydrochloric acid soluble and insoluble fractions; RLM- middle part of the flowstone section, ACM-the upper layer of the flowstone section

samples	HCl insoluble [by weight]									
	Ca [%]	Mg [ppm]	Fe [ppm]	Mn [ppm]	Sr [ppm]	P [ppm]	Al [ppm]	Ti [ppm]	residuum [%]	Mg [ppm]
RLM	39.32	2160	1900	166	-	990	6350	92	1.10	35
RLM	39.48	300	1880	88	-	47	5950	54	1.20	38
ACM	39.97	233	130	-	-	72	38	10	0.13	20

samples	HCl insoluble [by weight]				
	Fe [ppm]	Mn [ppm]	Al [ppm]	Si [%]	Ti [ppm]
RLM	140	-	2590	0.490	221
RLM	212	-	3070	0.510	238
ACM	20	-	45	0.047	33

oped under generally similar but more stable hydroclimatic regime. The proportion and composition of the clastic impurities in the both parts of the flowstone section are typical of soil covers developed under a warm humid climate (Olier, 1969). However, a redeposition of older residua into the cave system cannot be excluded. We propose that the clastics were transported, not directly down into the cave but rather subhorizontally from a large sinkhole situated about 200 m from the cave entrance (Fig. 2).

The uppermost layer of the section differs petrographically and geochemically from the both lower layers. $\delta^{13}C$ composition indicates a decline of the plant cover and a shorter pathway of the water infiltrating directly from the superjacent area (Fig. 2). This part developed during the Eemian interglacial, as indicates its U/Th data of 116 (+ 24,2; - 21) ka BP (H. Hercman, personal communication). This date correlates with those of other speleothems from the Slovakian Karst (Pazdur et al., 1994; 1995). Clastic impurities from the lower and mid-

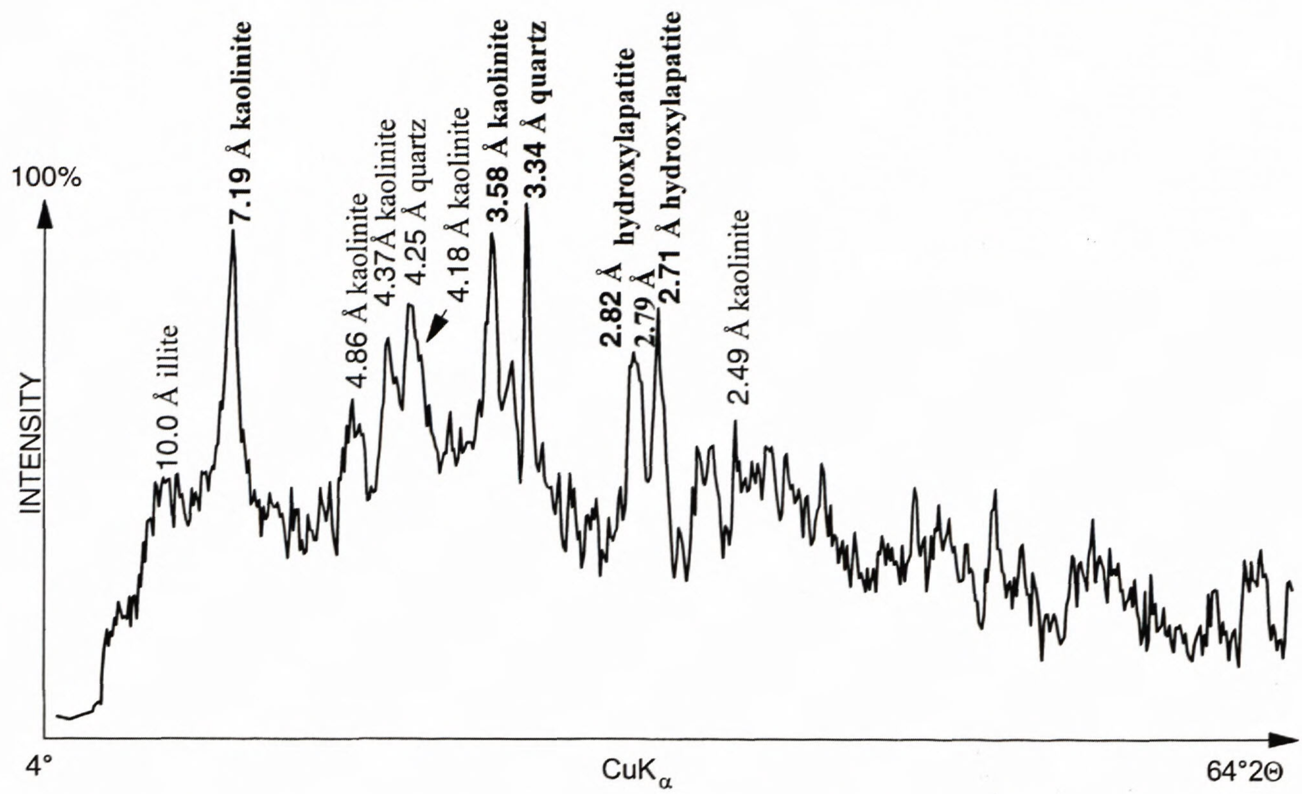

Fig. 13. Diffractogram of acetate buffered insoluble residue of RLM (middle layer of the section) revealing the presence of kaolinite, quartz, hydroxylapatite and illite (descriptions of the most intense reflexions for each mineral phase identified are in bold-face type)

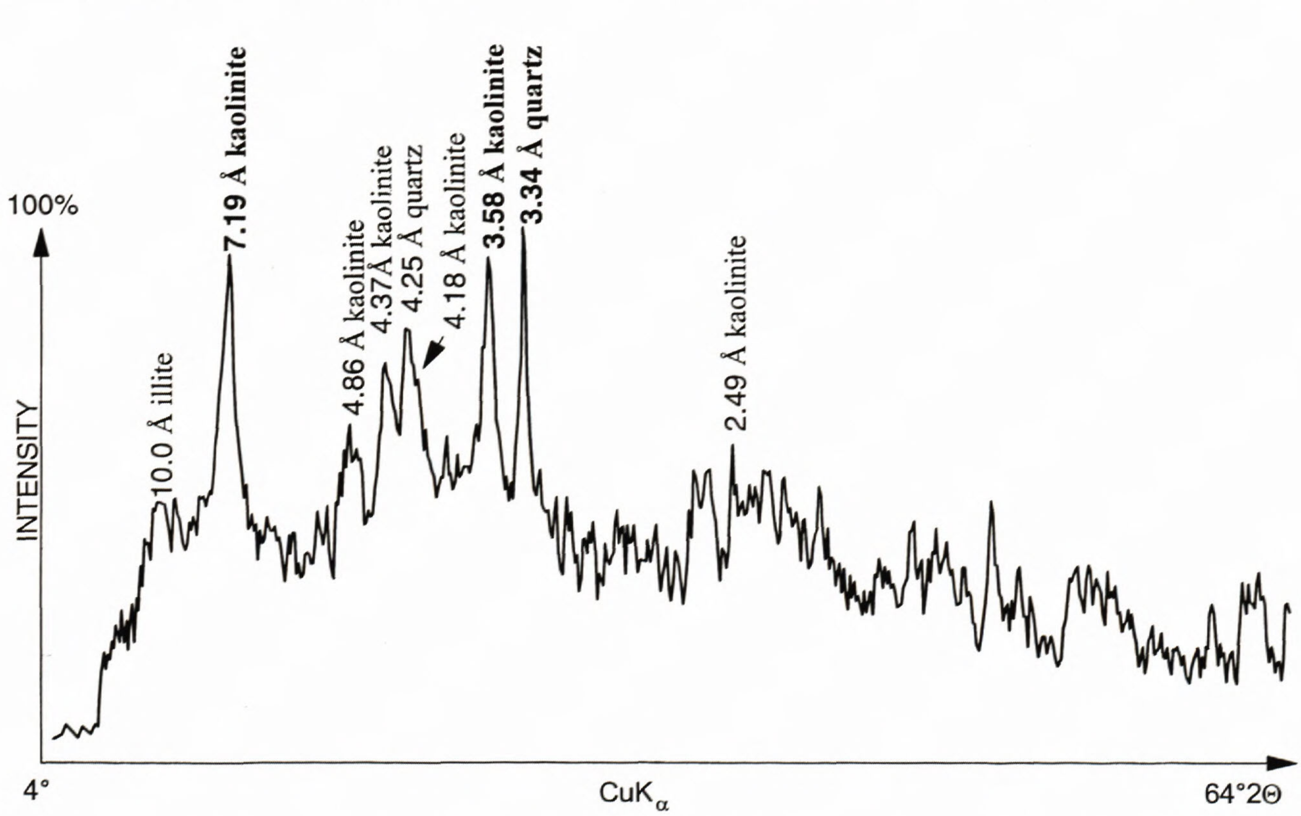

Fig. 14. Diffractogram of acetate buffor insoluble residue of the upper layer of the section revealing the presence of kaolinite, quartz and illite (descriptions of the most intense reflexions for each mineral phase identified are in bold-face type)

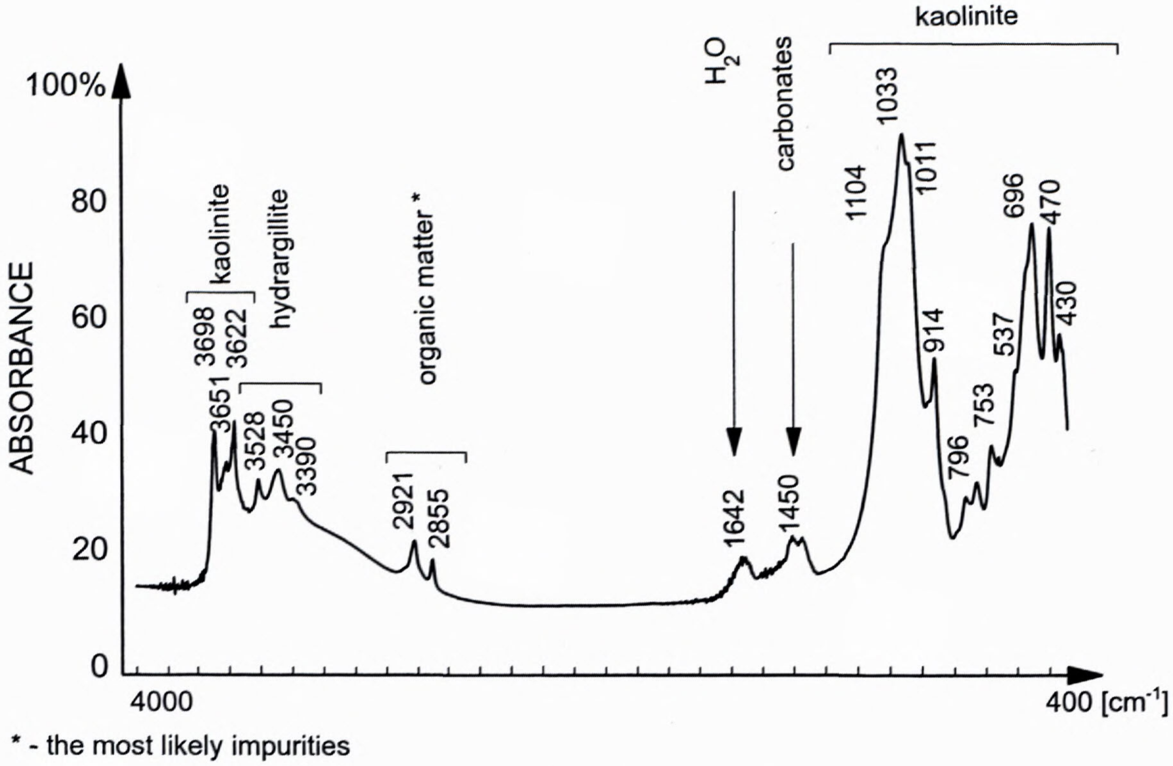

Fig. 15. Infrared absorption spectrum of acetate buffered insoluble residue of RLM (middle layer of the section) revealing the presence of hydrargillite and confirming the XRD identification of kaolinite (see Fig. 13)

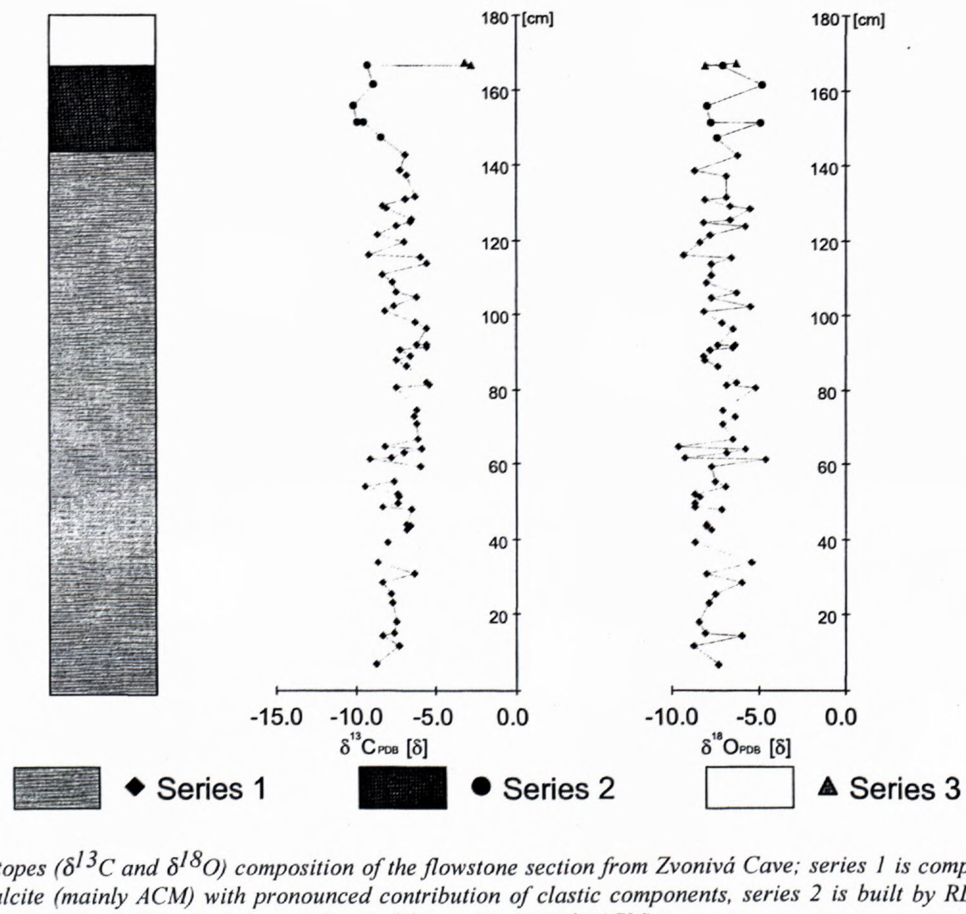

Fig. 16. Stable isotopes ($\delta^{13}C$ and $\delta^{18}O$) composition of the flowstone section from Zvonivá Cave; series 1 is composed mainly of porous acicular calcite (mainly ACM) with pronounced contribution of clastic components, series 2 is built by RLM with clastic impurities, series 3 represents light-coloured upper layer of the section (mainly ACM)

dle layers of the flowstone, hinder their being dated, nonetheless one may infer that they were developed during Late Pliocene-Early Pleistocene times, as found in the neighbouring area (Skřivánek, 1965; Jánossy and Kordos, 1977; Horáček, 1985; Bosák et al., 1989; Bárdossy and Kordos, 1989).

