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LADINIAN (MIDDLE TRIASSIC) SILICIFIED OSTRACOD FAUNAS FROM THE BALATON HIGHLAND (HUNGARY)

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Abstract. Uniquely preserved and diverse ostracod faunas from Middle Triassic (Ladinian) beds of the Balaton Highland (Hungary) are described and figured. The preservation is due to silicification of fine texture of the carapaces and valves providing high quality data for taxonomical analyses. The benthic faunas from three localities (Litér, Felsőörs and Nemesvámos) consist of 28 taxa belonging to 12 genera. Four species are new: *Polycope arcuatocosta* n. sp., *P. densoreticulata* n. sp., *Ptychobairdia tenuiornata* n. sp. and *Praemacrocypris literense* n. sp. Based on morphological and ecological characteristics the studied benthic ostracod assemblages are the latest occurrences of the Thuringian-type assemblages *sensu* Becker. The dominance of the Thuringian-type elements, smooth bairdiaceans and metacopids indicates an open marine, more than 200 m deep, oligotrophic, bathyal environment with low energy conditions.

Riassunto. Viene descritta e figurata una fauna ad ostracodi ottimamente conservata e con notevole diversità proveniene da livelli ladinici (Triassico Medio) della regione del Balaton (Ungheria). La silicizzazione di fini tessiture del carapace e delle valve fornisce dati di elevata qualità per l'analisi tassonomica. La fauna bentonica proveniente da tre località (Litér, Felsőörs and Nemesvámos) consiste di 28 taxa appartenenti a 12 generi. Quattro specie sono nuove: *Polycope arcuatocosta* n. sp., *P. densoreticulata* n. sp., *Ptychobairdia tenuiornata* n. sp. and *Praemacrocypris literense* n. sp. Sulla base delle caratteristiche morfologiche ed ecologiche, la fauna studiata rappresenta l'associazione di tipo Thuringiano (*sensu* Becker) più recente. La prevalenza di elementi di tipo Thuringico, con Bairdiacee lisce e Metacopidi, indica un ambiente marino aperto di profondità superiore ai 200 m, oligotrofico, con condizioni di bassa energia.

Introduction

The knowledge about the Middle Triassic ostracod faunas are very incomplete (e.g. Crasquin-Soleau & Gradinaru 1996; Kozur 1970a; Kristan-Tollmann 1991), practically there are no data about Ladinian ones.

First descriptions and illustrations of Triassic ostracods from Hungary were published by Méhes (1911). His taxonomic work including many new taxa was an important step in the recognition of Triassic ostracods. From the Balaton Highland, further studies have been made by Bunza & Kozur (1971), Kozur (1970a,

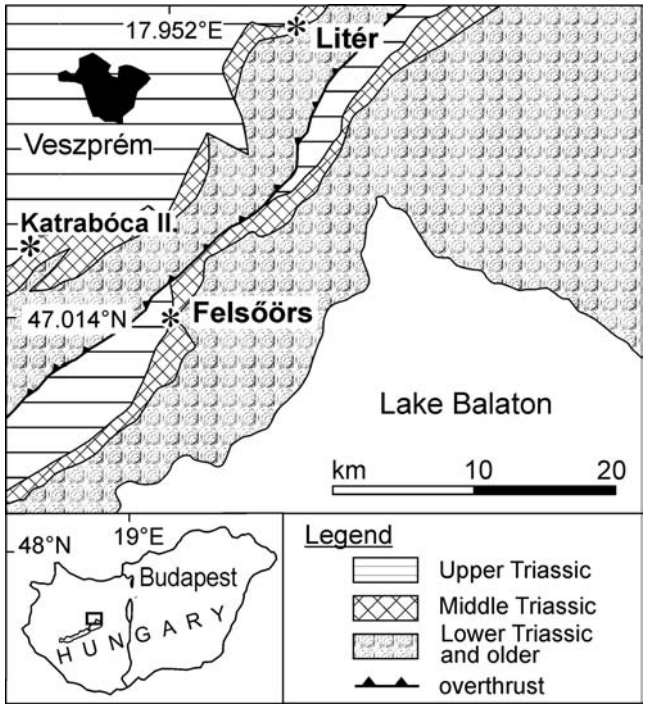

Fig. 1 - Location of the studied sections in a simplified geological map of the northeastern Balaton Highland and the Veszprém Plateau (modified after Pálfy et al. 2003).

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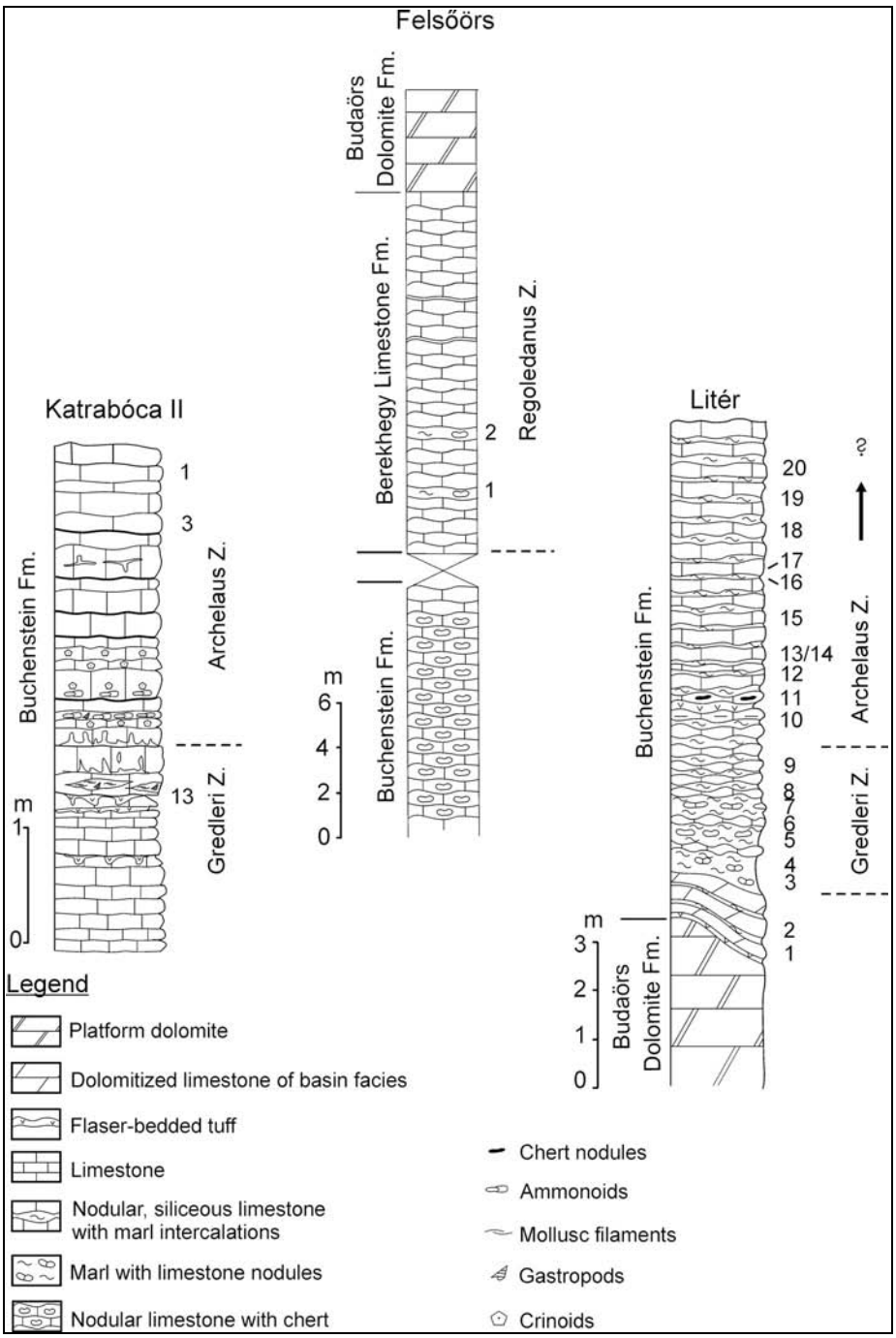


Fig. 2 - Lithologic columns of the Litér quarry, Felsőörs and Katrabóca II sections representing the Upper Ladinian sequence of the northeastern Balaton Highland. Biostratigraphic subdivisions based on the occurrences of the age-diagnostic ammonoid taxa (modified after Vörös 1998 and Budai and Vörös 2006).