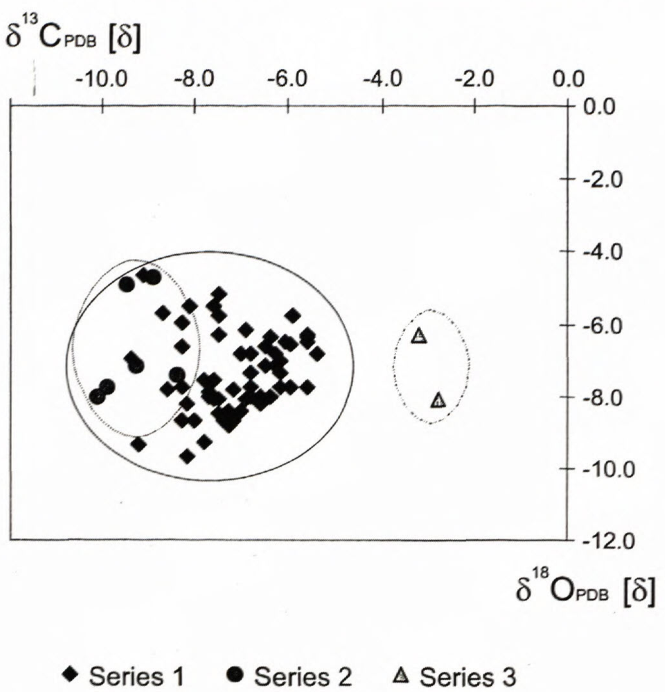

Fig. 17. Cross plots diagram of the stable isotopic measurements of the section, with recognized microfacies fields (see also Fig. 16)

Acknowledgments

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Biostratigraphical and lithological evaluation of the profile „BALCOVÁ“, Šiprúň sequence, Veľká Fatra Mts.

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Abstract. The profile „Balcová“ is located in the Ľubochnianska dolina valley (Veľká Fatra Mts.) north of elevation point Balcová (979). The subject of study was the Poruba Formation as uppermost in the Šiprúň sequence. From the point of view of lithofacial content we take this formation as a complex of marly shales and marlstones, with intercalations of more or less sandy limestones and sporadically sandstone beds. By analysis of foraminifers and nannoplankton assemblages we obtained precised dating of the formation, from Early Albian to Middle Turonian. In the upper horizons of the Poruba Formation we proved the presence of planktonic foraminifers of the Helvetoglobotruncana helvetica Zone (in the sense of Salaj 1986). We established a tectonic break in the succession of strata of the Šiprúň sequence in this area, between the Poruba Formation and underlying formations.

Key words: West Carpathians, Biostratigraphy, Middle Cretaceous, Poruba Formation, Šiprúň sequence, Veľká Fatra Mts., foraminifers, nannoplankton.

Introduction

The paper was prepared on the basis of the research activities under the project: *Regional Geological Research of Slovakia* in the frame of the theme „Biostratigraphy of the Phanerozoic of the Western Carpathians – Biostratigraphical and microfacial evaluation and correlation of selected Cretaceous lithostratigraphic sections“. The aim of this project is to document significant lithostatigraphic profiles in the Western Carpathians and to correlate stratigraphic range of individual groups and/or species of organisms on the basis of this documentation. Besides other, the profile through the Tatric Mesozoic succession of the Veľká Fatra Mts. – the Šiprúň sequence – in the Ľubochnianska dolina valley, north of mount Balcová (979) was chosen for investigation. Attention was paid to the higher part of the bed sequence overlying the Lučivná Formation - the Poruba Formation.

The choice of the section „Balcová“ was also motivated by the results of Bujnovský et al. (1988) and Bujnovský and Gašpariková (1990), which raised the question of the age range of the formation, colliding with the defined lithological content.

The profile „Balcová“ is situated in cuts along the forest road NW of Balcová (979), at the slope of Chmelinec, in altitude between 750 m and 900 m (Fig. 1).

We carried out documentation of the bed sequence, took samples for determination of foraminifers and nannoplankton and also petrographic analyses. The microfauna was evaluated from washings as well as in thin section material.

History of investigations

On the basis of mapping of the Nízke Tatry Mts. and adjacent part of the Veľká Fatra Mts. Matějka (1927, 1930) distinguished the so called „Šiprúň Series“ in the area of Revúca and Ružomberok, with specific bed sequence from the Triassic to Gaultian, considering it as overthrust tectonically to the position above the crystalline Ľubochňa massif of the Veľká Fatra Mts., but below the „lower Subtatric nappe“ (= Krížna nappe). Matějka (l. c.) described the uppermost members of the „Series“ as dark to black limestones with cherts – the marly limestones passing into dark shaly marls. To the top the latter are interbeded with some sandstones, upward passing to the flysch development. Further on, Matějka (op. cit.)

describes dark-grey, light-coloured and yellow marls and sandstones, fine-grained limestones, in places with muscovite sandstones with plant detritus. In the top part he noted thick layers of sandstones and conglomerates. Later Matějka (1931) supposed the age of the sequence range up to the „Gaultian“.

Bystrický (1956) has found out that the „Šiprúň Series“ is not of the character of particular nappe, but is only a higher part of the normal bed sequence of the Tatricum envelope.

In the General geological map (scale 1:200 000) the area was included in the „Veľká Fatra Series" (= Group) (Maheľ et al. 1964, p. 129), with the youngest member of grey marly shales with layers of sandstones (there „Albian“).

Lithofacial and paleogeographical analysis of the Mesozoic of Tatric envelope series was carried out by Polák (1976). He designates the uppermost part of the „envelope sequence" with the term „Albian“. In the individual analysed mountain ranges he distinguished various facial varieties of the formation, for the Veľká Fatra Mts. he mentions prevalence of pelitic facies with clayey and sandy marly shales with an amount of sericite, with intercalations of fine-grained sandstones and/or a limited intervals of „flysch character“ in the lower part of the complex. The Albian complex is underlain by Aptian dark limestones with cherts and intercalations of black clayey shales. Somewhat later Bujnovský and Polák (1979) acknowledged priority of the name „Šiprúň sequence“ for the envelope unit with the bed sequence from the Triassic to Early Cenomanian.

In the year 1985 Bujnovský and Polák published a brief information on the succession of strata of the Šiprúň sequence in the Veľká Fatra Mts. where they mention the find of *Hedbergella roberti* (Gandolfi), *Haplophragmoides nonioninoides* (Reuss) and *Rotalipora* ex gr. *cushmani* (Morrow), proving even an Early Turonian age of the uppermost formation. Similar finding was published previously by Cúlová and Andrusov (1964) from the „High Tatric Series“ in the Tichá dolina valley in the Vysoké Tatry Mts. where they found *Praeglobotruncana helvetica* (Bolli) and *Globotruncana renzi* Gandolfi, on the basis of which they shifted the upper boundary of the uppermost Tatric Mesozoic envelope formation to the Early Turonian.

The Poruba Formation was defined by Jablonský (1986) as the uppermost formation of the Krížna nappe bed sequence in the Strážovské vrchy Mts. and Malá Fatra Mts. and of the Tatricum in the Nízke Tatry Mts. and Veľká Fatra Mts. He divided the formation into the Homôlka Marlstones, Čavoj Member, Ludrová and Senkov Members. For „Tatric“ localities of the formation he mentions the range of age Albian-Middle Cenomanian, later (Jablonský in Samuel et al. 1988) the age from the Albian to Early Cenomanian, with total thickness of 30-400 m. He defines the lower boundary of the Poruba Formation as unsharp and asynchronous, the upper boundary as erosional and/or tectonic.

In the Krížna nappe between Early Cretaceous micritic limestones and Albian - Cenomanian flysch (thus understand the Poruba Formation) is an extensive complex of olistostromes (Jablonský - Marschalko, 1992), corresponding in its position to the Vlkolínec Breccia, of Aptian - lowermost Albian age (Jablonský in Samuel et al. 1988).

Detailed geological mapping of the surroundings of elevaton point Balcová in scale 1:25 000 was carried out by Bujnovský et al. (1988). In the Šiprúň sequence they distinguished as youngest the Poruba Formation, above the Lučivná Formation, ranging in age from the Aptian to Middle Cenomanian, in total thickness of 120 m.

On the basis of this mapping (l.c.) Bujnovský and Gašpariková (1990) also published data on the surroundings of Balcová. They again mention the position of the Poruba Formation overlying the Lučivná Formation, which range of age is Valangian - Late Barremian. They established the age of the Poruba Formation as Early Aptian to Middle Cenomanian, on the basis of foraminifer associations. Unfortunately, as in the foregoing (Bujnovský et al. 1988), also in this work a more precise localisation of sampling sites and their representation in the profile are missing, not making possible a more detailed analysis and correlation of data. They understand the Poruba Formation as a complex of spotted marls with intercalations of greywacke sandstones.

In a detailed microbiostratigraphical study of formations at the boundary of the Jurassic and Cretaceous in the profile along the forest road-cut NNE of Balcová Boorová (1992) distinguished the Osobitá Formation, overlying the Lučivná Formation. For the Lučivná Formation she stated the upper boundary as the Barremian(?) - Early Aptian (Bedulian). She descirebes the Osobitá Formation as marly dark-grey, in places spotted, predominantly thin platy limestones with thin inerbeds of dark shaly marlstones. Several limestone beds contain black cherty nodules. At the lower level are two beds of limestones with uneven „nodular“ divisional surface, at the top of the formation is a bed of black calcarenite, typical of this formation. Thickness of the formation is about 14 m. On the basis of the separated planktonic foraminifers its age was determined as Aptian (Gargasian - Clansay).

In the strata overlying this complex Boorová (l.c.) distinguished an unnamed formation of „Lower Albian dark-grey and black limestones“. It is formed by dark-grey to black platy limestones and layered spotted limestones (radiolarian biomicrite), in lower layers with black spotted marlstones. She also records several beds with

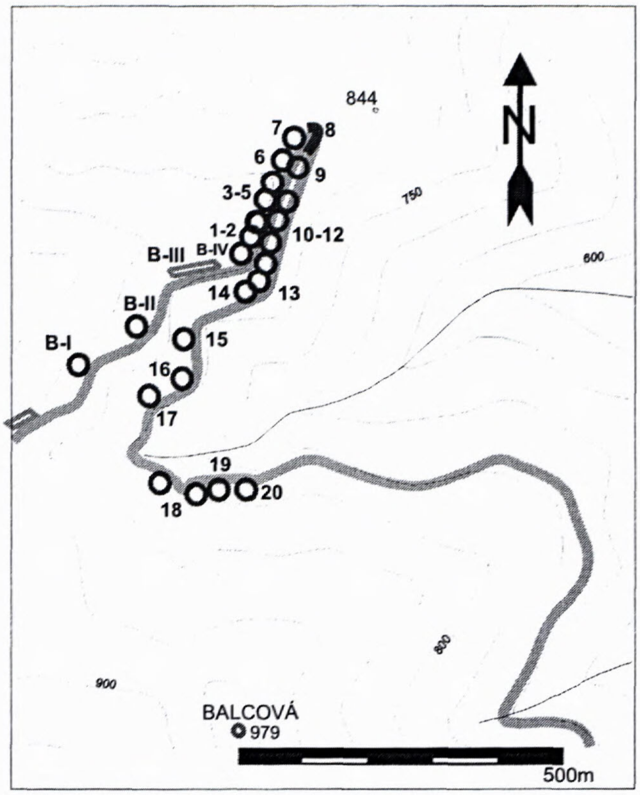

Fig. 1. Localization of profile and situation of documentation points

chert nodules and even continuous beds of cherts. The supposed age of this sequence (about 23 m thick) is Early Albian according to superposition.

Geological situation

For the preliminary geological localisation of our profile we used the map of Bujnovský et al. (1988). In this map the Osobitá Formation has not been plotted yet. With more detailed reconnaissance of the area it has been shown that the boundary of Krížna nappe overthrust in the place of the profile runs more to the west and higher (875 m above sea level) than indicated in the map (l.c.) (compare Fig. 2).

The youngest sediments of envelope (but also Krížna nappe) bed sequences of the Inner Carpathians are deposited atop of the Aptian shales and limestones (in places with cherts). It is mainly a complex of more or less shaly marlstones and marls, acquiring flysch character upwards due to increase of sandstone beds. In some mountain ranges also conglomerates are represented (Malé Karpaty, Žiar, Nízke Tatry, Humenské vrchy Mts. compare Salaj - Samuel 1966, Jablonský 1978, 1986). The age of topmost sediments of bed sequences in the individual mountain ranges was established as Albian (Žiar, Strážovské vrchy, Malá Fatra Mts. - autochtonous units), Albian - Early Cenomanian (Malé Karpaty, Malá Fatra Mts. - Krížna nappe) (Salaj - Samuel 1966, Bujnovský - Gašpariková 1990), even up to the Early Turonian (Vysoké Tatry, Veľká Fatra Mts.) (Cúlová - Andrusov 1964, Bujnovský - Polák 1985).

The lithofacial composition of the whole Poruba Formation is internally quite variegated (Jablonský 1986, also Samuel et al. 1988). Thickness of the formation is considerably variable from several tens of metres to more than 200 m. This results mainly from its position at the top of the bed sequence where it was eroded tectonically by overthrust nappes (unroofing). Its relatively „softer" lithology also plays role in thickness reduction, when squeezed between limestone complexes.

Description of the „Balcová" section

In the lower part of the profile limestones dominate. At the bottom are dark-grey and greenish-black platy limestones with dark spots and shaly intercalations (Pl. V., Fig. 3) (= Osobitá Limestones? - Boorová 1992). Higher up are dark-grey shales and layers of grey limestones. In places also nodules of black cherts are found. Boorová (l.c.) ranged this passage to the „unnamed" formation of the Early Albian.

Following above is the Poruba Formation. It is composed of a shaly limestone and marl beds, 30-200 cm thick. Grey argillaceous limestones are with silt admixture and darker spots after bioturbations (Pl. V., Figs. 1 and 2). Shaly marlstones, claystones and marls in the higher part of the sequence have an admixture of silt and sericite. Sparce thin beds of fine-grained sandstones to siltstones are found. In the upper part of the profile we found a set of irregular sandstone beds, limited lenticularly, interpreted as „channel fill" (Pl. VI., Fig. 1). To a limited degree regularly alternating beds of fine-grained sandstones with calcareous argillaceous shales were found (Pl. IV., Fig. 2). In the uppermost part occur some few cm thick reddish-brown marlstones.

Atop lies poorly outcroped tectonic breccia with fragments of sandstones, marlstones and limestones and layers of grey dolomites, belonging to the Krížna nappe. As a whole the bed sequence forms a flat anticline with NE-SW axis, transversally bent in NW-SE direction.

Documentation of selected parts of the profile

We present here description of the documentation points (from underlying to overlying), which are important from the point of view of general characterisation and from which decisive samples and determinations are coming. Their localisation is shown in Fig. 1. With regard to transversal bending of beds some passages of the profile are overlapping (B-14/-15= B-12/-13 and B-II/B-IV= B-1/B-2). Complete documentation is found in the archival report by Boorová - Potfaj (1996).