1971abc, 1972b) and Monostori (1991, 1995) about Anisian, by Széles (1965), Bunza & Kozur (1971), Kozur (1971c, 1972a) and Monostori (1994) about Carnian and by Kozur & Oravecz-Scheffer (1972) about Rhaetian ostracods. However, no study is available yet on Ladinian ostracods from Hungary. The main aim of the present paper is to give a detailed systematic description of Ladinian ostracods from Litér, Nemesvámos and Felsőörs. Moreover, a brief palaeoecological interpretation of the faunal composition is planned. Documentation of the exceptionally well preserved and diverse fauna from Litér can provide new data about the faunal changes of ostracods during the Early Mesozoic.

Geological setting and stratigraphy

The three localities are situated in the Balaton Highland, western Hungary, part of the Transdanubian Midmountains (Fig. 1). The Ladinian succession, from where most of the samples were obtained, is exposed in the western, abandoned part of the dolomite quarry near Litér, starting with a 10 m thick massive dolostone body, a tongue of the prograding Budaörs Dolomite (Budai et al. 2001; Vörös 1998). The Budaörs Dolomite is overlain by grey nodular siliceous limestone and marl of the Buchenstein Formation (section C on Fig. 2). The lowermost beds of the Buchenstein Formation contain

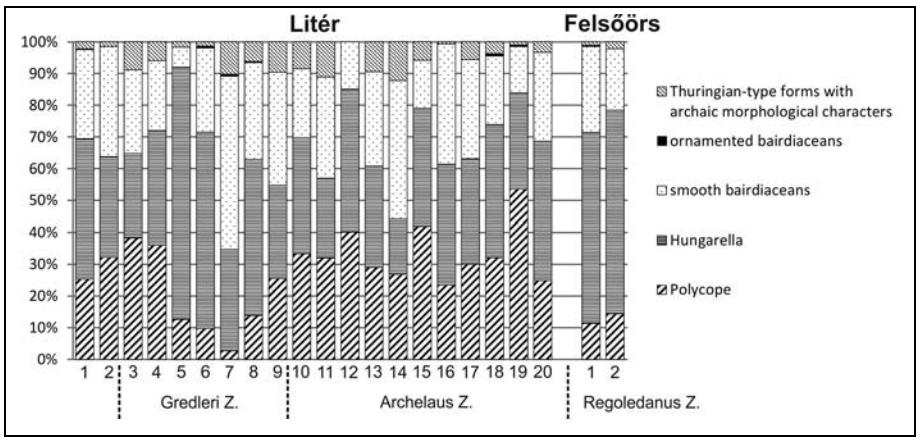


Fig. 3 - Distribution of different ostracod taxa and groups in Ladinian beds of Litér quarry and Felsőörs section.

tuffaceous marl and clay intercalations and yielded numerous ammonoids including Arcestidae and a specimen of *Protrachyceras* cf. *gredleri*, indicating the Gredleri Zone. The Archelaus Zone of the Upper Ladinian is recorded in the overlying beds by a specimen of *Protrachyceras ladinum* (Vörös 1998). A few layers (mainly in the lower part of the studied section) provided radiolarians in large quantity, suggesting Upper Ladinian age (middle Longobardian). Additional samples came from the Füred Limestone Formation of Felsőörs and from Nemesvámos (Katrabóca II section) (Fig. 1).

At Felsőörs (section B on Fig. 2) the Füred Limestone Formation is represented by the Berekhegy Limestone Member which consists of thin limestone beds and marl layers bearing the studied microfauna (Budai & Vörös 2006). This formation passes gradually into the Budaörs Dolomite platform carbonate with increasing number of dolostone interbeds. According to ammonite record (*Celtites epolensis*) the Berekhegy Limestone belongs to the Regoledanus Zone of the uppermost Ladinian (Budai & Vörös 2006).

The lower part of Katrabóca II section consists tuffitic, purplish-red micritic limestone beds overlain by massive crinoidal limestone with gastropod- and bivalve-bearing "lumachella" in lenticular bodies (Fig. 2). Upwards the sequence passes into thick-bedded light coloured micritic limestone with few ammonites and crinoid fragments. Due to the occurrence of *Protrachyceras gredleri* and the common *Arpadites* in the lower part, and of *P. archelaus, P. longobardicum* and *P. ladinum* in the upper part of the sequence, the section represents the Gredleri to Archelaus Zones of the Upper Ladinian (Vörös 1998). There are three thin tuffaceous horizons in the upper part of Gredleri Zone (Pálfy et al. 2003).

Material and methods

Twenty-five samples from the three above described sections were studied for their ostracod content (Fig. 1). For each sample (n= 20) from Litér quarry, about 500 g of air-dried silicified limestone was soaked in a dilute solution of chloridic and acetic acids to extract the siliceous and silicified skeletal material (ostracods, mollusc fragments, foraminifers, juvenile gastropods, embryonic ammonoids, sponge spicules and corroded radiolarians).

Five samples from limestones of the Katrabóca II section (Nemesvámos, n= 3) and Felsőörs (n= 2) were treated by acetolysis following a protocol originally worked out by Lethiers & Crasquin-Soleau (1988) with a slight modification to extract the carbonate skeletal microfauna. The acetolysis without heating produced very well preserved microfauna, but the duration of the extraction was longer (several weeks up to one month). The fine-scale textural silicification preserved the morphological features in details to provide high quality data for taxonomical analyses although in many cases, the minute features of calcareous ostracod carapaces or valves extracted from hard limestones by acetolyses cannot be studied. For the palaeoecological interpretation semi-quantitative analyses of the specimens of the different taxa or groups (percentage distribution) were made and drawn it in diagrams (except at Katrabóca II section because of the very low, unrepresentative number of the specimens) (Fig. 3).

Systematic palaeontology

Classification of the ostracods follows that of Becker (2000, 2001ab) and Martin & Davis (2001). The specimens are deposited in the Department of Palaeontology of Eötvös University and in the Eötvös Museum of Natural History (Budapest, Hungary). Abbreviations: L= length, H= height and d= diameter. Number of specimens (valves/carapaces) of the described taxa can be found in Tab. 1.

Class **Ostracoda** Latreille, 1802

Subclass **Myodocopa** Sars, 1866

Order **Halocyprida** Dana, 1853

Suborder **Cladocopina** Sars, 1866

Superfamily Polycopoidea Sars, 1866

Family Polycopidae Sars, 1866

Subfamily Polycopinae Sars, 1866

Genus *Polycope* Sars, 1866

Type species: *Polycope orbicularis* Sars, 1866

Polycope arcuatocosta n. sp.

Pl. 1, fig.1

1993 *Polycope cincinnata* Apostolescu – Harloff, pp. 158-159, pl. 14, fig. 4.