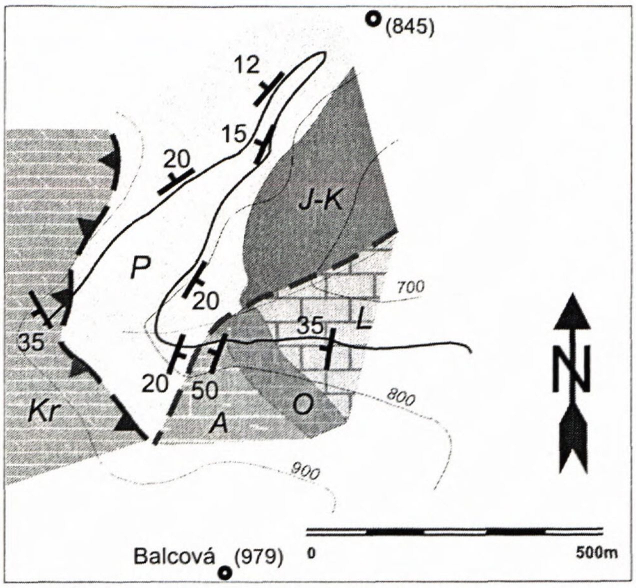

Fig. 2. Geological sketch-map of the profile area
Legend: Kr - Krížna nappe - undifferentiated
Šiprún sequence: P - Poruba formation, A - lower Albian limestones, O -Osobitá formation, L. Lučivná formation, J-K - older Cretaceous and Jurassic formations

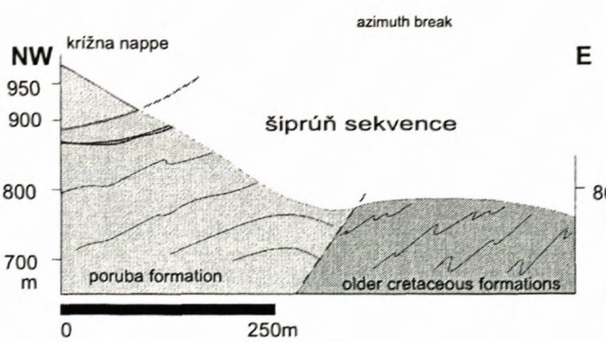

Fig. 3. Geological cross-section

Lower part of the profile - „unnamed“ formation of the Early Albian (Boorová 1992):

B-19: Grey platy limestones with Fe-coatings, bedding plane v = 260/32 (Pl. V., Fig. 3). Among limestone beds are dark-grey to black shales up to 10 cm thick. Angulary disintegrating shales (sample B-19, washing 146/94) contain a mixed association of recrystallised plankton and agglutinated benthonic foraminifers:

Glomospirella sp., *Ammodiscus tenuissimus* (Gümbel), *Glomospirella gaultina* (Berthelin), *Lenticulina* sp., *Epistomina* sp., *Anomalina* sp., *Anomalina (Gavelinella) complanata* Reuss, *Ticinella roberti* (Gandolfi). Age: Early Albian.

B-18 (797 m a.s.l.): Dark-grey, dark-green limestones with black spots, layered to platy, at bedding planes are „dendrites“ and Fe-coatings. The limestones are relatively massive, at the bottom bioturbated and shaly in places. In the lower part are two beds of light-grey spotted limestones with stylolites, lined by dark-grey shaly marlstones. Dip of beds is 48-30° to the west, cleavage k = ÷ 265/30. Total thickness at the outcrop is about 12 m. In thin section from dark-grey spotted limestones (sample B-18a) are cross sections of *Hedbergella infracretacea* (Glaessner), *Ticinella* sp. (Pl. II., Fig. 1), *Ticinella bejaouaensis* SIGAL, *Ticinella roberti* (Gandolfi) - Age: Early Albian.

The nannoplankton (B 18-99/94) contains the species: *Braarudosphaera africana* Stradner, *Cyclagelosphaera deflandrei* (Manivit) and *Watznaueria barnesae* (Black), being a little representative association. The age may be interpreted as Albian - Early Cenomanian, on the basis of the occurrence of *B. africana*.

Middle part of the profile - Poruba Formation:

B-17 (805 ? m a.s.l.): Greenish-grey marlstones-limestones, thinner beds of shaly marls with boudined intervals. In thin section display the individual components „schlieren-like” structure, with slight lamination. Dip v = 120/20°. The thin section contains *Hedbergella* sp., *Ticinella* sp. - Age: Early Albian.

B-16 (810 m a.s.l.): Shaly marlstones in beds 0,9-6 m at section of 25 m (Pl. V., Fig. 2). Immediately overlying are limestones with plant chaff, with rusty brown coating, highly tectonized. Dip v = 325/18, v_2 = 290/30, s_2 = 95/40. Between the ravines are shaly marlstones - green, dark spotted limestones 30-300 cm, dip v = 110/20. In thin section we identified: *Hedbergella* sp., *Hedbergella delrioensis* (Carsey), *Ticinella primula* Luterbacher, *Thalmanninella* cf. *ticinensis subticinensis* (Gandolfi), *Thalmanninella ticinensis ticinensis* (Gandolfi) - Age: younger part of Middle Albian - older part of the Late Albian.

B-13 (825 m a.s.l.): Greyish-green limestones with black spots and shaly marlstones/claystones (Fig. 4c). Well exposed beds of massive shaly limestone (30-80 cm) with black bioturbation marks. At the base is a laminated dark-grey calcareous sandstone of thickness 13 cm, roughly 3 distinct layers 30 to 50 cm at a section of 4 m. Dip v = 320/30-320/15°. In thin section from the lower part are cross sections of tests: *Planomalina (Planomalina) buxtorfi* (Gandolfi) (Pl. II., Fig. 4), *Hedbergella delrioensis* (Carsey), *Whiteinella gandolfii* Gašpariková et Salaj (Pl. II., Fig. 3), *Thalmanninella appenninica appenninica* (Renz), *Thalmanninella* cf. *brotzeni* (Sigal). Age: latest Albian - earliest Cenomanian.

B-15 (815 a.s.l.): Prevalence of shaly marlstones to green limestones with dark spots with sandy admixture, banks of 30-100 cm. Interlayered are distinctly cleeved layers up to thickness of 1,5 m. Dip v = 310/18. The nannoplankton (preparation No 96/94) contains the species:

Braarudosphaera cf. *batilliformis* Troelson & Quadros, *Cyclagelosphaera deflandrei* (Manivit), *Cyclagelosphaera margerelii* Noel, *Ellipsagelosphaera* sp., *Manivitella pemmatoidea* (Deflandre), *Watznaueria barnesae* (Black). It is a very poor sample with species of wide range. *B. batilliformis* indicates the age Middle Aptian - Early Cenomanian.

B-14 (820 m a.s.l.): Dark-grey spotted limestone to marlstone. There are several distinct boudined zones up to 2-10 cm (b = 15/10°, axes of minute folds o = 280/30°, extensional joints and extensional veinlets filled up with calcite reach 7-30 cm long, 1 cm width, with dip ž = 60/55° and 30/35°), v = 310/20. This part of the profile appears higher if compared to B-13. In thin section are cross sections of:

Hedbergella delrioensis (Carsey), *Ticinella* sp., *Thalmanninella* sp., *Thalmanninella appenninica appenninica* (Renz) (Pl. II., Fig. 5) - Age: Albian.

B-12: Shales, sandy limestones. Between B-12 and B-13 limestones are more massive and beds attain thickness from 50 cm to 2 m, v = 305/10.

B-11: (± 832 m a.s.l.): Shales, overlain by sandy limestone. Shales dominate, thickness of beds around 0,5 m, v = 310/20°. Joints and faults of dip z = 180/85-44°, with listric bending to 100/05°.

B-11B: (830 m a.s.l.): The same as B-11, v = 290/55, grey sandy shaly marlstones. In the lower part is a bed of fine-grained sandstone. From heavy minerals in thin section we found zircon, pyrite is present. In marlstones we determined cross-sections of foraminifers:

Nodosaria sp., *Hedbergella* sp., *Whiteinella* sp., *Praeglobotruncana stephani* (Gandolfi), *Clavihedbergella simplex* (Morrow), *Thalmanninella* cf. *brotzeni* (Sigal), *Thalmanninella brotzeni* (Sigal) - Age: basal part of the Early Cenomanian.

From the same piece we obtained the nannoplankton association, (preparation No. 130/94):

Braarudosphaera bigelowii (Gran & Braarud), *Cyclagelosphaera deflanderi* (Manivit), *Eifelithus turriseiffelii* (Deflandre), *Watznaueria barnesae* (Black) – abundant is *W. barnesae*, other species sporadically only. It is similar to other samples from Balcová. Age: Late Albian.

B-10: (840 m a.s.l.): Black-spotted layers of limestones and marlstones, 10-40 cm thick, wedging out lenticularly, more or less compact, in places shaly. Calcite veinlets follow schistosity planes in more argillaceous beds. Alternation with 10-15 cm thick beds of shales with fine silty - muscovite admixture. Total thickness of the sequence is 8 m, bedding v = 320/05 - 315/20°. In thin section from overlying limestones we found:

Planomalina sp., *Hedbergella* sp., *Praeglobotruncana* sp., *Thalmanninella* cf. *brotzeni* (Sigal). Age: basal part of the Early Cenomanian.

B-9: In places beds of highly cleaved and folded limestones and/or calcareous shales are jutting out. The thin section from limestones contains the association of foraminifers:

Hedbergella sp., *Praeglobotruncana* sp., *Praeglobotruncana delrioensis* (Plummer), *Thalmanninella deeckei* (Franke). Age: younger part of the Early Cenomanian.

B-7, B-8: Dark-grey shales (sample B-8), cleaved marlstones to shales of light-grey colour (sample B-8/A). On bedding planes are Fe-coatings. The limestones are pale-grey, more-less compact (Fig. 4b). V = 320/10° (above the small saddle before the curve v = 80/30°). At the curve (B-7): shaly claystones in prevalence over marlstones and limestones, v = 80/30°, lot of calcite. Individual components are schlieren-like ordered, in thin sections lamination is visible. In thin sections are present: *Hedbergella* sp., *Praglobotruncana* sp. and *Thalmanninella* sp. - Age: Cenomanian.

B-6: Alternation of shales and limestones and/or marlstones. Washing from grey shales (146/94) contains Cenomanian foraminifers:

Ammodiscus cretaceous (D`Orbigny), *Lenticulina* sp., *Thalmanninella appenninica balernaensis* Gandolfi (Pl. III., Figs. 1 and 2.).

In thin section are: *Dorothia* aff. *oxycona* (Reuss), *Hedbergella* sp., *Praeglobotruncana delrioensis* (Plummer), *Thalmanninella appenninica* (Renz), *Thalmanninella* ex gr. *deeckei* (Franke) - Age: Cenomanian.

B-5: Covered section, in places cleaved limestones and grey shales are jutting out (in alternation). From the substratum of the shales is the sample of dark-grey limestone for thin section, in which we determined:

Hedbergella sp., *Hedbergella planispira* (Tappan), *Whiteinella* sp., *Praeglobotruncana* sp., *Thalmanninella* sp. Age: Cenomanian.

Higher part of the profile

B-4: Alternation of beds of dark-grey cleaved limestones, marlstones with thin beds of grey (sample B-4) and greyish-brownish shales (Fig. 4a). Fine calcite veinlets and polished surfaces are common. The rocks are more compact than in B-3, v = 270/12°. The thin section contains cross sections of planktonic foraminifers:

Hedbergella sp., *Whiteinella* sp., *Sigalitruncana sigali* (Reichel) (Pl. II., Fig. 9), *Dicarinella* sp. Age: Middle Turonian.

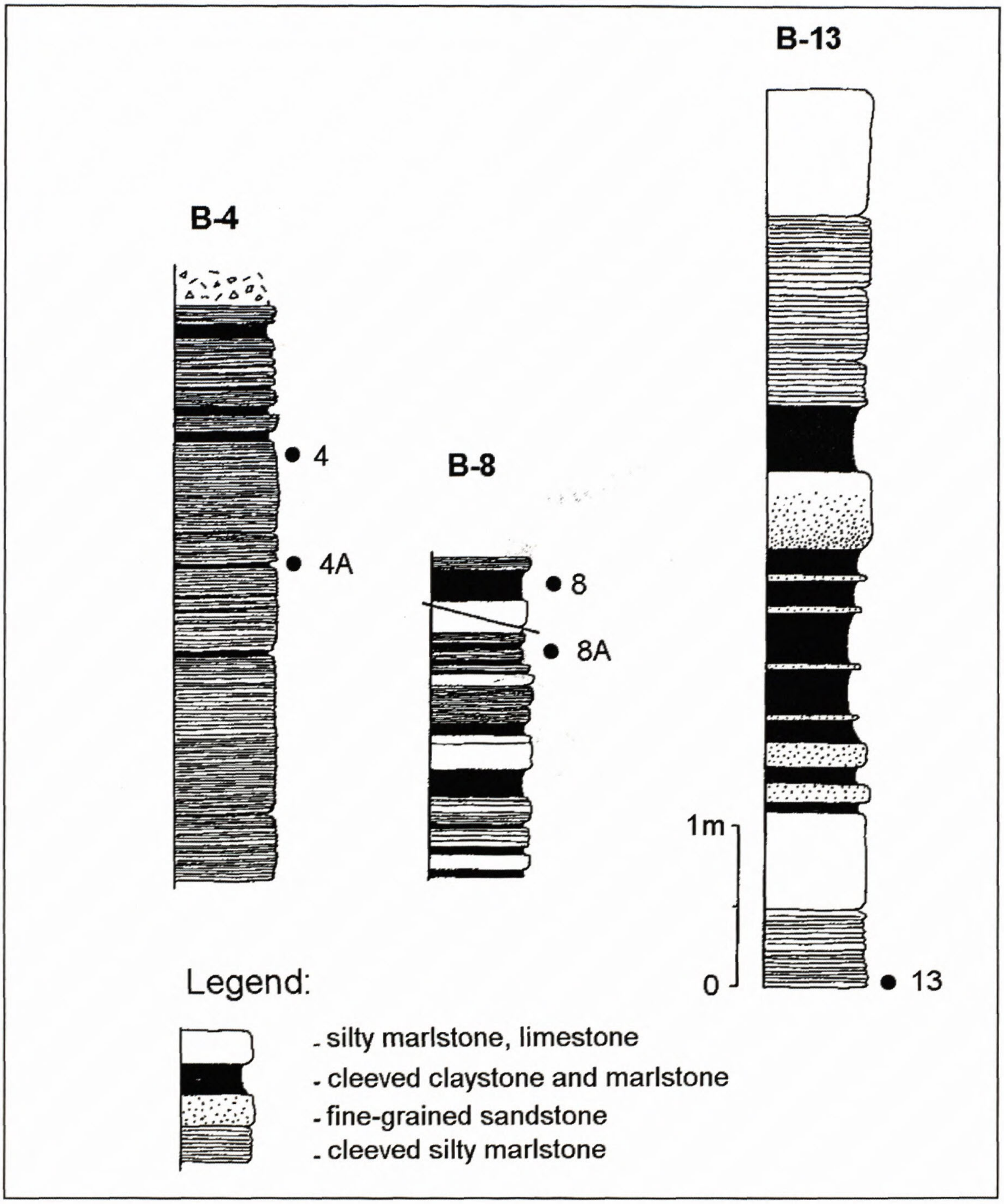

Fig. 4. Lithological profiles of the Poruba formation

In thin section B-4/A from brownish shale with leafy disintegration are found:

Tritaxia sp., *Dorothia* sp., *Nodosaria* sp., *Anomalina* sp., *Hedbergella* sp., *Whiteinella* sp., *Praeglobotruncana* sp., (Pl. I., Fig. 1), *Helvetoglobotruncana helvetica* (Bolli) (Pl. I., Fig. 2), *Dicarinella oraviensis* (Scheibnerová) - Age: Middle Turonian.

B-3: Marlstones in beds of lenticular course, bedding v = 285/18°. The sample for thin section is from greyish-green shaly claystone to dark-grey limestone. We determined here:

Hedbergella sp., *Whiteinella* sp. (Pl: II., Fig. 6), *Praeglobotruncana* sp., *Helvetoglobotruncana helvetica* (Bolli) (Pl. I., Fig. 3), *Dicarinella hagni* (Scheibnerová) (Pl. II., Fig. 8). Age: Middle Turonian.

B-IV/B-1: Marlstones and silty limestones, thin intercalations of fine-grained sandstones, v = 305/10 - 310/12. In thin section are cross sections of *Praeglobo-*

truncana sp., *Sigalitruncana sigali* (Reichel), *Dicarinella* sp. Age: Middle Turonian.

B-I (at the marked tree): Greyish-green, cleaved silty ?marlstones and limestones with dark spots, beds of greyish-green shales (3-10 cm), fine - grained carbonate sandstones. The rocks are dragged out in lenticular form, polished surfaces and calcite veinlets at S-1 planes, bedding v = 330/20°. In sample B-I_3 (2 thin sections) from the uppermost marly horizon – from brownish sandy shaly marlstones around allochems and/or recrystallized parts of rock are „hems", from which some resemble cross-sections of planktonic foraminifers.

Nannoplankton in repeated preparation from grey sandy shaly marls with dark spots:

Braarudosphaera cf. *africana* Stradner, ?*Conusphaera* sp., *Manivitella pemmatoidea* (Deflandre), *Nannoconus* sp., ?*Prediscospahera* sp., *Rucinolithus wisei* Thierstein and coprolites.

On the basis of the presence of *B. africana* we interprete the age of the association as Aptian - Albian.

B-II (870 m a.s.l.): Cleaved greenish-grey, dark-spotted calcareous claystones with muscovite and silty admixture (30-50 cm), laminae of blackish-grey claystones, layers of fine-grained carbonate sandstones, green limestones with fucoids, bedding v = 340/40°. Next 5 m as B-I, mostly scree-covered. The sample is from grey and/or brownish-greyish-green shales.

In thin sections from reddish-brown shaly marlstones (sample B-IIb) planktonic and benthonic foraminifers were established. An association of foraminifers was identified, represented by planktonic forms *Sigalitruncana sigali* (Reichel) (Pl. I., Fig. 5), *Dicarinella* sp. and *Dicarinella hagni* (Scheibnerová) (Pl. I., Fig. 6) which indicate the Middle Turonian.

The washing from the sample contains the association of foraminifers:

Ammodiscus cretaceous (D'Orbigny), *Trochammina* sp., Anomalina (*Gavelinella*) sp., *Sigalitruncana sigali* (Reichel) (Pl. III., Fig. 3), *Dicarinella biconvexa* (Samuel et Salaj) (Pl. III., Figs 10 and 11), *Dicarinella* sp., (Pl. III., Fig. 13), Dicarinella aff. *hagni* (Scheibnerová) (Pl. III., Fig. 5), *Dicarinella hagni* (Scheibnerová), (Pl. III., Fig. 9), *Dicarinella imbricata* (Mornod), *Dicarinella oraviensis* (Scheibnerová) (Pl. III., Figs 6, 7 and 12) - Age: Middle Turonian.

Nannoplankton (118/94) B-II from light-grey silty marly shales:

?*Cyclagelosphaera* sp., *Cyclagelosphaera margerelii* Noel, *Ellipsagelosphaera fossacincta* Black, *Manivitella pemmatoidea* (Deflandre), *Prediscosphaera* sp. - spines, *Prediscosphaera* aff. *cretacea* (Arkhangelsky) s.l., *Stradneria crenulata* (Bramlette & Martini).

This is a relatively poor, little diversified assemblage. Its age is at least Albian. We understand *P.* ex gr. *cretacea* here in widest conception of the group of elliptical Prediscospheras.

B-III/D: About 10 m NE of B-II, 1,5 m below of greyish-green shaly marlstones is a sandstone body 4 m thick, a complex of 8 beds of fine-grained to medium-grained sandstones (5-100 cm). Bedding v = 300/30 - 360/15°. The sandstone body is limited primarily (sedimentary), but from the eastern side also by faults (z = 65/30° and 247/42°). The axis of small boudined SW-vergent fold o = 320/25°.

B-III/C: About 10 m to NE, cleaved greenish-grey argillaceous limestones with laminae of calcareous siltstones up to 5 mm, beds are discontinuous, lenticular, v = 300/30 - 360/15° (Pl. V., Fig. 2).

B-III/B: In the middle part are lenticular laminae of fine-grained sandstones and a bed (13 cm) of fine-grained carbonate sandstone. According to the texture of silt laminae and bedding the rocks they are in normal position. In places the formation is penetrated by a dense network of calcite veinlets and softly boudined (axe of boudines = 230/10° - SW vergency, bedding v = 350/12 - 330/08°.

B-III/A: (865 m a.s.l., at length of about 15 m): Cleaved greenish-grey marls and claystones, fine-sandy admixture with scattered muscovite. Beds up to about 10-50 cm. Intercalations (1-5 cm) of fine-grained carbonate sandstones with pieces of carbonised plant chaff. Structure of the Bouma sequence T(a)c. Sand to shale ratio $P < 0,1$, bedding index $I = \pm 5$. Dip of the body is to NNW, at angle of 10-45°.

Remarks to foraminifer microfauna and petrography

For microscopic study we took from the Poruba Formation samples of greyish-brown, greyish-green marlstones to limestones and calcareous shales with dark-grey to black spots. From the point of view of texture they belong to biomicrites to biomicrosparites (Folk 1962). According to Dunham's classification they are biogenic wackestones, sporadically packstones. The samples are more or less recrystallized, with variable, in places considerably high content of clayey admixture. Most samples contain a foraminifer microfacies, less radiolarian, foraminifer - radiolarian and/or calcispherule - foraminifer microfacies is found. Of dominant position among biogens are cross sections of recrystallized tests of planktonic foraminifers (see Plts. I. and II.). In some samples a part of the specimen is diagenetically affected by stress. In the sequence (from bottom to top) gradually appear forms of the genera *Hedbergella, Ticinella, Thalmanninella, Whiteinella, Praeglobotruncana, Dicarinella, Helvetoglobotruncana* and *Sigalitruncana* (Fig. 5).

In thin section material of Bujnovský and Gašparíková (1990), which was available to us, we confirmed the presence of the genus *Rotalipora*. In our samples we were not successful to find this genus. Benthonic forms are found rarely only. The amount of foraminifers in the individual samples is variable. In association with foraminifers are usually rare *Globochaete alpina* LOMBARD, sporadically fragments of thick-walled bivalves, very scarcely „filaments" and Ostracode valves. In samples B-19 and B-18a large amount of radiolarians of *Spumellaria* type are filled up with sparry calcite. Sponge spicules mostly of monaxonic type are in sample B-19. Abundant recrystallized circular cross sections belonging to *Calcisphaerula innominata* Bonnet, are found in samples B-6 and B-5. It is not excluded that some of them can belong to radiolarians of the group *Spumellaria*, mainly in sample B-5. In association of calcispherules *Pithonella ovalis* (Kaufmann) appears (mainly in sample B-6).

Planktonic and benthonic foraminifers are also in thin sections of samples B-IIb from reddish-brown shaly marlstones. The association consists of *Sigalitruncana sigali* (Reichel) (Pl. I., Fig. 5), *Dicarinella* sp. (Pl. I., Fig. 4) and *Dicarinella hagni* (Scheibnerová) (Pl. I., Fig. 6) and indicates the Middle Turonian age.

Only several few horizons are suitable to the study of foraminifers, because of strong recrystallisation. In washings pyrite and/or limonite cores of foraminifers are -except scarce cases- undeterminable (Pl. III., Figs. 1 and 8). Free separated forms were compared with cross sections of tests from thin sections, which mostly provided a better preserved microfauna.

The mineral admixture in marlstones is represented by clastic quartz of aleuritic, scarcely sandy fraction. Its content varies usually around 1%. Hydromicas, sericite and/or muscovite in some places emphasise the oriented structure of sediments and in samples B-17 and B-7 indications of lamination are observable.

Discusion

Establishing of such a wide age range as the Aptian - Middle Turonian for a formation deposited by currents seems to be suspicious. Thus we examined the preceding determinations of foraminifers and nannoplankton at the profile and state the following: The Aptian associations of Bujnovský and Gašpariková (1990) are determined correctly, however, are not original, but probably redeposited, or they are not collected from the Poruba Formation. We cannot confirm this assumption unambiguously, because precise localisation of samples is missing. The Early Cenomanian association mentioned under No. 35 and 36 by Gašpariková (in Bujnovský et al. 1988) with *Thalmanninella* ex gr. *brotzeni* (Early to Middle Cenomanian) may be accepted even when determination of the species is only „ex gr." – even if there could be some similar species, the occurrence of this does not exceed the range of the mentioned one. We have, however, serious remarks to composition of nannoplankton association from doc. point 37 as to its interpretation: *Cribrosphaera (=Cribrosphaerella) ehrenbergi* Arkhangelsky, *Prediscosphaera cretacea* (Black), *Podorhabdus albianus* Black and *Eifelithus turriseiffelii* (Deflandre) are concerned. *C. ehrenbergi* is a species already found in the Late Albian. The first occurrence of *P. albianus* was already recorded also from the Barremian! Thus these two species do not satisfactorily prove the Cenomanian age of the association. The question of the presence of *P. cretacea* is a somewhat different – according to Perch-Nielsen (in Bolli et al. 1985) this species is ranging in the Senonian (Campanian - Maastrichtian). This, however raises the question of correctness of its determination and/or purity of the sample. In case there is no contamination (and if we do not want to admit directly the Cenomanian age of the Poruba Formation), we could consider the determination of *P. cretacea* as erroneous. Probably it could have been mistaked with *P. intercisa* (DEFLANDRE), however, this would imply dating at least to the Late Cenomanian. It is, however, a certain possibility that some of the circular forms *Prediscosphaera* ex gr. *columnata - avitus - cantabrigensis* was concerned, which were found already in the Albian to Early Cenomanian. We, however, have no available documentation material to rewiew, by which we should take the final conclusion. The occurrence of „zonal species" *E. turriseiffelii* has not been recorded in the association (Bujnovský et al., 1988), but is mentioned (Bujnovský - Gašpariková 1990) by a formulation, which arises suspicion of an error in retyping of the original text. If, however, also this species was present in the sample, its occurrence is already in the Late Albian, what means that the association could still belong to the Late Albian.

The lower boundary of the Poruba Formation at the profile „Balcová" is disputable. According to Bujnovský and Gašpariková (1990) the formation starts in the Early Aptian. The foraminifers *Hedbergella infracretacea* (Glaessner), *Anomalina (Gavelinella) sigmoicosta barremiana* (Bettenstaedt) and nannoplankton *Chiastozygus litterarius* (Gorka) established by Boorová (1992), prove the presence of the Osobitá Formation at the profile „Balcová", dated to the Aptian. In the overlying part is still the sequence of limestones with cherty horizons, which, with regard to their lithology, cannot be ranged to the Poruba Formation. This complex is older than the Early Albian. According to description and localisation this part of the formation corresponds to our documentation points **B-18 - B-20**. For them equally an age older than the Early Albian is established. This part of the profile probably still may also be ranged to the Osobitá

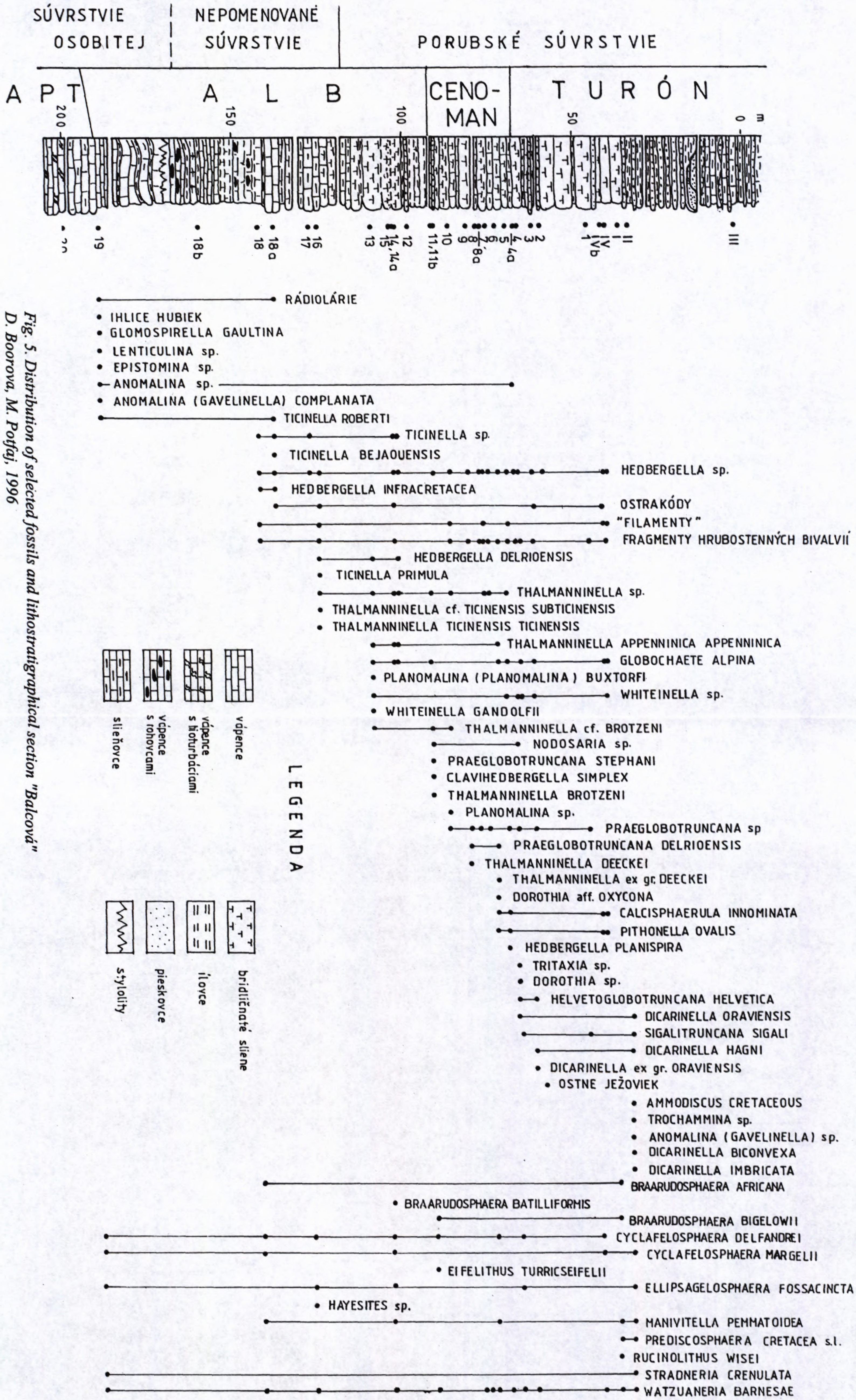

Fig. 5. Distribution of selected fossils and lithostratigraphical section "Balcová"
D. Boorova, M. Potfaj, 1996

Formation.* Therefore the lower boundary of the Poruba Formation at Balcová cannot be older than the Early Albian.

Gašpariková (Bujnovský - Gašpariková, 1990) established the upper age boundary of the Poruba Formation at the profile „Balcová" as Middle Cenomanian, defined by the presence of planktonic foraminifers from the *Rotalipora cushmani montsalvensis* Zone. This sample obviously could have not been collected from the uppermost part of the formation.

Bujnovský - Polák (1985) mentioned that the youngest Mesozoic Tatricum sequence of the Veľká Fatra Mts. are sandstones, sandy limestones and claystones with foraminifers proving stratigraphic range as Albian - Early Turonian: *Hedbergella roberti* (Gandolfi), *Haplophragmoides nonioninoides* (Reuss) and *Rotalipora* ex gr. *cushmani* (Morrow). This we cannot consider as sufficient evidence. According to present-day state of knowledge, *R. cushmani*, on the basis of which the upper age boundary of the Tatricum sequence was established, does not exceed the Cenomanian boundary (Robaszynski - Caron 1979, Caron 1985).