Locality	Katrabóca II			Litér quarry																			Felsőörs	
ammonite zones	Gredl.	Arch.		?		Gredleri							Archelaus										Regoledanus	
samples	13	3	1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	1	2
Polycope arcuatocosta n. sp.				1/0				1/0				1/0					2/0	1/0			1/0	2/0			
Polycope cincinnata				1/0	1/0								1/0									3/0			
Polycope densoreticulata n. sp.				13/0		1/0						4/0	5/0	2/0	4/0	3/0	4/0		1/0	2/0	3/0	2/0			
Polycope pelta	0/1	0/1	0/1	60/7	86/0	21/3	81/4	21/0	32/3	4/0	38/0	35/0	37/0	20/1	59/4	37/0	48/3	71/0	33/0	46/0	35/3	96/3	30/0	28/3	20/0
Polycope pumicosa schleferae						1/0											2/0				1/0				
Hungarella problematica	0/1	0/1	0/1	117/26	72/13	13/5	72/13	138/1	201/20	43/4	128/7	34/12	44/3	17/1	72/3	42/2	38/0	51/13	46/9	49/4	52/4	60/0	47/6	149/15	86/3
Acratia goemoeryi						1/0	1/0	1/0						3/0		1/0	4/0			1/0					
Bairdia (Urobairdia) angusta				9/0	19/1	4/3	5/4	2/0	18/3	9/0	8/6	4/0	5/0		3/0	8/2	6/0		9/4	8/3	14/5	5/2	5/0	5/1	
Bairdia (Urobairdia) austriaca				1/0	1/0			1/0	1/0	4/0	3/0			2/0			1/0		3/0	3/0	2/0		4/0	1/0	
Bairdia balatonica				13/2	38/6	0/1	5/3	2/0	35/13	35/6	20/5	28/8	0/2	2/3		5/3	49/5	18/5	18/0	7/0	13/0	8/4	13/5	22/0	17/0
Bairdia bicostata							1/0								1/0		1/0			1/0			1/0		
Bairdia cassiana	1/0			17/7	3/0	1/0	14/1		1/1	12/0	10/1	7/0	2/0	3/2	3/2	1/0	9/0	2/0	2/0	2/0	34/5	3/0		7/2	6/0
Bairdia (Urobairdia) lata				1/0		2/0		1/2				2/0	1/0		2/0						0/1				
Bairdia parvula					2/2	0/1	1/2			8/1	0/1	2/0			2/6	2/0	18/0		8/2	0/1	6/1		4/0	13/2	2/1
Bairdiacypris anisica			0/8	15/11	6/0	3/1	10/4	3/0	8/7	0/4	14/11	3/3	11/5	8/0	5/0	0/13	0/5		5/3		7/4	4/3	1/0	17/2	
Bairdiacypris mirautaae											3/0	1/0			1/0				1/0						
Bairdiacypris triassica	0/1	0/2	0/1	13/2	10/6	0/2	2/0		2/7	0/1		0/1	2/0	3/0		5/2	0/2	1/0		13/12	0/1		1/0	3/0	1/0
Ceratobairdia longispinosa											1/0														
Ptychobairdia ex gr. *lordi*																								1/0	
Ptychobairdia mostleri	0/4			1/0					2/0	0/1											1/0				
Ptychobairdia tenuiornata n. sp.										1/0	1/0											1/0			
Acanthoscapha bogschi				2/0	2/0	1/0	1/0		3/0	5/0	1/0	1/0	2/0	2/0		2/0	4/2	3/0	1/0	2/0	1/0	1/0		2/0	1/0
Acanthoscapha veghae				1/0	1/0		2/0			5/0	3/0	2/0	1/0			1/0	2/0	1/0				1/0			
Nagyella longispinosa						0/1	1/0				2/0	3/0	2/0	2/0		1/0	1/0			1/0	2/0		2/0		1/0
Spinocypris vulgaris				0/2				0/1				0/1	2/0												
Aglaiocypris? *aequalis*				0/1																					
Praemacrocypris literense n. sp.				0/1		1/0	1/0									3/1	1/2	0/1							
Praemacrocypris mocki				1/0	1/0	1/1	8/0	1/0	2/0	4/1	10/1	8/0	4/0	1/0		4/0	11/0	5/0		5/0	2/0		2/0	1/0	0/1

Tab. 1 - Quantitative data (valves/carapaces) of Ladinian ostracod taxa from each sample from the studied Katrabóca II, Litér quarry and Felsőörs sections. Abbreviations: Gredl.= Gredleri Zone, Arch.= Archelaus Zone.

1996 *Polycope cincinnata* Apostolescu – Beutler et al., pl. 8, fig. 20.

Derivatio nominis: After the strong semicircular arcs on the heavily reticulated valve.

Holotype: Right valve, Eötvös Museum of Natural History, EMNH 1.2011.2.5.5., figured pl. 1., fig. 1.

Locus typicus: Litér quarry, Hungary.

Stratum typicum: Bed 13/14, Upper Ladinian (Archelaus Zone).

Material: 9 valves.

Diagnosis: Strong reticulation with two crest-like semicircular costa.

Description. Circular valve in lateral view with strong reticulation, anteroventral and central distinct costa, and small central ribs on the valve surface, rostrum and rostral incisure weakly developed.

Dimensions. d= 0.41-0.53 mm.

Comparison. Ornamentation of the holotype is similar to that of *Polycope cincinnata* Apostolescu, 1959, but the latter species has many semicircular ribs instead of two well developed crests on the valve surface. The ornamentation of the specimens described by Harloff (1993) and Beutler et al. (1996) as *P. cincinnata* Apostolescu coincides in all details with that of *P. arcuatocosta*.

Occurences. Katrabóca II, Litér quarry (Hungary): Ladinian (this paper), NW-Germany: Early Pliensbachian (Beutler et al. 1996), SW-Germany: Early Pliensbachian (Harloff 1993).

Polycope cincinnata Apostolescu, 1959

Pl. 1, fig. 3

1959 *Polycope cincinnata* n. sp. – Apostolescu, pp. 801-802, pl. 1, fig. 2.

1967 *Polycope cincinnata* Apostolescu – Donze, p. 73, pl. 1, figs 7-8.

1970a *Polycopsis hungarica* n. sp. – Kozur, p. 407, pl. 3, fig. 12.

1971 *Polycopsis cincinnata* (Apostolescu) – Bunza & Kozur, p. 15, pl. 2, figs 10-11.

1972 *Polycope cincinnata* Apostolescu – Ulrichs, p. 696, pl. 4, fig. 13.

non 1975 *Polycope cincinnata* Apostolescu – Michelsen, p. 260, pl. 40, fig. 563.

1981 *Polycope cincinnata* Apostolescu – Herrig, pp. 680-681, text-fig. 2, pl. 3, figs 1-6.

1985 *Polycope cincinnata* Apostolescu – Donze, pl. 21, fig. 1.

1985 *Polycope cincinnata* Apostolescu – Riegraf, p. 71, pl. 1, fig. 6.

1986 *Polycope cincinata* Apostolescu – Fischer et al., p. 118, pl. 24, fig. 9.

non 1993 *Polycope cincinnata* Apostolescu – Harloff, pp. 158-159, pl. 14, fig. 4.

non 1996 *Polycope cincinnata* Apostolescu – Beutler et al., pl. 8, fig. 20.

1999 *Polycope cincinnata* Apostolescu – Arias & Lord, pp. 76-78, pl. 1, fig. 2.

2001 *Polycope cincinnata* Apostolescu – Beher et al., pp. 376-377, text-fig. 5.3.

Remarks. The reticulation pattern is very characteristic of this species with the parallel and concentrical ribs. The ornamentation of the specimen described and figured by Kozur (1970a) as *Polycopsis hungarica* coincides in all details with that of the studied specimens and the holotype described by Apostolescu (1959).

Dimensions. d= 0.39-0.43 mm.

Occurrences. Felsőörs: Anisian (Kozur 1970a), Litér quarry (Hungary): Ladinian (this paper), Kössen (Austria): Late Norian (Ulrichs 1972), Germany: Late Sinemurian to Early Toarcian (Herrig 1981; Riegraf 1985; Fischer et al. 1986; Beher et al. 2001), Paris Basin (France): Pliensbachian (Apostolescu 1959; Donze 1967, 1985), Spain: Early Toarcian (Arias & Lord 1999).

Polycope densoreticulata n. sp.

Pl. 1, figs 4-7

Derivatio nominis: After the density of the reticulation on the valve surface.

Holotype: Right valve, Eötvös Museum of National History, EMNH 1.2011.1.4.13., figured pl. 1., fig. 6.

Locus typicus: Litér quarry, Hungary.

Stratum typicum: Bed 1, Ladinian.

Material: 44 valves.

Diagnosis: Very characteristic ornamentation, dense reticulation in equable distribution on the valve surface.

Description. Valve circular in lateral view with very characteristic ornamentation: the valve surface densely reticulated with more or less distinct arched ribs. In the central part of the valve surface three distinct holes in triangular position. The rostrum and rostral incisure weakly developed.

Dimensions. d= 0.43-0.53 mm.

Comparison. *Polycope arcuatocosta* is similar to *P. cincinnata* but differs from the latter species in the more distinct ribs and less dense reticulation pattern.

Occurrences. Litér quarry (Hungary): Ladinian (this paper).

Polycope pelta Fischer, 1961

Pl. 1, figs 8-9

1961 *Polycope pelta* n. sp. – Fischer, pp. 499-500, text-fig. 1.

?1963 *Polycope pelta* Fischer – Plumhoff, pp. 17-18, pl. 1, figs 1-2.

1975 *Polycope pelta* Fischer – Michelsen, pp. 265-266, pl. 40, figs 570-573.

1981 *Polycope pelta* Fischer – Herrig, pp. 679-680, pl. 2, figs 1-5.

non 1983 *Polycope pelta* Fischer – Knitter, p. 217, pl. 34, fig. 3.

non 1984 *Polycope pelta* Fischer – Exton & Gradstein, pl. 2, fig. 13.

1985 *Polycope pelta* Fischer – Riegraf, p. 71, pl. 1, fig. 4.

1986 *Polycope pelta* Fischer – Fischer et al., p. 119, pl. 24, fig. 12.

1990 *Polycope pelta* Fischer – Brand, p. 142-143, pl. 1, fig. 1.

1992 *Polycope pelta* Fischer – Arias & Comas-Rengifo, p. 432, pl. 1, fig. 1.