In our material (in washings as well as thin sections), in the upper horizons of the Poruba Formation, the presence of planktonic foraminifers from the *Helvetoglobotruncana helvetica* Zone (in the sense of Salaj 1986) was observed. So the upper boundary of the Šiprúň sequence in the Veľká Fatra Mts. at the locality Balcová can be shifted to the Middle Turonian.

The continuity of bed sequence to underlying formations (Osobitá Formation) is made doubtful at the profile. According to geological settings the Poruba Formation is folded to a slight anticlinal form, the NW limb dipping at angle 10-20° to north-west where it submerges under the Krížna nappe, whereas the SE limb is dipping to south-east, apparently beneath the older - underlying limestone complex (Fig. 3). Therefore it is not possible to confirm continuity of the Šiprúň sequence to the north of Balcová. For this reason it is also problematic to determine the lower boundary of the Poruba Formation at the profile. According to Jablonský (1992) the formation should be underlain by the Vlkolínec Breccia, the equivalent of which we have not found here. The earliest association determined by us (higher Middle Albian in sample **B-16**) also appears too young for the base of the formation, we could consider this part as the middle interval.

Continuity of the bed sequence of the Poruba Formation itself is more vindicable when also not proved directly. The setting and succession of onset of individual species - markers of foraminifer zones testifies in favour of minimum reductions and breaks of the bed sequence in the Poruba Formation.

In nannoplankton associations we have found out a sporadical occurrence of young (Campanian - Maastrichtian) species in several preparations. We consider them as contaminations during the process of sample preparation. This is indicated by the fact that these young species have not been found any more in the repeated preparations from the same sample. In determination of the age we were not taking into consideration contaminated samples. The method of age determination according to nannoplankton associations has not brought satisfying results, preservation of the associations is relatively poor, their reduction and selective diagenetic dissolution were quite possible (compare determinations of associations in the plates).

* We refused the speculation that there could be the Párnica Formation, because this is formed by dark-spotted calcareous shales (marls) of the Late Barremian to Aptian (Andrusov et al. 1985).

Conclusion

At the profile north of elevation point Balcová (978,5) in the Šiprúň sequence the Poruba Formation occurs as the uppermost lithostratigraphical unit. According to the lithological content there is an equivalent of the Homôlka Marlstones, only locally in the higher part of the profile also the Senkov flysch Member and Ludrová sandstone Member occur (Jablonský in Samuel et al. 1988). The established thickness of the Poruba Formation is here only a little more than 200 m. The study of planktonic foraminifers of the Poruba Formation at the profile Balcová has brought new knowledge concerning its age. The associations of nannoplankton were not sufficiently conclusive, however, are not in contradiction to the range on the basis of foraminifers.

Our determinations of planktonic foraminifers from the *Helvetoglobotruncana helvetica* Zone (sensu Salaj 1986) unambiguously prove the Middle Turonian age of the uppermost parts of the Poruba Formation.

Although we could not establish foraminifer associations in succession of individual biozones in continuity one after another, we suppose (taking into account the interval of sampling, considerable recrystallization, the results of Bujnovský and Gašpariková (1990)) a more or less continuous bed sequence of the Poruba Formation at the profile Balcová in the range Albian - Middle Turonian. Incidental absence of certain horizons in the bed sequence may be explained as a secondary phenomenon caused by tectonic and not sedimentary reduction.

The lower boundary of the Poruba Formation, after confrontation with the results of Boorová (1992) is Early Albian, that is younger than mentioned by Bujnovský et al. (1988, 1990).

At the profile „Balcová" the continuity of the Šiprúň bed sequence cannot be proved. This is tectonically interrupted between the Poruba and underlying formations.

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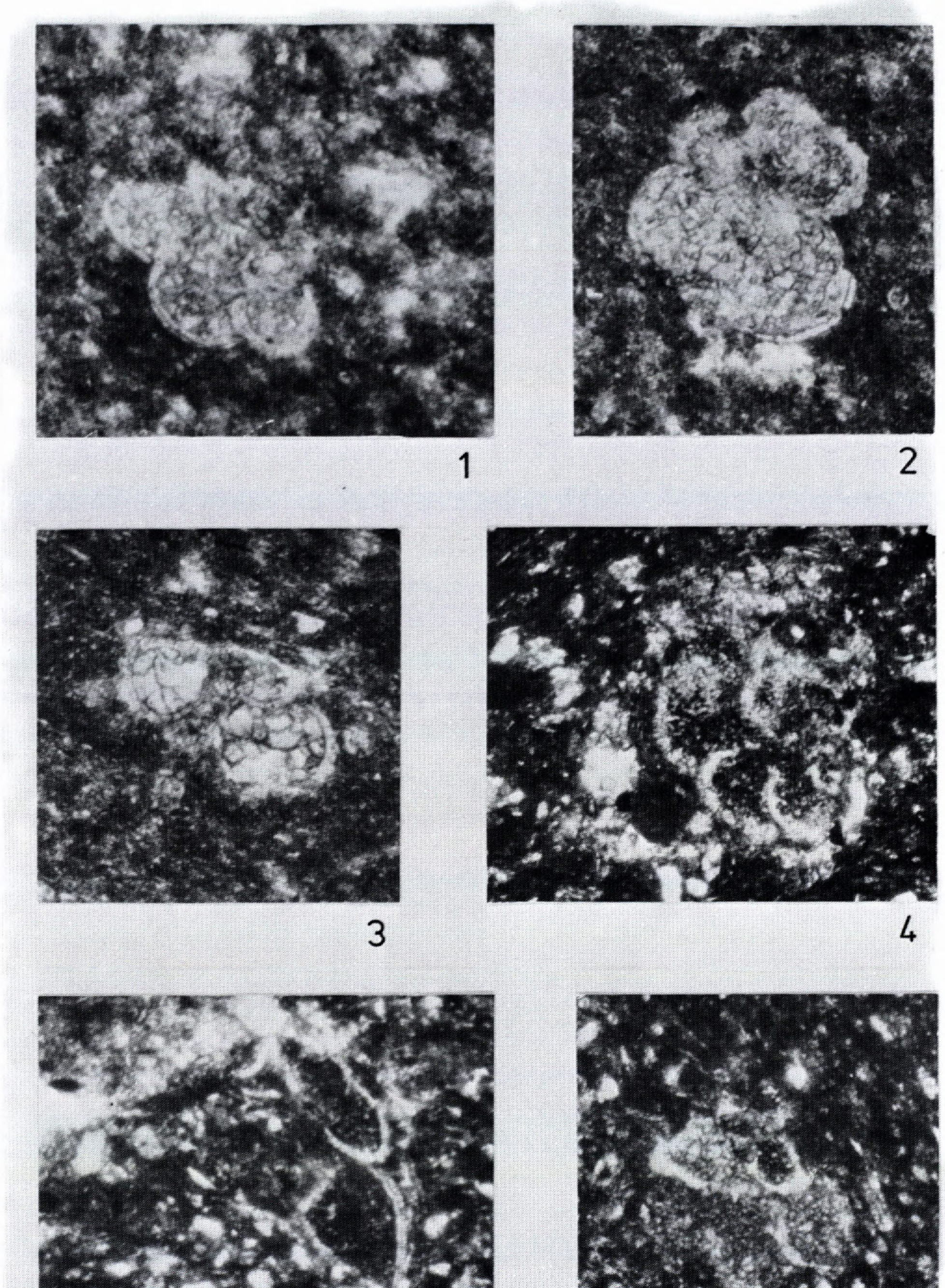
Plate I



Cross sections of recrystallized planktonic foraminifer. Poruba Formation:

Fig. 1: *Praeglobotruncana* sp.; Middle Turonian, sample B-4/A; magnif. 109x
Fig. 2: *Helvetoglobotruncana helvetica* (Bolli); Middle Turonian, s. B-4/A; magn. 103x
Fig. 3: *Helvetoglobotruncana helvetica* (Bolli); Middle Turonian, sample B-3; magnif. 109x
Fig. 4: *Dicarinella* sp.; Middle Turonian, sample B-II_b; magnif. 96x
Fig. 5: *Sigalitruncana sigali* (Reichel); Middle Turonian, sample B-II_b; magnif. 85x
Fig. 6: *Dicarinella hagni* (Schreibnerová); Middle Turonian, sample B-II_b; magnif. 98x

Plate II

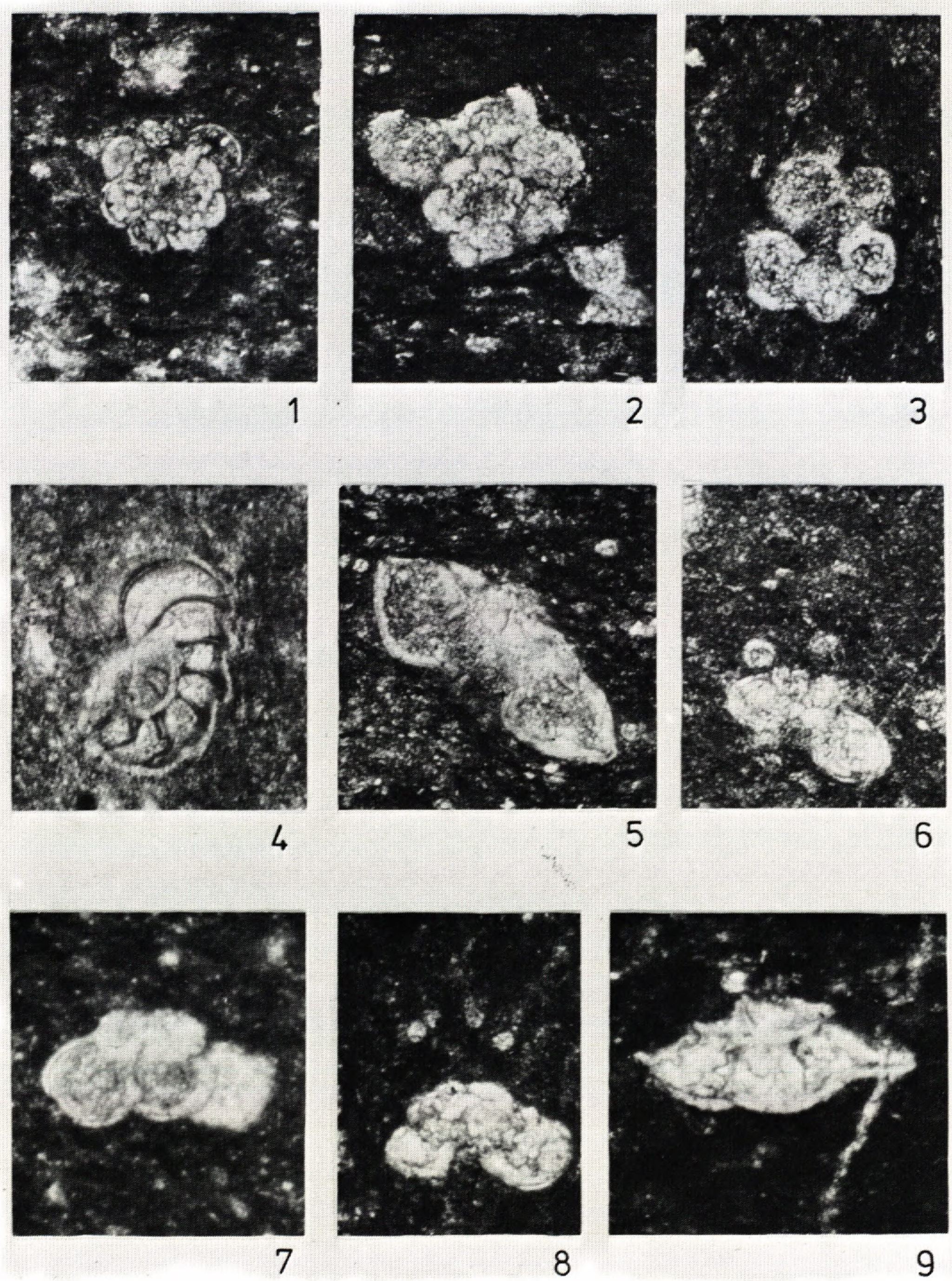


Plate II: Cross sections of recystallized planktonic foraminifers. Poruba Formation:
Fig. 1: *Ticinella* sp.; Early Albian, sample B-18; magnif. 100x
Fig. 2: *Ticinella primula* Luterbacher; younger part of Middle Albian - older part of Late Albian, sample B-16; magnif. 96x
Fig. 3: *Whiteinella gandolfii* Gašpariková et Salaj; Albian - oldest Cenomanian, sample B-13; magnif. 100x
Fig. 4: *Planomalina (Planomalina) buxtorfi* (Gandolfi); the youngest Albian - oldest Cenomanian, sample B-13; magnific. 70x
Fig. 5: *Thalmanninella appenninica appenninica* (RENZ); Albian, sample B-14; magnif. 95x
Fig. 6: *Whiteinella* sp.; Middle Turonian, sample B-3; magnif. 100x
Fig. 7: *Dicarinella hagni* (Scheibnerová); Middle Turonian, sample B-3; magnif. 95x
Fig. 8: *Dicarinella* ex gr. *oraviensis* (Scheibnerová); Middle Turonian, sample B-3; zväčšenie 103x
Fig. 9: *Sigalitruncana sigali* (Reichel); Middle Turonian, sample B-4; magnif. 95x