1998 *Polycope pelta* Fischer – Andreu et al., p. 94, pl. 1, fig. 6.

1999 *Polycope pelta* Fischer – Arias & Lord, pp. 78-79, pl. 1, fig. 4.

Remarks. Circular outline in lateral view with slight ornamentation, valve surface smooth, sometimes with weakly reticulated peripheral parts. The strength of ornamentation of valve margins is probably linked to intraspecific variability.

Dimensions. d= 0.41-0.44 mm.

Occurrences. Litér quarry, Felsőörs, Katrabóca II (Hungary): Ladinian (this paper), Germany: Hettangian to Pliensbachian (Herrig 1981; Fischer 1962; Fischer et al. 1986; Riegraf 1985); Denmark: Late Sinemurian to Late Pliensbachian (Michelsen 1975); Aquitanian Basin, France: Pliensbachian (Andreu et al. 1998), Spain: Late Pliensbachian to Early Toarcian (Arias & Lord 1999; Arias & Comas-Rengifo 1992).

Polycope pumicosa schleferae Bunza & Kozur, 1971

Pl. 1, fig. 2

1971 *Polycope pumicosa schleferae* n. subsp. – Bunza & Kozur, p. 14, pl. 2, fig. 17.

1996 *Polycope* cf. *pumicosa schleferae* Kozur, 1971 – Crasquin-Soleau & Gradinaru, pl. 1, fig. 7.

Remarks. Strongly reticulated valve with densely arranged circular pits as described by Bunza & Kozur (1971).

Dimensions. d= 0.80-0.86 mm.

Occurrences. Dobrogea (Romania): Early Anisian (Crasquin-Soleau & Gradinaru 1996), Litér quarry (Hungary): Ladinian (this paper), Bakonyszűcs (Hungary): Early Carnian (Bunza & Kozur 1971).

Subclass **Podocopa** Müller, 1894

Order **Podocopida** Müller, 1894

Suborder **Metacopina** Sylvester-Bradley, 1961

Superfamily Healdiacea Harlton, 1933

Family Healdiidae Harlton, 1933

Subfamily Hungarellinae Kristan-Tollmann, 1971

Genus *Hungarella* Méhes, 1911

Type species: *Bairdia*? *problematica* Méhes, 1911

Hungarella problematica (Méhes, 1911)

Pl. 4, figs 14-17

1911 *Bairdia*? *problematica* n. sp. – Méhes, pp. 20-21, pl. 3, figs 14-18.

1911 *Bairdia problematica* var. *reniformis* Méhes – Méhes, p. 21, pl. 2, figs 19-23.

1965 *Hungarella problematica* (Méhes) – Széles, pp. 414-415, fig. 6.

1970a *Healdia (Healdia) felsoeoersensis* n. sp. – Kozur, p. 409, pl. 3, fig. 13, pl. 4, figs 1-6.

1970a *Healdia (Hungarella) reniformis* (Méhes) – Kozur, pp. 410-411, pl. 4, figs 15-17.

1995 *"Hungarella" felsooersensis* (Kozur) – Monostori, pp. 40-41, pl. 1, figs 2-4.

1996? *Healdia (Healdia) felsooersensis* Kozur – Crasquin-Soleau & Gradinaru, pl. 9, fig. 14.

Description. Lateral carapace outline subcircular due broadly rounded anterior and posterior margins; right with a slight angulation at the posterodorsal margin (sometimes with a little projection) which is observable posterodorsally on the right valve; ventral outline also broadly rounded; overlap of the left valve very variable. The generally well preserved hinge consists of three parts (wide anterior and posterior, narrow median part) which are densely crenulated. The carapace is more or less laterally compressed posteriorly, the posterior spine distinct, rarely absent. Sometimes there is a short anterior angular projection. The length/height ratio of the carapace is variable.

Remarks. The classification of Triassic elements within Healdiidae is controversial. For example, authors considered the mainly Triassic genus *Hungarella* as synonym of *Ogmoconcha* that is frequent in Jurassic beds (e. g. Bolz 1971). The assignment of the studied specimens at subfamily and genus level is based on the shape and arrangement of their muscle scars (Kristan-Tollmann 1979). The carapace outline of specimens described by Kozur as *Healdia (Healdia) felsoeoersensis* (Kozur 1970a) not differs significantly from that of studied specimens and the holotype of Méhes (1911). This difference can be considered as intraspecific variability.

Dimensions. L= 0.71-0.86 mm, H= 0.52-0.6 mm, L/H= 1.36-1.43.

Occurrences. Dobrogea (Romania): Early Anisian (Crasquin Soleau & Gradinaru 1996), Felsőörs, Katrabóca II, Litér quarry (Hungary): Ladinian (this paper), Felsőörs (Hungary): Anisian (Méhes 1911; Kozur 1970a; Monostori 1995), Nosztori Valley (Hungary): Late Carnian (Széles 1965).

Suborder **Podocopina** Sars, 1866

Superfamily Bairdioidea Sars, 1887

Family Bairdiidae Sars, 1887

Genus *Acratia* Delo, 1930

Type species: *Acratia typica* Delo, 1930

Acratia goemoeryi Kozur, 1970

Pl. 4, figs 1-2

1970a *Acratia goemoeryi* n. sp. – Kozur, p. 391, Pl. 3, figs 10-11.

1970a *Acratia triassica* n. sp. – Kozur, p. 390-391, Pl. 3, figs 1-5.

1971c *Acratina* sic *geoemoeryi* (Kozur) – Kozur, p. 11, fig. 1B,E.

1971c *Acratina goemoeryi jordani* n. ssp. – Kozur, p. 12, fig. 1C.

1971c *Acratina transita* n. sp. – Kozur, pp. 12-13, figs 1D,G,K.

1972b *Acratina goemoeryi* (Kozur) – Kozur, pl. 1, fig. 11.

1995 *Acratia* cf. *goemoeryi* Kozur – Monostori, p. 45.

1996 *Acratia goemoeryi* Kozur- Crasquin-Soleau & Gradinaru, pl. 7, figs 1-3.

2011 *Acratia goemoeryi* Kozur – Forel et al., p. 168, pl. 1, fig. 6.

Remarks. The specimens of the Litér material fit into the large variation of the species detected by Crasquin-Soleau & Gradinaru (1996) from Anisian beds of Romania. The stubbier carapace shape of specimens described by Kozur (1970a, 1971c) as *A. triassica* and *A. cratina transita* can be explained by sexual dimorphism. The males are often more elongate than females. In our opinion the subdivision of the species on subspecies level is not justified, being based on the small differences of carapace outline.

Dimensions. L= 0.96-1.06 mm, H= 0.29-0.34 mm, L/H= 3.31-3.11.

Occurrences. Greece, Austria, Slovakia, Hungary and Himalaya: Early Triassic (Kozur 1971c), South Tibet (China): Early Triassic (Spathian) to Middle Triassic (Anisian) (Forel et al. 2011), Dobrogea (Romania): Early Anisian (Crasquin Soleau & Gradinaru 1996), Felsőörs: Anisian (Kozur 1970a, 1972b; Monostori 1995), Litér quarry (Hungary): Ladinian (this paper).

Genus *Bairdia* McCoy, 1844

Type species: *Bairdia curta* McCoy, 1844

Bairdia (Urobairdia) angusta Kollmann, 1963

Pl. 1, figs 10-12

1963 *Urobairdia angusta* n. sp. – Kollmann, p. 167, pl. 6, figs 1-4.

1995 *Bairdia (Urobairdia) angusta recta* n. ssp. – Monostori, p. 43, pl. 3, figs 3-4.

1965 *Urobairdia angusta* Kollmann – Széles, p. 414, pl. 6, fig. 5.

2010 *Urobairdia angusta* Kollmann – Zorn, pp. 270-271, pl. 6, figs 12-15.

Remarks. Characteristic features are the trapezoidal dorsal margin and the narrow and pointed posterior end. In our opinion, the subdivision of the species on subspecies level is not justified based on the small differences of carapace outline.

Dimensions. L= 0.88-0.96 mm, H= 0.4-0.47 mm, L/H= 2.04-2.2.

Occurrences. Felsőörs (Hungary): Anisian (Monostori 1995), Felsőörs, Litér quarry (Hungary): Ladinian (this paper), Nosztori Valley (Hungary): Carnian (Széles 1965), Rossmoos (Austria): Late Norian (Kollmann 1963).