Plate III

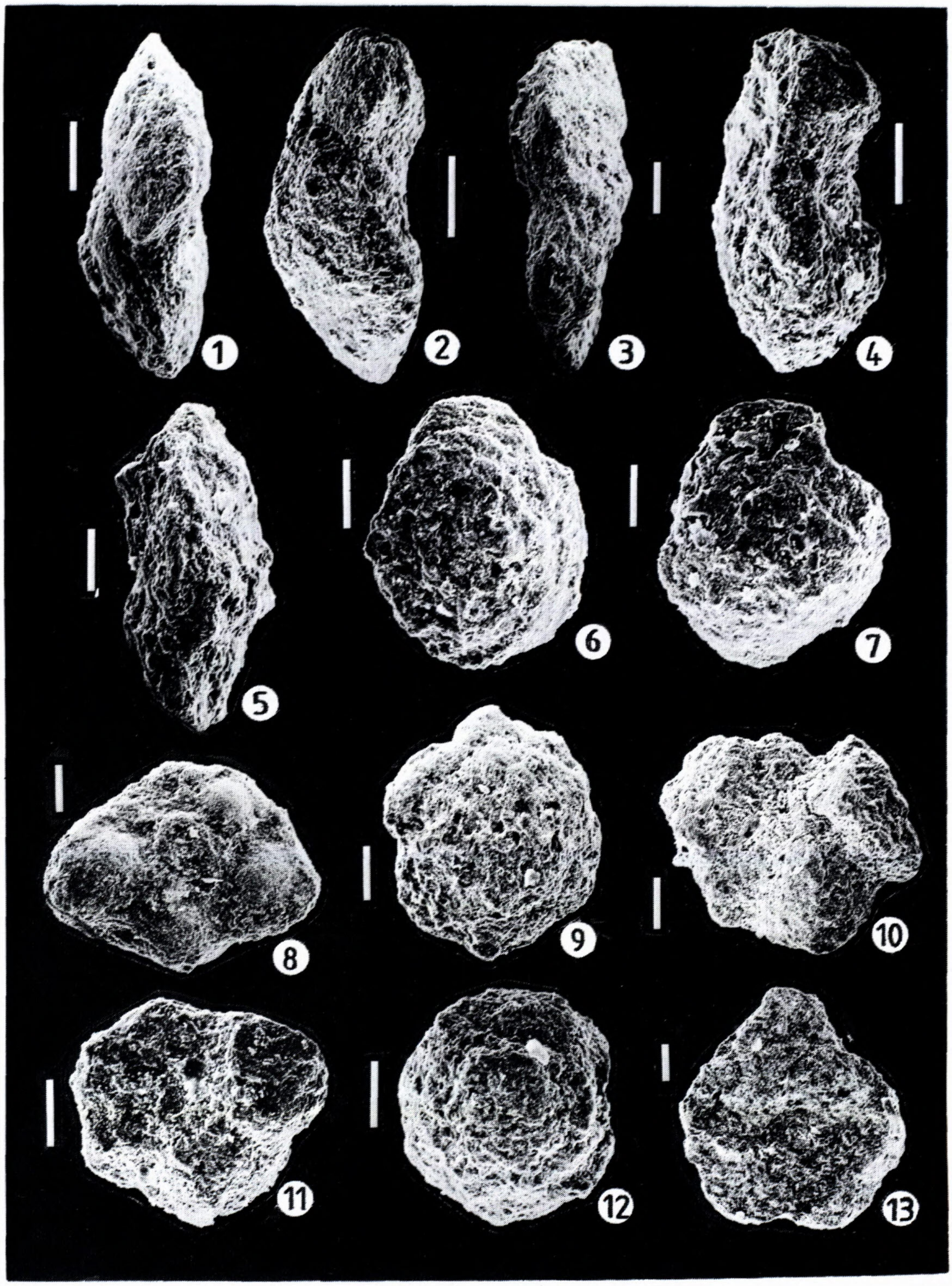


Plate III: Recystallised planktonic foraminifers. Poruba Formation.
Fig. 1, 2: *Thalmanninella appenninica balernaensis* Gandolfi; Cenomanian, Fig. 1. - limonite core. sample B-6; washing 149/94
Fig. 3: *Sigalitruncana sigali* (Reichel); Middle Turonian, sample B-II; washing 285/94
Fig. 4, 9: *Dicarinella hagni* (Scheibnerová); Middle Turonian, sample B-II; washing 285/94
Fig. 5: *Dicarinella* aff. *hagni* (Scheibnerová); Middle Turonian, sample B-II; washing 285/94
Fig. 6, 7, 12: *Dicarinella oraviensis* (Scheibnerová); Middle Turonian, sample B-II; washing 285/94
Fig. 8: *Hedbergella* sp. Limonitové jadro. sample B-2; washing 285/94
Fig. 10, 11: *Dicarinella biconvexa* (Samuel - Salaj); Middle Turonian, sample B-II; washing 285/94
Fig. 13: *Dicarinella* sp.; Middle Turonian, sample B-II; washing 285/94
bar scale = 100 m

Plate IV

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2

Plate. IV

Fig. 1: Lenticular layers of sandstones, incised supply channel filled up with fine to coarse-grained sandstones. Docum. point B-IIID. View from the south.

Fig. 2: Thin-bedded fine-grained sandstones in greenishgrey silty marlstone. The sandstone beds are discontinuous. Marginal part of the supply channel. Docum. point (B-III/c).

Plate V

Fig. 1: Shaly greyish-green marlstone. Distinct is alternation of more-less „mylonitized" rocks in 0,5-1,5 m intervals. Docum. point B-11b.

Fig. 2: Layered marlstone with indication of gradation (increasing clastic silt admixture to the top). In the upper part of the outccrop is distinct cleavage. Document. point 16.

Fig. 3: Limestone formation of the Early Albian. Between limestone beds are dark-grey to black shaly marlstones. Docum. point 19.

Plate V

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2

3

Slovak Geol. Magazine 3,4(1997) 331–340

Mistaken identity of wheel-shaped sclerites of Ophiocistioidea and Holothurioidea.

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Abstract. Remains of ophiocistioids were often described as holothurian sclerites or even echinoids. Holothuroid remains are quite common fossils although they are rarely described in literature. Type species of *Protocaudina* based on ophiocistioid sclerites. Few species were described from different part of the World, some specimens were presented from Slovak Republic by Kozur and Mock (1972, 1974), Kozur, Mock and Mostler (1976). Revision of systematics, phylogenetic relationships, cocnclusions and references have been given. Subphylum *Echinozoa* Haeckel in Zittel, 1895, Class *Ophiocistioidea* Sollas, 1899, Family *Rotasacciidae* Haude and Langenstrassen, 1976: *Rotasaccus* Haude and Langenstrassen, 1976 - *Rotasaccus dentifer* Haude and Langenstrassen, 1976: *Microantyx* Kornicker and Imbrie, 1958 - *Microantyx permiana* Kornicker and Imbrie, *Pararotasaccus* Kozur and Mostler, 1989 - *Pararotasaccus permicus* Kozur and Mostler, 1989, *Protocaudina* Croneis, 1932 - *Protocaudina traquairii* (Etheridge, 1881), *Protocaudina botoni* (Gutschick, 1959), *Protocaudina sosioensis* (Kozur and Mostler, 1989), *Protocaudina tarazi* (Kozur and Mostler, 1989). Class *Holothurioidea* de Blainville, 1834, Order *Dendrochirotida* Grube, 1840, Family *Cucumariidae* Ludwig, 1894 emend. Pawson and Fell, 1965, Subfamily *Staurocaudininae* subfam. n.: *Staurocaudina* gen. n. - *Staurocaudina khadirensis* (Soodan, 1977): *Staurocaudina mortenseni* (Deflandre - Rigaud, 1946); *Staurocaudina rigaudae* (Mostler, 1970); *Mercedescaudina* Schallreuter, 1975 - *Mercedescaudina triperforata* (Schallreuter, 1968); *Mercedescaudina mostleri* Schallreuter, 1975; Order *Elasipoda* Théel, 1882, Family *Palaeocaudinidae* fam. n.; *Palaeocaudina* gen. n. - *Palaeocaudina hexagonaria* (Martin, 1952 emend. Gutschick and Canis, 1971); *Palaeocaudina acmaea* (Matyja, 1972); *Palaeocaudina hannai* (Croneis, 1932); *Palaeocaudina herrigi* (Reich, 1995); *Palaeocaudina kansasensis* (Hanna, 1930). Wheel-shaped sclerites from the body wall of Ophiocistioidea in the central area have the buttons with curved arch on the opposite side, but Holothurioidea have sclerites without buttons or buttons have no arches and slates on the opposite sides.

Keywords. Ophiocistioidea, Holothurioidea, wheel-shaped sclerites from the body wall, Palaeozoic, Evolution, Systematics, Revision.

Introduction

Quite commonly the dispersed fragments of ophiocistioids were described as holothurian sclerites (Croneis & Mc Cormack 1932) or even as echinoids (Spandel 1898). Examples of these misassignments are *Microantyx* from the Permian of Kansas (Kornicker & Imbrie 1958), Devonian of Germany (Beckmann 1965) and from the Namurian of Slovakia (Kozur, Mock & Mostler 1976), or *Protocaudina* (formerly described as *Microantyx*) from the Carboniferous of Poland (Alexandrowicz 1971), Indiana, Montana and Missouri (Gutschick 1959; Gutschick, Canis & Brill 1967) and China (Ding 1985; Zhang 1987). Mostler (1983) wrote article about *Microantyx* from Late Palaeozoic. Turning point were the two studies of the palaeontologists from Göttingen: R. Haude & F. Langenstrassen (1976a, b), who not only reviewed all the taxa known so far but also described complete specimens from the genus *Rotasaccus* from the Lower Devonian of Germany and *Anguloserra thomasi* Haude & Langenstrassen, 1976 from the Lower Carboniferous of Germany (Haude & Thomas 1994). In 1976 Mostler & Rahimi-Yazd described specimens of wheel-shaped ophiocistioid sclerites as holothurian remains from the Permian of North Iran. Kozur & Mostler (1989) described new genus *Pararotasaccus* from the Permian of Western Sicily. Though in general opinion the ophiocistioids are uncommon (Ubaghs 1953, 1966), in my material their remains are ubiquitous in the open-marine Devonian, and not only in the Holy Cross Mountains.

Holothuroid remains are quite common fossils although they are rarely described in literature; in the Holy Cross Mountains they occasionally occur in great abundance in Upper Palaeozoic strata. On the other hand, common, fossils described as holothurian sclerites in reality represent other echinoderm groups, as it has been on numerous occasions suggested by Pawson (1966, 1980). These sclerites can be mistaken with other echinoderms, e.g. the representatives of the family *Calclyridae,* have been proposed to be arm spines of the ophiuroids (Mostler 1971b), or even of the other animal phyla, for instance sponge spicules (Mostler 1971c).

Systematic part

Subphylum *ECHINOZOA* Haeckel in Zittel, 1895
Class *OPHIOCISTIOIDEA* Sollas, 1899
Family *ROTASACCIIDAE* Haude & Langenstrassen, 1976

Rotasaccus Haude & Langenstrassen, 1976

Species typica: *Rotasaccus dentifer* Haude & Langenstrassen, 1976

Rotasaccus dentifer Haude & Langenstrassen, 1976

1976. *Rotasaccus dentifer* n. g. n. sp.; Haude & Langenstrassen, p. 133-142, 148, Text-figs 2-9.
1983. *Rotasaccus dentifer* Haude & Langenstrassen ; Haude, p. 105, 107, Text-figs 11 A-B.
1991. *Rotasaccus* cf. *dentifer* Haude & Langenstrassen; Langer, p. 44, Taf. 3: 9.
1991. *Rotasaccus dentifer* Haude & Langenstrassen; Langer, p. 44, Taf. 3: 10.

Holotypus: 730/S, Haude & Langenstrassen 1976: Text-fig. 7A.

Stratum typicum: Early Givetian, Wiedenester Schichten.

Locus typicus: Roadcut on L 708 way, near Germinghausen, MTB, Drolshagen, Oberbergisches Land, Rhenish Slate Mts., Germany.

Occurrence: Early Givetian: Wiedenester Schichten, Roadcut on L 708 way, near Germinghausen, MTB, Drolshagen, Oberbergisches Land, Rhenish Slate Mts. Wotan quarry near Üxheim; Loogh Formation, Hustley-Barley-Members, Daasberg near Gerolstein, Rohr (Eifel), Germany.

Microantyx Kornicker & Imbrie, 1958

Species typica: *Microantyx permiana* Kornicker & Imbrie, 1958.

Emended diagnosis: The sclerites from the body wall of ophiocistioids are circular or oval in outline. The two intersecting arches frame the volume of depression of a ventral button forming at the exterior 4 oval or tear-shaped, symmetrically arranged openings. At their margins the sclerites are framed by a distinct rim. The ventral button is well-marked, covered by concentric rings. There are 10 oval pores by the marginal ring.

Remarks: In 1983 Kozur and Mostler emended diagnosis for *Microantyx* but the specimens presented belong to the genus *Protocaudina,* because they have 8 marginal pores. Presence of an arch, markedly curved and closed from its ventral side by a button, differs this material from the holothurian sclerites. Openings of the central pore zone are oval, and not triangular, by *Microantyx praedulcis* sp. n. and *Protocaudina dulcis* sp. n. (Boczarowski in press), similarly as by sclerites of *Rotasaccus* Haude & Langenstrassen, 1976. In the post-Devonian evolutionary stage there occurred few species of almost cosmopolitan nature, as can be judged from the fossil material. Among the sclerites of this type also the specimen of Lane (1976) can be classified, with 10 marginal pores (Pennsylvanian of Lane Shale, Crown Center, Kansas City). On the other hand *Microantyx mudgei* of Gutschick *et al.* (1967) are real holothurian sclerites and display quite different structure, among others they lack the ventral button. Also the specimen of Garcia-López & Truyols (1974) from the Devonian of the Cantabrian Mts. is a holothurian sclerite.

Microantyx permiana Kornicker & Imbrie, 1958

1958. *Microantyx permiana* Kornicker & Imbrie new species; Kornicker & Imbrie, p. 94, Pl. 1: 1-6.
non 1965. *Microantyx permiana* Kornicker & Imbrie; Beckmann, p. 205-206, Text-fig. 15.
non 1971d. *Microantyx* cf. *permiana* Kornicker & Imbrie; Mostler, p. 10, Pl. 2: fig. 15.
non 1976. *Microantyx permiana* Kornicker & Imbrie; Kozur, Mock & Mostler, p. 13, Taf. 1: fig. 1, 2.
non 1991. *Microantyx permiana* Kornicker & Imbrie; Langer, p. 44, Taf. 3: 7, 8, 11.

Holotypus: CU no. 28,260, Kornicker & Imbrie: Pl. 1: 1-3.

Stratum typicum: Permian, Wolfcampian, Florena shale (Beattie limestone).

Locus typicus: Morris County, Kansas.

Remarks: Also in this species the paleontological identifications are somewhat superficial. The typical sclerites of the species were described as holothurian remains (Kornicker & Imbrie 1958) though associated with them were evident fragments of goniodonts, n.b. also classified into Holothurioidea. Specimens from the Givetian of the Paffrath syncline of the Rhenish Slate Mts. unequivocally represent the other, new species of ophiocistioids. Its sclerites are flat, supplied with large, knob-like ventral buttons, thin marginal ring and central pores of the outer surface arranged in plane of a square (cf. Beckmann 1965). From the same region collected were also other ophiocistioid sclerites, interpreted as holothurians by Langer (1991 - Early Givetian, Daasberg near Gerolstein). In spite of fact that their marginal zone is also with 10 openings, the sclerites are of more delicate structure, their marginal ring is thinner, the central cross arches are of different development and the ventral button is smaller. Quite different are the problems with the specimens of Mostler (1971d) from the Early Carboniferous of Afghanistan (Hindukush). They are superficially similar to *Microantyx permiana*, but differ from the latter by more delicate structure, smaller ventral convexity and lack the rim surrounding the central cross zone. The forms similar to *Palaeocaudina* gen. n. possibly have their thin wall of the ventral button broken, what is the common case. Specimens of Kozur, Mock & Mostler (1976) from the Namurian of Slovak Republic and classified as holothurian sclerites *Microantyx permiana* Kornicker & Imbrie, 1958 undoubtedly belong to the genus but represent its another species. The differences are delicacy of sclerite structure and different shape of a central cross. Ventral button is more flat than in the other species. Illustrated in the above mentioned paper specimen of *Protocaudina hexagonaria* Martin, 1952 most probably represents a species of *Microantyx* lacking the ventral button.

Occurrence: Only typical occurrence.

Pararotasaccus Kozur & Mostler, 1989

Species typica: *Pararotasaccus permicus* Kozur & Mostler, 1989

Remarks: Wheels of this genus have the 6 marginal pores and quite different central excavation.

Pararotasaccus permicus Kozur & Mostler, 1989

1989. *Pararotasaccus permicus* n. gen. n. sp.; Kozur & Mostler, p. 679, Pl. 1: 5

Holotypus: KoMo 1988 I-3/IV-55, Kozur & Mostler 1989, Pl. 1: 5

Stratum typicum: Sample 12 D, light coloured, ammonoid-bearing limestone with *Mesogondolella siciliensis*, Wordian, Permian.

Locus typicus: Rupe del Passo di Burgio, Sosio Valley, Sicily.

Occurrence: Only typical occurrence.

Protocaudina Croneis, 1932

Species typica: *Cheirodota* (?) *traquairii* Etheridge, 1881

Emended diagnosis: As for the typical species.