Bairdia (Urobairdia) austriaca (Kollmann, 1963)

Pl. 1, figs 13-14

1963 *Urobairdia austriaca* n. sp. – Kollmann, pp. 166-167, pl. 6, figs 5-8.

1971 *Bairdia austriaca* (Kollmann) – Bolz, pp. 144-148, pl. 2, figs 21-28, text-figs 5-7.

1971c *Bairdia austriaca csopakensis* n. ssp. – Kozur, pp. 3-4, fig. 2A.

1972b *Bairdia austriaca* (Kollmann) – Kozur, pl. 2, fig 4.

2010 *Urobairdia austriaca* Kollmann – Zorn, p. 270, pl. 6, figs 16-19.

Remarks. The specimens are characterized by a dorsal depression and granules on the valve surface. There are transitions from the typical form with arcuate posterior end to forms with a straight posterior end (e.g. the subspecies *Bairdia austriaca csopakensis* described by Kozur (1971c)). The juveniles have less distinct ornamentation than the adults. In our opinion the subdivision of the species on subspecies level is not justified based on the small differences of carapace outline.

Dimensions. L= 1.13-1.17 mm, H= 0.54-0.73 mm, L/H= 1.6-2.09.

Occurrences. Felsőörs, Litér quarry (Hungary): Ladinian (this paper), Nosztori quarry (Hungary): Early Carnian (Kozur 1971c), Northern Calcareous Alps, Zlambach Beds (Austria): Rhaetian (Kollmann 1963; Bolz 1971).

Bairdia balatonica Méhes, 1911

Pl. 2, figs 1-5

1911 *Bairdia balatonica* n. sp. – Méhes, pp. 13-14, pl. 1, figs 8-11.

1911 *Bairdia dadayi* n. sp. – Méhes, p. 17-18, pl. 1, figs 29-30.

1965 *Bairdia dadayi* Méhes – Széles, pp. 412-413, fig. 1.

1965 *Bairdia balatonica* Méhes, var. – Széles, p. 414, fig. 4.

1971 *Bairdia ventriosa* n. sp. – Bolz, pp. 158-161, pl. 4, figs 49-54, text-figs 14-15.

1978 *Bairdia* cf. *balatonica* Méhes – Kristan-Tollmann, p. 81, pl. 1, figs 1-3.

1995 *Bairdia balatonica* Méhes – Monostori, p. 42, pl. 2, figs 1-3.

Remarks. This is the most frequent species in the Transdanubian Middle Triassic beds. There are some variations in the elongation (stubby and more elongated specimens) and in the dorsal overlap with transitional forms. The stubbier forms were described by Méhes (1911) as *Bairdia dadayi* n. sp. Considering the variations of the lateral outline, the species *Bairdia dadayi* described by Méhes (1911) and *Bairdiacypris ventriosa* described by Bolz (1971) probably fit in this extended species.

Dimensions. L= 0.8-1.38 mm, H= 0.45-0.9 mm, L/H= 1.53-1.77.

Occurrences. Felsőörs Hill (Hungary): Anisian (Monostori 1995), Felsőörs, Litér quarry (Hungary): Ladinian (this paper), Southern Alps, Cassian Beds (Italy): Early Carnian (Kristan-Tollmann 1978), Nosztori Valley (Hungary): Carnian (Méhes 1911; Széles 1965), Northern Calcareous Alps, Zlambach Beds (Austria): Rhaetian (Bolz 1971).

Bairdia bicostata (Kristan-Tollmann, 1969)

Pl. 2, figs 6, 9

1969 *Parurobairdia bicostata* n. sp. – Kristan-Tollmann, p. 89, pl. 3, figs 6-8.

1971 *Bairdia bicostata* (Kristan-Tollmann) – Bolz, p. 149-150, pl. 2, figs 29-31.

Remarks. Characteristic features are the two dorsal weak ribs and the angular dorsal margin.

Dimensions. L= 1.25-1.35 mm, H= 0.58-0.77 mm, L/H= 1.75-2.15.

Occurrence. Litér quarry (Hungary): Ladinian (this paper), Southern Alps, Cassian Beds (Italy): Early Carnian (Kristan-Tollmann 1969), Northern Calcareous Alps, Zlambach Beds (Austria): Rhaetian (Bolz 1971).

Bairdia cassiana (Reuss, 1868)

Pl. 2, figs 7-8, 10

1868 *Cythere Cassiana* n. sp. – Reuss, p. 108.

1869 *Bairdia cassiana* (Reuss) – Gümbel, p. 180, pl. 5, figs 18-19.

1970 *Bairdia cassiana* (Reuss) – Ulrichs, pp. 705-706, pl. 1, figs 1-2.

1978 *Bairdia cassiana* (Reuss) – Kristan-Tollmann, p. 81, pl. 1, fig. 4, pl. 6, fig. 6.

1995 *Bairdia cassiana rotundidorsata* n. ssp. – Monostori, p. 42, pl. 2, figs 4-5.

1996 *Bairdia (Rectobairdia) garciai* n. sp. – Crasquin-Soleau & Gradinaru, pp. 77-78, pl. 2, figs 5-8.

Remarks. The most characteristic features are the slightly upward-directed posterior end, the sloping dorsal margin and the asymmetrical anterior margin. Because of the large morphological variation of *Bairdia cassiana*, the justification of the subspecies *Bairdia cassiana rotundidorsata* (Monostori 1995) is questionable.

Dimensions. L= 0.71-1.32 mm, H= 0.37-0.67 mm, L/H= 1.92-1.97.

Occurrences. Dobrogea (Romania): Early Anisian (Crasquin-Soleau & Gradinaru 1996), Felsőörs Hill: Anisian (Monostori 1995), Southern Alps, Cassian Beds (Italy): Early Carnian (Reuss 1868; Gümbel 1869; Ulrichs 1970; Kristan-Tollmann 1978).

Bairdia (Urobairdia) lata Monostori, 1995

Pl. 2, figs 11-12

1995 *Bairdia (Urobairdia) lata* n. sp. – Monostori, pp. 43-44, pl. 4, fig. 1.

Remarks. The ventral margin of the left valve seems to be less convex (sometimes straight) than that of the holotype. The valve surface displays a fine reticulation.

Dimensions. L= 1.16-1.20 mm, H= 0.77-0.81 mm, L/H= 1.49-1.51.

Occurrences. Felsőörs (Hungary): Anisian (Monostori 1995), Litér quarry (Hungary): Ladinian (this paper).

Bairdia parvula Méhes, 1911

Pl. 2, figs 13-15

1911 *Bairdia parvula* n. sp. – Méhes, p. 15, pl. 1, figs 17-18.

Description. Anterior margin of the left valve somewhat asymmetrically rounded; dorsal margin slightly arcuated subcentrally (at ¾ of the length), truncated posteriorly; ventral margin nearly straight; weak tapering of posterior end at left valve. Dorsal margin of right valve wide trapezoidal; ventral sinus prominent; distinct tapering of posterior end at right valve. There is a distinct overlap dorsally and mid-ventrally.

Remarks. A strong variation has been observed with regard to the slope of the anterior and posterior parts of the dorsal margin, the shape of the posterior end and the convexity of the left dorsal margin.

Dimensions. L= 0.87-1.12 mm, H= 0.37-0.48 mm, L/H= 2.33-2.35.

Occurrence. Felsőörs (Hungary): Anisian (Méhes 1911); Felsőörs, Litér quarry (Hungary): Ladinian (this paper).

PLATE 1

Scale bar = 100 μm. Abbreviations: C= Carapace, RV= Right valve, LV= Left valve.

Fig. 1 - *Polycope arcuatocosta* n. sp. RV in lateral view, Litér quarry, sample 14, EMNH 1.2011.2.5.5.

Fig. 2 - *Polycope pumicosa schleferae* Bunza & Kozur, 1971. RV in lateral view, Litér quarry, sample 3, EMNH 1.2011.1.8.4.

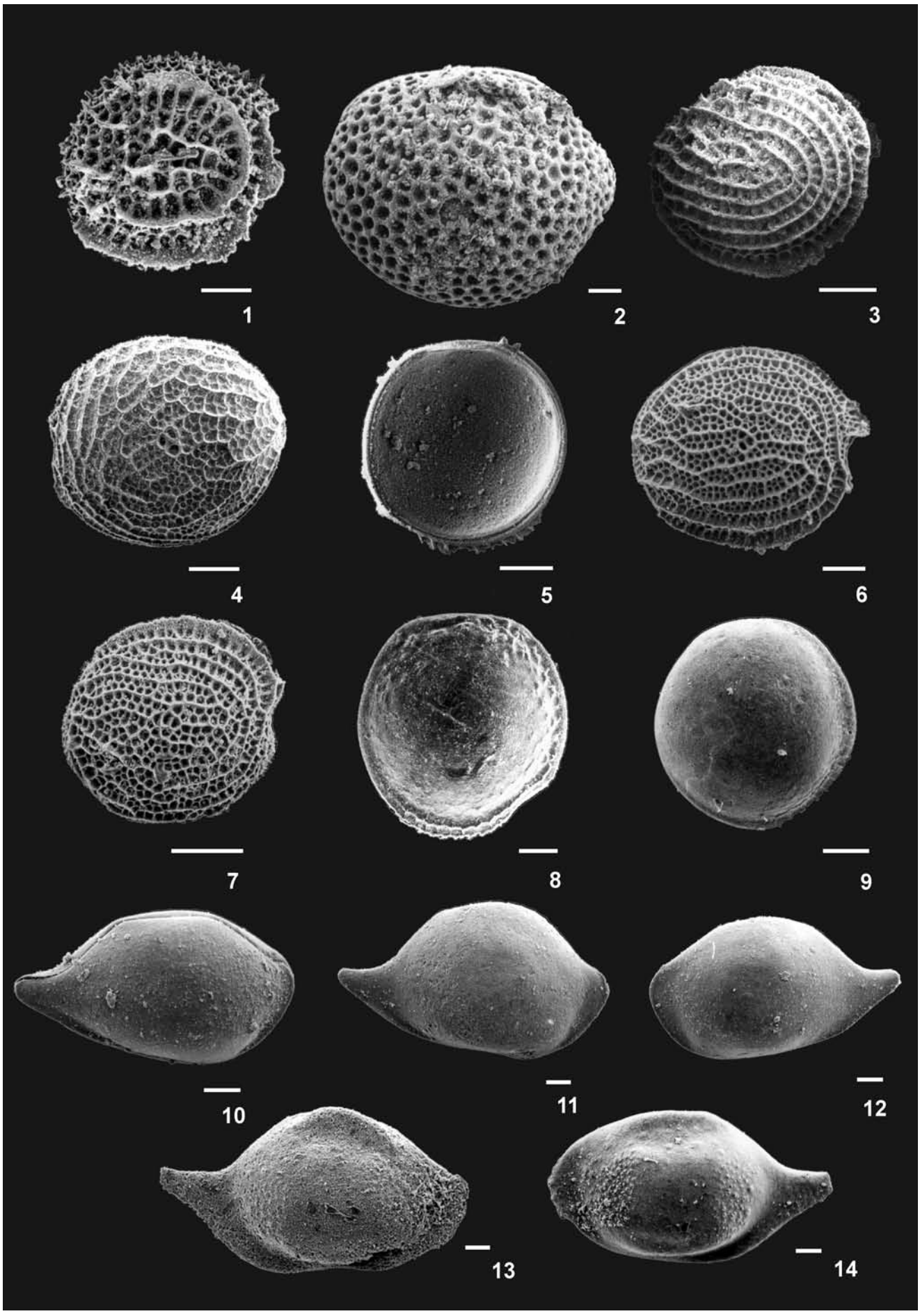
Fig. 3 - *Polycope cincinnata* Apostolescu, 1959. RV in lateral view, Litér quarry, sample 1, EMNH 1.2011.1.4.11.

Figs 4-7 - *Polycope densoreticulata* n. sp. 4) LV in lateral view, Litér quarry, sample 1, EMNH 1.2011.1.4.12. 5) LV inner view, Litér quarry, sample 1, EMNH 1.2011.1.5.9. 6) RV in lateral view, Litér quarry, sample 12, EMNH 1.2011.2.1.3. 7) LV in lateral view, Litér quarry, sample 1, EMNH 1.2011.1.5.8.

Figs 8-9 - *Polycope pelta* Fischer, 1961. 8) RV in lateral view, Litér quarry, sample 1, EMNH 1.2011.1.4.2. 9) RV in lateral view, Litér quarry, sample 1, EMNH 1.2011.1.4.14.

Figs 10-12 - *Bairdia* (*Urobairdia*) *angusta* Kollmann, 1963. 10) C in right view, Litér quarry, sample 3, EMNH 1.2011.1.8.6. 11) RV in lateral view, Litér quarry, sample 4, EMNH 1.2011.1.8.10. 12) LV in lateral view, Litér quarry, sample 4, EMNH 1.2011.1.9.1.

Figs 13-14 - *Bairdia (Urobairdia) austriaca* Kollmann, 1963. 13) RV in lateral view, Litér quarry, sample 7, EMNH 1.2011.2.6.7. 14) LV in lateral view, Litér quarry, sample 2, EMNH 1.2011.1.7.5.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Genus *Bairdiacypris* Bradfield, 1935

Type species: *Bairdiacypris deloi* Bradfield, 1935

Bairdiacypris anisica Kozur, 1971

Pl. 3, figs 6, 9, 12, 14

1971c *Bairdiacypris anisica* n. sp. – Kozur, pp. 4-5, figs 2B, C, E-G.

1984 *Bairdiacypris anisica* Kozur – Salaj & Jendrejáková, pl. 1, fig. 2.

1995 *Bairdiacypris anisica* Kozur – Monostori, p. 46, pl. 5, fig. 3.

1996 *Bairdiacypris galbruni* n. sp. – Crasquin-Soleau & Gradinaru, pp. 83-84, pl. 5, figs 1-5.

2010 *Bairdiacypris anisica* Kozur – Crasquin et al., p. 353, fig. 22Y-A'.

2011 *Bairdiacypris anisica* Kozur – Forel & Crasquin, p. 461.

2011 *Bairdiacypris anisica* Kozur – Forel et al., p. 168, pl. 1, fig. 5.

Remarks. There is a great variability in the lateral shape of the valves. Co-occurrence of the specimens with more and less arcuate dorsal margin can be observed. In the Upper Anisian and Ladinian beds the more arcuate forms are more common. The roundness of the anterior and posterior margins is also variable in the same sample. Considering these variations of the lateral outline the species *Bairdiacypris galbruni* described by Crasquin-Soleau & Gradinaru (1996) probably fits in this extended species. Equivalents of specimens figured in Crasquin-Soleau & Gradinaru (1996) can be found in the Ladinian beds of the Balaton Highland.

Dimensions. L= 0.78-0.91 mm, H= 0.31-0.37 mm, L/H= 2.46-2.52.

Occurrences. Meishan (South China): Late Permian to Early Triassic (Griesbachian) (Crasquin et al. 2011; Forel & Crasquin 2011), South Tibet (China): Early Triassic (Spathian) (Forel et al. 2011), Felsőörs (Hungary): Anisian (Kozur 1971c; Monostori 1995), Dobrogea (Romania): Early Anisian (Crasquin-Soleau & Gradinaru 1996), Katrabóca II, Felsőörs and Litér quarry (Hungary): Ladinian (this paper).

Bairdiacypris mirautaae Crasquin-Soleau & Gradinaru, 1996

Pl. 3, fig. 13.

1996 *Bairdiacypris mirautaae* n. sp. – Crasquin-Soleau & Gradinaru, pp. 82-83, pl. 4, figs 9-12.

Remarks. Specimens characterized by the subcentrally pointed posterior end suggest that they may belong to the species *Bairdiacypris mirautaae* described by Crasquin-Soleau & Gradinaru (1996).

Dimensions. L= 1.3-1.32 mm, H= 0.47-0.5 mm, L/H= 2.64-2.76.

Occurrences. Dobrogea (Romania): Early Anisian (Crasquin Soleau & Gradinaru 1996), Litér quarry (Hungary): Ladinian (this paper).

Bairdiacypris triassica Kozur, 1971

Pl. 3, figs 7-8, 10.

1911 *Bairdia harrisiana* Jones, 1849 – Méhes, p. 16. Pl. 1, fig. 22.

1911 *Bairdiacypris silicula* Jones, 1849 – Méhes, p. 15, Pl. 1, figs 19-21.

1971c *Bairdiacypris triassica* n. sp. – Kozur, pp. 5-6, fig. 2H-L.

Description. Valve shape very elongate; anterior margin of the left valve broadly and slightly asymmetrically rounded; dorsal margin slightly arcuate with a break before midlength; posterior margin dorsally straight and pointed near mid-height; ventral margin slightly sinuous. Right valve more distinctly angulated at the dorsal margin with a stronger concavity at the ventral margin and more sharply pointed posteriorly than the left valve. Dorsal and midventral overlap strong.