Remarks: In 1881 Etheridge described small, circular sclerites, as holothurian remains of the new species *Cheirodota* (?) *traquairii.* Subsequently Croneis designs the species as the type of his newly erected genus *Protocaudina* (Croneis In: Croneis & Mc Cormack 1932). For years various authors described new species of *Protocaudina* (see below). However, as it has been demonstrated by Gilliland (1993) only the type species of *Protocaudina* is based on ophiocistioid sclerites. At the original illustration of Etheridge the type specimen is presented from one side only, on the opposite side, however, there is a characteristic, and diagnostic ventral button (cf. Gilliland 1993). *Protocaudina* is very close to *Microantyx* Kornicker & Imbrie, 1958, it differs from the latter by number of marginal pores and development of central zone. Most probably the specimen illustrated by Sandberg & Gutschick (1984) from the Early Carboniferous of Utah, and assigned to holothurian species *Rota campbelli*, is also a sclerite of ophiocistioid *Protocaudina.*

Protocaudina traquairii (Etheridge, 1881)

1881. *Cheirodota* (?) *Traquairii*, Sp. nova; Etheridge, p. 194, Pl. 6: 1.
1901. *Chiridota traquairi* (Etheridge); Smith, p. 509.
non 1930. *Laetmophasma* (?) *kansaenis* sp. n.; Hanna, p. 413-414, Pl. 40: 1-7.
non 1932. *Protocaudina traquairii* (Etheridge); Croneis & Mc Cormack, p. 137-138, Pl. 20: 1, 3-5, 7-11, 14-17, 22-24, 26, 28.
1932. *Protocaudina traquairii* (Etheridge); Croneis & Mc Cormack, p. 137, Pl. 18: 43.
1955. *Protocaudina traquairii* (Etheridge); Frizzell & Exline, p. 138-139, Pl. 8: 15.
1993. *Cheirodota* (?) *traquairii* (Etheridge); Gilliland, p.97-99.
1993. *Cheiridota* (= *Protocaudina*) *traquairii* (Etheridge); Gilliland, Pl. 11: 1-2.

Holotypus: Etheridge 1881: Pl. 6: 1.

Stratum typicum: Lower Carboniferous, shales within the Calderwood limestones.

Locus typicus: Woodend quarry, near Fordel, Fife, Lanarkshire, Scotland.

Emended diagnosis: Small sclerites from the body wall of Ophiocistioidea, oval in outline. Corners of a star-shaped hub pass into gradually narrowing spokes. Four pores of the central zone are of triangular shape. The arches cross with each other perpendicularly, with an additional bar at place of intersection. In the marginal zone there are 8 oval marginal pores. The ring of wheel is narrow; ventral button is small.

Remarks: The sclerites under consideration are undoubtedly elements of the ophiocistioid sklerotome, what was already indicated by Gilliland (1993). This is confirmed not only by morphology of these elements but also by their very small size. The latter author noted, that taxonomical revision of these fossils is necessary, if not for any other reasons then to correct the situation, when *Cheirodota traquairii* Etheridge, 1881 is designed as the type species of a holothurian *Protocaudina*. Indeed, the species is very similar to some *Rotasaccus* and *Microantyx* but number of marginal pores and development of central zone of the sclerite allow to classify it to *Protocaudina* only. Various authors ascribed to this species various specimens collected outside Great Britain. In my opinion, the specimens from type area, Scotland, are so far the only certain occurrence. One source of possible errors is a practice of illustrating of specimens from one side only; therefore the specimens from North America and Germany (Croneis & McCormack 1932; Frizzell & Exline 1955) are in need of restudy. The specimen of Lane (1976), on the other hand, is with quite different structure and resembles *Microantyx.*

Occurrence: Early Carboniferous: shales within the Calderwood limestones, Woodend quarry, near Fordel, Fife; Limekilns near East Kilbride, Lanarkshire, Scotland. Late Carboniferous: shales within the Orchad limestones, Orchad quarry near Glasgow, Scotland.

***Protocaudina botoni* (Gutschick, 1959)**

1959. *Microantyx botoni* n. sp.; Gutschick, p. 134-135, Pl. 26: 22, 23, 28, 29; Text-fig. 3.
1966. *Microantyx botoni* Gutschick; Frizzell & Exline, p. U668, Text-fig. 527.2.
1967. *Microantyx botoni* Gutschick; Gutschick, Canis & Brill, p. 1472-1473, Pl. 186: 41-51; 187: 16.
non 1971. *Microantyx botoni* Gutschick; Alexandrowicz, p. 288-289, Text-fig. 2: 3-4.
non 1971d. *Microantyx botoni* Gutschick; Mostler, p. 10, Pl. 2: 16, 17.
non 1975. *Microantyx botoni* Gutschick; Nabavi & Hamdi, p. 14-15, Pl. 3: 1-4.
non 1976. *Microantyx botoni* Gutschick; Mostler & Rahimi-Yazd, p. 22, Pl. 1: 1-5, 7, 11.
non 1976. *Microantyx* cf *botoni* Gutschick; Mostler & Rahimi-Yazd, Pl. 1: 6.
1985. *Microantyx botoni* Gutschick; Ding, p. 344, Pl. I: 12, 13, 16; Text-fig. 4.

Holotypus: USNM 137039, Gutschick 1959: Pl. 26: 28, 29.

Stratum typicum: Tournaisian, *Siphonodella isorticka* Zone.

Locus typicus: Rockford Limestone, Jasper County, Indiana.

Remarks.- Most probably the sclerites assigned to this species in reality represent sklerotomes of various species. The Chinese specimens (Ding 1985) are poorly illustrated, what hinders comparisons. Those from the Carboniferous of Poland (Alexandrowicz 1971 - Namurian A: marine band Barbara, Jaworzno, Upper Silesia) possibly represent a new species, more closely related to *Protocaudina dulcis* sp. n. then to the present species. The species from Silesia is with button-shaped ventral button, different is width of its marginal ring and outline of sclerite. Also the specimens from Montana (Gutschick *et al.* 1967) display some variation when compared with the type material. So far as it can be deduced from the published illustrations the cross formed of arches at the central zone distinctly protrudes towards exterior, forming ornamentation of a sort. Specimens of Mostler (1971d) from the Early Carboniferous of Hindukush (Afghanistan) and Mostler & Rahimi-Yazd (1976) from Late Permian of Iran, represent another species.

Occurrence: Tournaisian: Rockford Limestones, Jasper County, Indiana; Lodgepole, Allan Mountain, Missouri; Guangdong and Shaodong Formations, Hunan, China (?). Visean: Shidengzi Formation, Hunan, China (?). Late Carboniferous: Taiyuan Formation, Henan, China (?).

***Protocaudina sosioensis* (Kozur & Mostler, 1989)**

1989. *Microantyx sosioensis* n. sp.; Kozur & Mostler, p. 638, Pl. 1: 1, 2.
1989. *Microantyx pseudobotoni* n. sp.; Kozur & Mostler, p. 639, Pl. 1: 3, 4.

Holotypus: KoMo 1988 I/1/IV-55a, Kozur & Mostler 1989: Pl. 1: 1.

Stratum typicum: Sample 12 D, light coloured, ammonoid-bearing limestone with *Mesogondolella siciliensis,* Wordian, Permian.

Locus typicus: Rupe del Passo di Burgio, Sosio Valley, Sicily.

Remarks: The sclerites assigned to *Microantyx pseudobotoni* Kozur & Mostler, 1989 represent various sklerotomes of one species, rim is quite round or undulated. Both the species were found at the same locality.

Occurrence: Only typical occurrence.

***Protocaudina tarazi* (Mostler & Rahimi-Yazd, 1976)**

1976. *Microantyx tarazii* Mostler & Rahimi-Yazd; Mostler & Rahimi-Yazd, p. 22-23, Pl. 1: 10.

Holotypus: Mostler & Rahimi-Yazd, 1976: Pl. 1: 10.

Stratum typicum: Rote, Paratirolites beds, Late Permian.

Locus typicus: Dzhulfa, Kuh-e-Ali Bashi, North Iran.

Remarks: The sclerites are similar to *Protocaudina botoni* (Gutschick, 1959) but rim is undulated.

Occurrence: Only typical occurrence.

Class *HOLOTHURIOIDEA* de Blainville, 1834
Order *DENDROCHIROTIDA* Grube, 1840.
Family *CUCUMARIIDAE* Ludwig, 1894 emend. Pawson & Fell, 1965.
Subfamily *STAUROCAUDININAE* subfam. n.

Diagnosis: Oval sclerites with distinctly outlined central and marginal zones. At the center there are usually 3 to 4 pores (rarely also another number of them). Marginal zone is perforated by pores, arranged in a ring and delimited from the central pores by the hub. Marginal edge of the girdle and/or pore margins are with fine toothlets or spaghetti-like outgrowths, what is a peculiar feature of the family.

Staurocaudina gen. n.

Species typica: *Staurocaudina canina* sp. n. (Boczarowski in press)

Deriviato nominis: similar to the living genus *Staurocucumis*.

Diagnosis: Sclerites typically are with 4 pores in their centres and fine toothlets at the pore margins.

Staurocaudina khadirensis (Soodan, 1977)

1977. *Protocaudina khadirensis* sp. nov.; Soodan, p. 181-182, Pl. 1: 1, 2.
1977. *Protocaudina elliptica* sp. nov.; Soodan, p. 181, Pl. 1: 3, 4.

Holotypus: I.P.E./H04/04/186, Soodan 1977: Pl.1:1, 2.

Stratum typicum: Callovian (?), lower part of Khadir Formation.

Locus typicus: Khadir Island, Kutch, India.

Remarks: *Protocaudina elliptica* is only a morphological variety, only slightly differing from the species described herein (*S. khadirensis*). Classification of both species of Soodan (1977) to the same genus is justified by presence of the delicate indentation of the ventral edge. Moreover, both the species were found at the same localities.

Occurrence: Only typical occurrence.

Staurocaudina mortenseni (Deflandre - Rigaud, 1946)

1946. *Protocaudina mortenseni* Deflandre-Rigaud; Deflandre -Rigaud, p. 514, Text-fig. 1-2.
1952. *Protocaudina mortenseni* Deflandre-Rigaud; Deflandre -Rigaud p. 6.
1953. *Protocaudina mortenseni* Deflandre-Rigaud; Deflandre - Rigaud, p. 954, Text-fig. 14.
1955. *Protocaudina mortenseni* Deflandre-Rigaud; Frizzell & Exline, p. 39, 58, 138, Pl. VIII: 13, 14.
1962. *Protocaudina mortenseni* Deflandre-Rigaud; Deflandre -Rigaud: 98, Pl. III: 1, 2; Text-fig. 148, 149.
1962. *Protocaudina paucispinosa* cent. nov. vel parasp. nov.; Deflandre-Rigaud, p. 98, Pl. III: 3; Text-fig. 145.
1966. "*Protocaudina*" *mortenseni* Deflandre-Rigaud; Frizzell & Exline, p. U668, Text-fig. 527.1d.
1966. "*Protocaudina*" *paucispinosa* Deflandre-Rigaud; Frizzell & Exline, p. U668.
non 1992. *Protocaudina mortenseni* Deflandre-Rigaud; Lipiec, p. 442-443, Pl. II: 3, 4.

Holotypus: AM 8, (1962) Deflandre-Rigaud 1946: Pl. III: 1, Text-fig. 149.

Stratum typicum: Oxfordian.

Locus typicus: Villers-sur-Mer, Calvados, France.

Remarks.- *Protocaudina paucispinosa* seems to be a typical morphological variety, from the holotype it differs by simplified structure and most probably is a juvenile specimen.

Frizzell & Exline (1955) present the totally changed version of the original, as noted by Deflandre-Rigaud (1962). As the first illustrations and description of the species were given by Deflandre-Rigaud (1946) and repeated in 1962 this settles the question of priority, contrary to opinions of Frizzell & Exline (1966) who believe the name appears for the first time in the thesis of Deflandre-Rigaud of 1961 and in a paper of 1962.

Jurassic specimens from the Tatra Mts. of Lipiec (1992) differ from the type material by development of the central area, details of indentation of ventral space on the sclerite's girdle, its degree of convexity and the width of spokes. Denticles of the girdle in the French material are triangular, relatively large, rarely and unevenly distributed at the girdle (3-5), they do not form a continuous crenulation. Moreover, the arches, separating the central pores are in a form of convex rolls, provided with outgrowths, diagnostic for the species, also in the opinion of Lipiec (1992). The principal difference in relation to the other specimens is in clear separation of bars of the central cross and in presence of the 2 smaller pores along the longer axis and, respectively, 2 larger ones at the shorter axis in the type material. The Polish specimens are with the opposite relationships so they mast represent a new species. Excluded must be also identity with the types of *Palaeocaudina rigaudae* and its younger synonyms (Kozur & Mock 1972, 1974).

Occurrence: Only typical occurrence.

Staurocaudina rigaudae (Mostler, 1970)

1970. *Protocaudina rigaudae* n. sp.; Mostler, p. 352, Taf. 3: 5, 6.
non 1972. *Protocaudina rigaudae* Mostler; Kozur & Mock, p. 10, Taf. IV: 8-10.
non 1974. *Protocaudina rigaudae* Mostler; Kozur & Mock, p. Taf. II: 22, 23.

Holotypus: Mostler 1970: Taf. 3: 6.

Stratum typicum: Carnian, K 19, Salzkammergut.

Locus typicus: Raschberg, Alps, Austria.

Remarks.- Specimens from the Slovak Republic (Kozur & Mock 1972, 1974), though also Carnian in age are clearly different from the type material. The Austrian specimens are with different central region: pores are here of uniform size, symmetrically arranged, bars of the arches are thin. In the Slovak material the pores are also of uniform size, but 2 of them are much closer to each other, therefore shorter and longer axis can be distinguished. The central pores in the type material are proportionally larger then by the Slovak specimens. Also the external margin surrounding these pores as seen from the interior of the sclerite (cf. Mostler 1970) forms a continuous serrated edge what differs *Palaeocaudina rigaudae* from all the species described so far. Additional, less important differences are in number of marginal pores, typically 10-12, in Slovak material 8-10, as can be judged from the illustrations. Specimens of Kozur & Mock (1972, 1974) are with crenulation fully surrounding the borders of the marginal pores. In light of this comparison the Slovak material must represent another species.

Occurrence: Only typical occurrence.

***Mercedescaudina* Schallreuter, 1975**

Species typica: *Protocaudina triperforata* Schallreuter, 1968.

Diagnosis: As for the typical species.

Remarks: Due to fundamental differences between the type material and *Palaeocaudina* gen. n. the genus *Mercedescaudina* is to be retained.

***Mercedescaudina triperforata* (Schallreuter, 1968)**

1968. *Protocaudina triperforata* sp. n.; Schallreuter, p. 523-528, Text-fig. 1: 1-16; 2: 1-17.
non 1972. *Eocaudina* cf. *triperforata* (Schallreuter); Mostler, p. 19, Taf. 2: 15-17.
non 1991. *Protocaudina triperforata* Schallreuter; Langer, p. 46, Taf. 8: 1-4.

Holotypus: Schallreuter 1968: Text-fig. 1: 1.

Stratum typicum: Middle Ordovician, Backsteinkalk type 1B1 (erratic).

Locus typicus: Hiddensee Island, Baltic Sea, Germany.

Occurrence: Only typical occurrence.

***Mercedescaudina mostleri* Schallreuter, 1975**

1975. *Mercedescaudina mostleri* sp. n.; Schallreuter, p. 728-732, Text-fig 1: 1-4.

Holotypus: Schallreuter 1975: Text-fig. 1: 3.

Stratum typicum: Ashgill, Öjlemyrgeschiebe, Borkholmer Stufe (F) 21/3.