Dimensions. L= 0.72-0.96 mm, H= 0.38-0.46 mm, L/H= 1.89-2.09.

Remarks. The specimens are variable in convexity of the dorsal margin. These differences can be considered as intraspecific variability.

PLATE 2

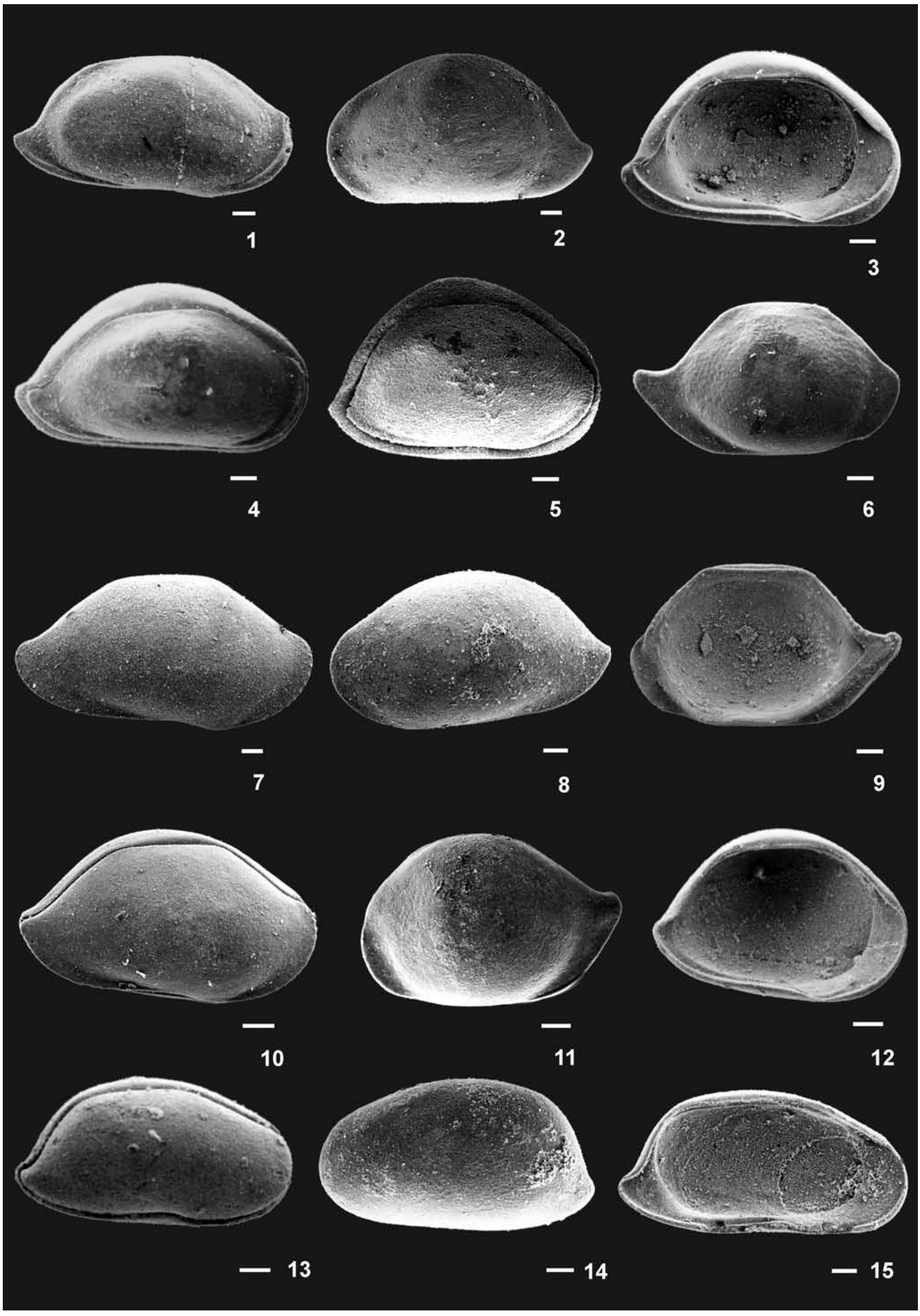
Figs 1-5 - *Bairdia balatonica* Méhes, 1911.1) RV in lateral view, Felsőörs, Füred Limestone Fm., EMNH 1.2012.1.8.13. 2) LV in lateral view, Litér quarry, sample 2, EMNH 1.2011.1.6.8. 3) LV in inner view, Litér quarry, sample 4, EMNH 1.2011.1.7.2. 4) C in right view, Litér quarry, sample 15, EMNH 1.2011.2.2.7. 5) C in right view, Litér quarry, sample 1, EMNH 1.2011.1.10.4.

Figs 6, 9 - *Bairdia bicostata* (Kristan-Tollmann, 1969). 6) RV in lateral view, Litér quarry, sample 20, EMNH 1.2011.2.3.8. 9) RV in inner view, Litér quarry, sample 4, EMNH 1.2011.1.8.9.

Figs 7-8, 10 - *Bairdia cassiana* (Reuss, 1868). 7) RV in lateral view, Litér quarry, sample 2, EMNH 1.2011.1.7.7. 8) LV in lateral view, Felsőörs, Füred Limestone Fm., EMNH 1.2012.2.1.1. 10) C in right view, Litér quarry, sample 1, EMNH 1.2011.1.6.6.

Figs 11-12 - *Bairdia (Urobairdia) lata* Monostori, 1995. 11) LV in lateral view, Litér quarry, sample 1, EMNH 1.2011.1.3.3. 12) LV in inner view, Litér quarry, sample 9, EMNH 1.2011.2.5.9.

Figs 13-15 - *Bairdia parvula* Méhes, 1911. 13) C in right view, Litér quarry, sample 7, EMNH 1.2011.2.7.4. 14) LV in lateral view, Felsőörs, Füred Limestone Fm., EMNH 1.2012.2.2.3. 15) LV in inner view, Felsőörs, Füred Limestone Fm., EMNH 1.2012.1.9.4.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Occurrences. Katrabóca II, Felsőörs and Litér quarry (Hungary): Ladinian (this paper), Nosztori Valley (Hungary): Carnian (Méhes 1911), Hungary: Carnian (Kozur 1971c).

Genus *Ceratobairdia* Sohn, 1954

Type species: *Ceratobairdia dorsospinosa* Sohn, 1954

Ceratobairdia longispinosa Kozur, 1971

Pl. 3, fig. 1

1971a *Ceratobairdia longispinosa* n. sp. – Kozur, pp. 4-5, fig. 1e.
1984 *Ceratobairdia longispinosa* Kozur – Salaj & Jendrejáková, pl. 1, fig. 12, pl. 3, figs 1-4.
?1996 *Ceratobairdia* cf. *longispinosa* Kozur – Crasquin-Soleau & Gradinaru, pl. 5, fig. 6.

Remarks. Left valve characterized by two strong and symmetrically arranged anterodorsal and posterodorsal spines which are directed forwards and backwards with an angle of 45° and have a broad basis. In the type specimen figured by Kozur (1971a) the anterodorsal spine is broken. However, the basal part of the spine is still discernable.

Dimensions. L= 0.74 mm, H= 0.4 mm, L/H= 1.85.

Occurrence. Slovakia: Late Anisian (Kozur 1971a), Litér quarry (Hungary): Ladinian (this paper), West Carpathians (Romania): Middle Triassic (Salaj & Jendrejáková 1984).

Genus *Ptychobairdia* Kollmann, 1960

Type species: *Ptychobairdia kuepperi* Kollmann, 1960

Ptychobairdia ex gr. **lordi** Monostori, 1996

Pl. 3, fig. 2.

Remarks. In the studied material some single damaged carapaces can be found with similar outline and ornamentation to *Ptychobairdia lordi* described by Monostori (1996).

Dimensions. L= 1.55 mm, H= 0.93 mm, L/H= 1.66.

Occurrence. Felsőörs (Hungary): Ladinian (this paper).

Ptychobairdia mostleri (Kozur, 1971)

Pl. 3, figs 3-5

1971b *Triebelina mostleri* n. sp. – Kozur, pp. 11-12, fig. 1/i (subsp. *mostleri*), 1j, 2/c (subsp. *praecursor*).

Remarks. The preservation of the specimens is variable, but the main ornamental elements are visible even on molds. These elements are a sharp dorsal costa which is arcuate on the right valve and nearly trapezoidal on the left valve, two short median costae (indistinct on the right valve) and a long, sharp ventral costa curved upwards at both ends. Sometimes the remains of the fine secondary reticulation are also visible.