Locus typicus: island of Gotland, Baltic Sea, Sweden.

Occurrence: Only typical occurrence.

Order *ELASIPODA* Théel, 1882
Family *PALAEOCAUDINIDAE* fam. n.

***Palaeocaudina* gen. n.**

Species typica: *Protocaudina hexagonaria* Martin, 1952 emend. Gutschick & Canis, 1971.

Deriviato nominis: (Gr.) παλαιος - ancient.

Diagnosis: Sclerites with the central pore cross have contained four pores, none and marginal girdle have had no indentation on the edge.

Remarks: The type species of *Protocaudina* Croneis, 1932 (*Cheirodota* ? *traquairii* Etheridge, 1881) is an element of the ophiocistioid sklerotome. Therefore for *Palaeocaudina* gen. n. a new type species has been selected, the oldest described and more fully describing features of the genus than *Palaeocaudina regia* sp. n.

***Palaeocaudina hexagonaria* (Martin, 1952 emend. Gutschick & Canis, 1971)**

non 1952. *Protocaudina hexagonaria* Martin, n. sp.; Martin, p. 728, Text-fig. 1.
non 1955. *Protocaudina hexagonaria* Martin; Frizzell & Exline, p. 137, Pl. 8: 12.
non 1966. *Protocaudina hexagonaria* Martin; Frizzell & Exline, p. 668, Text-fig. 527: 1c.
1971. *Protocaudina hexagonaria* Martin; Gutschick & Canis, p. 335-336 (partim), Pl. 47: 3, 6-13 (non fig. 2); 48: 1-14; Text-fig. 4.
non 1976. *Protocaudina hexagonaria* Martin; Kozur, Mock & Mostler, p. 13, Taf 1, fig. 3.

Neotypus: UND 461, Gutschick & Canis 1971: Pl. 47: 3, 6, 7.

Stratum typicum: Middle Devonian, Solon member of Cedar Valley Formation.

Locus typicus: Shellsburg-Urbana Bridge quarry, Winthrop Quadrangle, Benton County, near Urbana, Iowa.

Occurrence: Middle Devonian: Solon Member of Cedar Valley Formation, Shellsburg-Urbana Bridge quarry, Winthrop Quadrangle, Benton County, near Urbana, Iowa.

***Palaeocaudina acmaea* (Matyja, 1972)**

1972. *Protocaudina acmaea* sp. n.; Matyja, p. 243-244, Text-fig. 12: a-d.

Holotypus: Matyja 1972: Text-fig. 12a, b.

Stratum typicum: Oxfordian, ammonite zone *Gregoryceras transversarium*, subzone *Perisphinctes bifurcatus*.

Locus typicus: Tokarnia, near Kielce, Holy Cross Mts.

Remarks: Shape of the pores and their distribution are most unlike in the type species; on the other hand there is no doubt it is still a representative of *Palaeocaudina* gen. n.

Occurrence.- Only typical occurrence.

***Palaeocaudina hannai* (Croneis, 1932)**

1932. *Protocaudina traquairii* (Etheridge); Croneis & Mc Cormack, p. 137-138, Pl. 20: 1, 3-5, 7-11, 14, 16-17, 23-24, 26, 28 (non fig. 15).

1932. *Protocaudina hannai* Croneis, n. sp.; Croneis in Croneis & Mc Cormack, p. 139, Pl. 20: 25, 27.
1952. *Protocaudina hannai* Croneis; Deflandre-Rigaud, p. 6.
1955. *Protocaudina hannai* Croneis; Frizzell & Exline, p. 136-137, Pl. 8: 11.

Lectotypus: Croneis 1932: Pl. 20: 27.

Stratum typicum: Lower Carboniferous, Paint Creek Formation.

Locus typicus: Illinois.

Remarks: Croneis (1932) part of his specimens of *Protocaudina* assigned to *P. traquairii*, a species which, as it has been demonstrated are sclerites from the body wall of the ophiocistioid (cf. Gilliland 1993). Also part of this material is conspecific with *Palaeocaudina hannai* (Croneis 1932: Pl. 20: 15, 16, 22, 23, 28) more so that it was collected also in the Paint Creek Formation.

Occurrence: Early Carboniferous: Paint Creek Formation, Randolf County; St. Clair County, Illinois.

***Palaeocaudina herrigi* (Reich, 1995)**

1995. *Protocaudina herrigi n. parasp.*; Reich, p. 683-685, Text-figs 1-4.

Holotypus: FGWG 109/2, Reich 1995: Text-figs 2-4.

Stratum typicum: The latest Maastrichtian, Late Cretaceuos.

Locus typicus: Zarrenthin limestones, Jarmen, N Germany, sample Zarrenthin 3/1.90.

Occurrence: Only typical occurrence.

***Palaeocaudina kansasensis* (Hanna, 1930)**

1930. *Laetmophasma ? kansasensis* Hanna, n. sp.; Hanna, p. 413-414, Pl. 40: 1-7.
1932. *Protocaudina traquairii* (Etheridge); Croneis & Mc Cormack, p. 137-138, Pl. 20: 15 (non fig. 1, 3-5, 7-11, 14, 16-17, 23-24, 26, 28).
1932. *Protocaudina kansasensis* (Hanna); Croneis in: Croneis & Mc Cormack, p. 138-139, Pl. 20: 2, 6.
1935. *Protocaudina kansasensis* (Hanna); Bailey, p. 496, Pl. 55: 18-20.
1952. *Protocaudina kansasensis* (Hanna): Deflandre-Rigaud, p. 6.
1955. *Protocaudina kansasensis* (Hanna); Frizzell & Exline, p. 137-138, Pl. 8: 16.
1966. *Protocaudina kansasensis* (Hanna); Frizzell & Exline, p. 668, Text-fig. 527: 1b.

non 1971. *Protocaudina kansasensis* (Hanna); Alexandrowicz, p. 284-288, Text-fig. 2: 1 a-c, 2 a-c.

non 1976. *Protocaudina* cf. *kansasensis* (Hanna); Mostler & Rahimi-Yazd, p. 23, Pl. 1: 9, 12.

Lectotypus: Hanna 1930: Pl. 40: 7.

Stratum typicum: Permian, limestones in Elmdale shales, Wabaunesee Formation.

Locus typicus: Elmdale, Kansas.

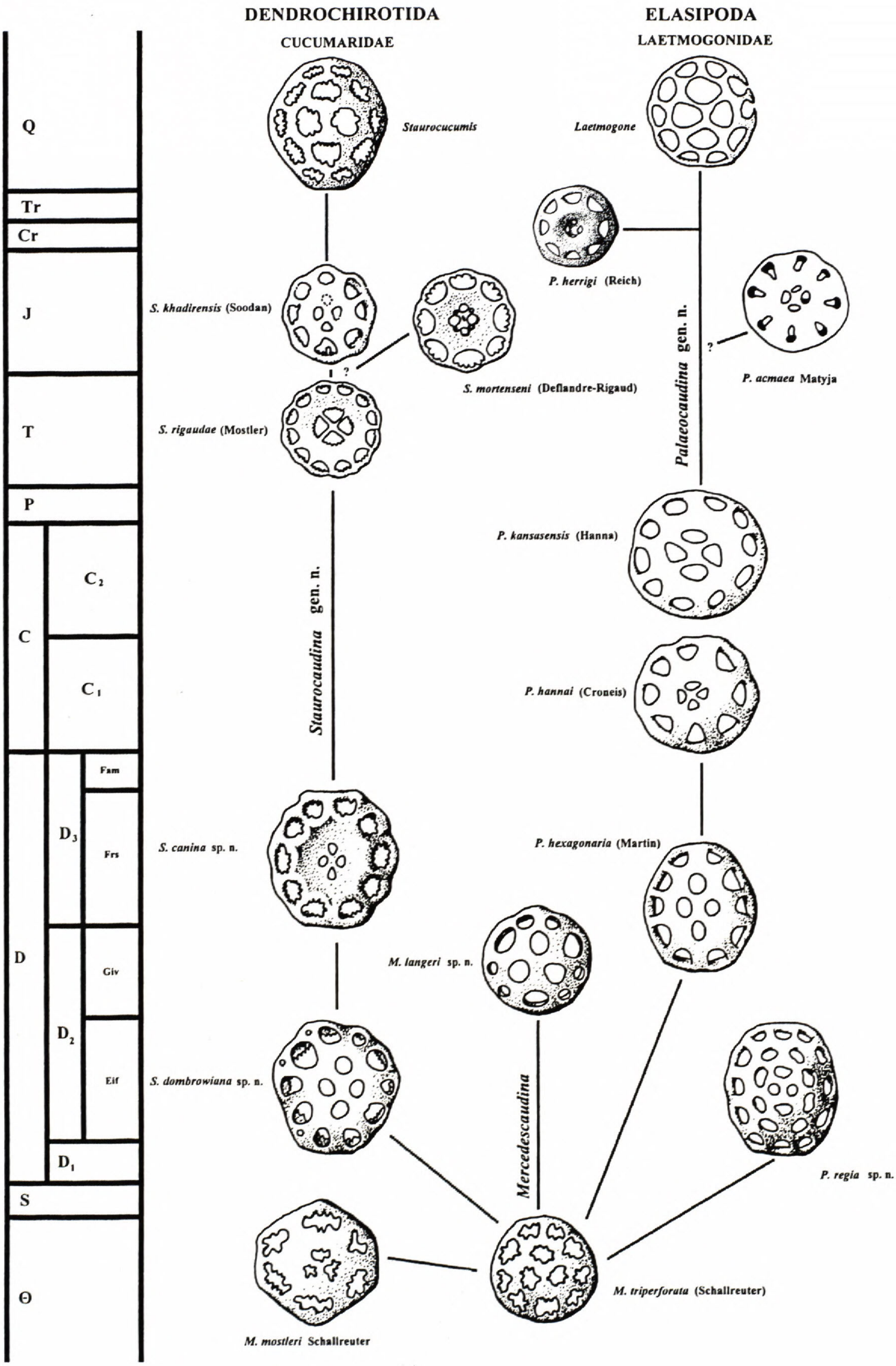
Remarks: Part of the material of Croneis (1932), other than *Protocaudina hannai* seems to represent *Palaeocaudina kansasensis* (Croneis - Pl. 20: 1, 3-5, 7-11, 14, 17, 24, 26) known also from the Pennsylvanian of Texas. Specimens of Mostler & Rahimi-Yazd (1976) described as *Protocaudina* cf. *kansasensis* (Hanna) represent different species.

Occurrence: Late Carboniferous, Pennsylvanian: Cherokee Group, Missouri; Texas. Permian: limestones in Elmdale shales, Wabaunesee Formation, Elmdale, Kansas.

Conclusions

The sclerites from the body wall are wheel-shaped, similarly as by some holothuroids (e.g. Chiridotidae). On the other hand the skeletal bodies from tube-feet are similar to perforate plates - elements typical also of the Holothurioidea. These similarities were possibly the reason so many authors confused the sclerotomes of Holothurioidea and Ophiocistioidea. Below revised are the formerly described species of the genera *Microantyx* and *Protocaudina*.

There are two independent lineages within *Palaeocaudina* gen. n. (Text-fig. 1; Boczarowski in press), linking it with ancestral *Mercedescaudina* Schallreuter, 1975 (Text-fig. 1). One of the lineages goes to the Cucumariidae; it is among the living representatives of the latter (e.g. *Staurocucumis* Ekman, 1927) where sclerites of the same type can be found. The most primitive descendant of *Mercedescaudina* is *Staurocaudina dombrowiana* sp. n. (Text-fig. 1; Boczarowski in press); its ancestors might occur in the Lower Devonian or Silurian. The suggested affinities of *Mercedescaudina* with ophiocistioids (Gilliland 1993) is apparent. The latter display the ventral convexity in their sclerites, from without they are covered by rods, forming quasi-pores, as by *Rotasaccus*, totally absent by *Mercedescaudina*. In the lineage under consideration one can observe simplification of structure of the sclerites. First reduced is duplication of the marginal girdle. Its indentation passes onto lateral margins of the pores. This is the important feature as it can be observed within the lineage for millions of years. *Staurocaudina mortenseni* displays some additional trends within the lineage, with central pores framed by a cross, in form of protruding rolls. *Mercedescaudina langeri* sp. n. is an element of a separate lineage that led to early formation of the palaeocaudinids. The modern Synaptidae also resemble by their plates to the wheels of *Mercedescaudina*. Examples are numerous, as *Leptosynapta* Verrill, 1867 and particularly *Opheodesoma* Fischer, 1907 and *Euapta* Oestergren, 1898 (cf. Cannon & Silver 1986; Cherbonnier 1951, 1953; 1955). According to investigations of Stricker (1985, 1986) during


DENDROCHIROTIDA
CUCUMARIDAE
ELASIPODA
LAETMOGONIDAE
Q
Tr
Cr
J
T
P
C
C2
C1
D
D3
Fam
Frs
Giv
D2
Eif
D1
S
Θ
Staurocucumis
Laetmogone
P. herrigi (Reich)
S. khadirensis (Soodan)
S. mortenseni (Deflandre-Rigaud)
P. acmaea Matyja
S. rigaudae (Mostler)
Palaeocaudina gen. n.
P. kansasensis (Hanna)
Staurocaudina gen. n.
P. hannai (Croneis)
S. canina sp. n.
P. hexagonaria (Martin)
M. langeri sp. n.
S. dombrowiana sp. n.
Mercedescaudina
P. regia sp. n.
M. triperforata (Schallreuter)
M. mostleri Schallreuter
?

growth of the anchor plate there occurs the stage closely similar to typical *Staurocaudina*. Possibly *Mercedescaudina* was the ancestor for numerous groups of holothurians.

Palaeocaudinidae fam. n. are derived from *Mercedescaudina* (Text-fig. 1). Majority of its species belongs to the single lineage up to extant Elasipoda. *Palaeocaudina regia* sp. n., though a typical form intermediate between *Palaeocaudina* gen. n. and the early *Eocaudina* is with all the diagnostic features of the genus and only with exceptionally high number of rings of the marginal pores shows some similarity with the latter genus. *Eocaudina* must have appeared earlier (Ordovician ?) than *Palaeocaudina* gen. n.. *Palaeocaudina regia* sp. n., is close to the common ancestor of these lineages. Unfortunately, though *Eocaudina* was with the skeleton in its tentacles no such elements can be connected with *Palaeocaudina* gen. n. Interesting is the case of *Palaeocaudina acmaea*, with differentiated sclerites and the conservative Bauplan. The most striking similarities with *Palaeocaudina* gen. n. can be found among Elasipoda; in the family Laetmogonidae e.g. *Bathygone* Pawson, 1965; *Laetmogone* Théel, 1882 or even Deimatidae (cf. Ludwig 1894; Mitsukuri 1912; Pawson 1965).

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Fig. 1. Proposed phylogeny of the families Cucumariidae and Laetmogonidae.

Figures of *Mercedescaudina mostleri* after Schallreuter (1975), *Mercedescaudina triperforata* after Schallreuter (1968), *Staurocaudina rigaudae* after Mostler (1970), *Staurocaudina mortenseni* after Deflandre-Rigaud (1946, 1962), *Staurocaudina khadirensis* after Soodan (1977), *Staurocucumis* after Ekman (1927), *Palaeocaudina hexagonaria* after Gutschick and Canis (1971), *Palaeocaudina hannai* after Croneis & Mc Cormack (1932), *Palaeocaudina kansasensis* after Hanna (1930), Frizzell & Exline (1966), *Palaeocaudina acmaea* after Matyja (1972), *Palaeocaudina herrigi* after Reich (1995) and *Laetmogone* after Mitsukuri (1912).

Not to scale.

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