Dimensions. L= 0.92-1.08 mm, H= 0.55-0.62 mm, L/H= 1.67-1.74.

Occurrences. Felsőörs (Hungary): Anisian (Kozur 1971b), Katrabóca II, Litér quarry (Hungary): Ladinian (this paper).

Ptychobairdia tenuiornata n. sp.

Pl. 3, fig. 4

Derivatio nominis: After its weak ornamentation.

Holotype: Left valve, Eötvös Museum of Natural History, EMNH 1.2011.2.6.2, figured pl. 3, fig. 4.

Locus typicus: Litér quarry.

Stratum typicum: Bed 8, Lower Ladinian (Gredleri Zone).

Material: 3 valves.

Diagnosis: Large, stubby form with dorsal, ventral and central flat and broad costa.

PLATE 3

Fig. 1 - *Ceratobairdia longispinosa* Kozur, 1971. LV in lateral view, Litér quarry, sample 8, EMNH 1.2011.2.5.11.

Fig. 2 - *Ptychobairdia* ex. gr. *lordi* Monostori, 1996. RV in lateral view, Felsőörs, Füred Limestone Fm. EMNH 1.2012.1.9.10

Figs 3, 5 - *Ptychobairdia mostleri* (Kozur, 1971). 3) RV in lateral view, Katrabóca II. section (Nemesvámos), bed 13, EMNH 1.2012.2.7.17. 5) RV in lateral view with a bioerosion trace, Litér quarry, sample 1, EMNH 1.2011.1.3.6.

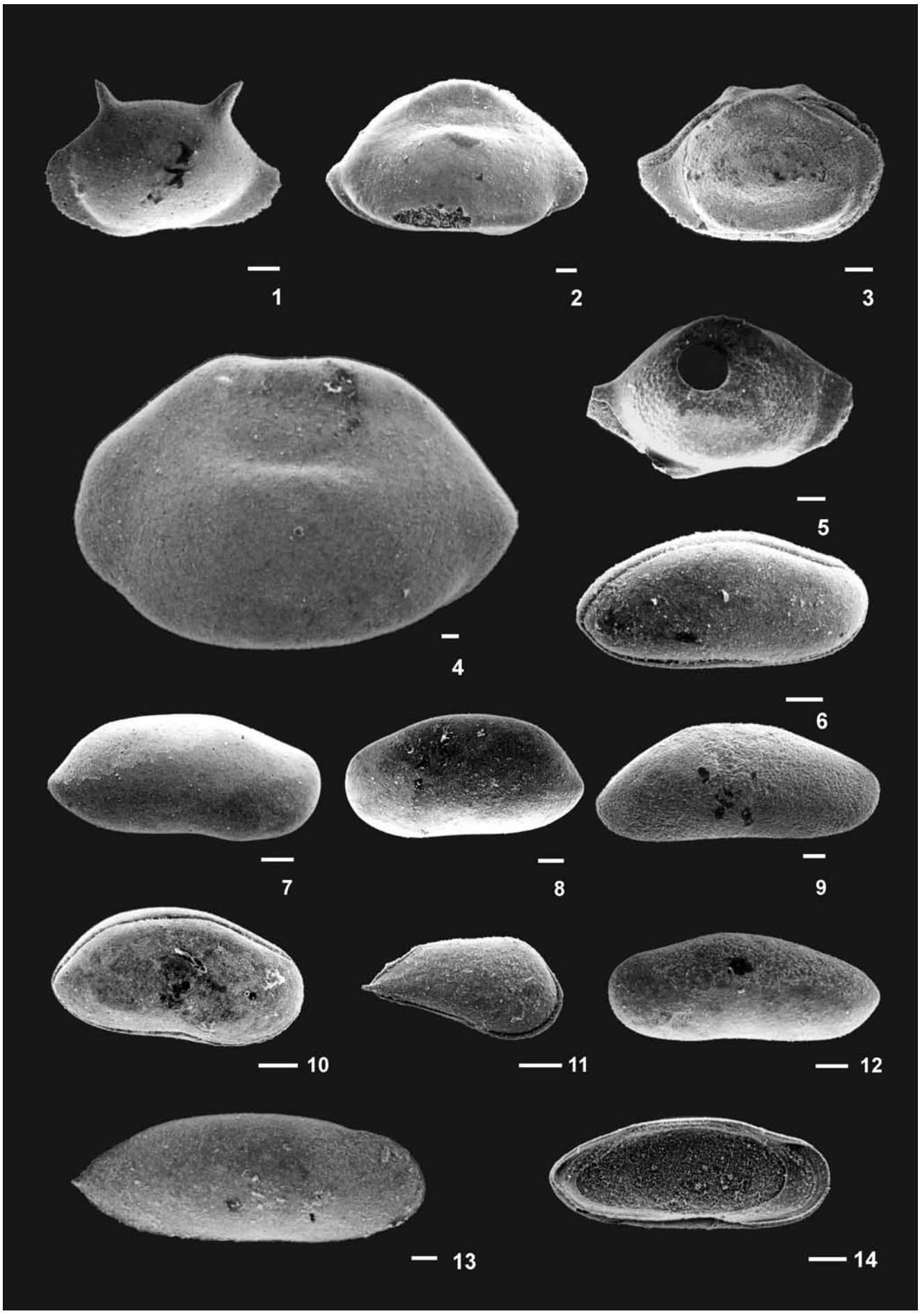
Fig. 4 - *Ptychobairdia tenuiornata* n. sp. LV in lateral view, Litér quarry, sample 8, EMNH 1.2011.2.6.2.

Figs 6, 9, 12, 14 - *Bairdiacypris anisica* Kozur, 1971. 6) C in right view, Felsőörs, Füred Limestone Fm., EMNH 1.2012.2.2.6. 9) RV in lateral view, Litér quarry, sample 1, EMNH 1.2011.1.2.3. 12) LV in lateral view, Litér quarry, sample 9, EMNH 1.2011.2.5.10. 14) LV in inner view, Felsőörs, Füred Limestone Fm., EMNH 1.2012.1.7.12.

Figs 7-8, 10 - *Bairdiacypris triassica* Kozur, 1971. 7) RV in lateral view, Litér quarry, sample 1, EMNH 1.2011.1.6.5. 8) LV in lateral view, Litér quarry, sample 1, EMNH 1.2011.1.4.1. 10) C in right view, Litér quarry, sample 1, EMNH 1.2011.1.11.1.

Fig. 11 - *Spinocypris vulgaris* Kozur, 1971. C in right view, Litér quarry, sample 1, EMNH 1.2011.1.5.10.

Fig. 13 - *Bairdiacypris mirautaae* Crasquin-Soleau & Gradinaru, 1996. RV in lateral view, Litér quarry, sample 8, EMNH 1.2011.2.6.1.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Description. Anterior margin of the left valve broadly rounded; dorsal margin trapezoidal; posterior margin pointed, dorsally slightly concave and ventrally slightly convex; ventral margin convex; short dorsal costa emphasized by a depression; short and flat costa at mid-height and parallel with the median part of the dorsal margin, a weak and slightly arched ventral costa near to the ventral margin.

Dimensions. L= 1.67-1.69 mm, H= 1.03-1.10 mm, L/H= 1.54-1.62.

Comparison. Similar to *Ptychobairdia mostleri* (Kozur, 1971) but there are differences in the outline and ornamentation. In *Ptychobairdia mostleri* the posterior end is more distinctly pointed (Kozur 1971a).

Occurrence. Litér quarry (Hungary): Ladinian (this paper).

Family Beecherellidae Ulrich, 1894

Genus *Acanthoscapha* Ulrich & Bassler, 1923

Type species: *Beecherella navicula* Ulrich, 1891

Acanthoscapha bogschi Kozur, 1970

Pl. 4, figs 9-10

1970a *Acanthoscapha bogschi* n. sp. – Kozur, pp. 391-392, pl. 2, figs 1, 3-5.

1971c *Acanthoscapha bogschi interrupta* n. ssp. – Kozur, pp. 7-8, fig 1A.

1972b *Acanthoscapha bogschi* Kozur – Kozur, pl. 1, figs 3, 5.

1984 *Acanthoscapha bogschi interrupta* Kozur – Salaj & Jendrejáková, pl. 1, figs 7-8.

1996 *Acanthoscapha bogschi* Kozur – Crasquin-Soleau & Gradinaru, pl. 6, figs 6-9.

Remarks. The posterior and anterior spines are variably directed. In contrast to the holotype, the median part of the costa is weak or absent. The depressed circumperiferial area and the shape also show minor variability. In our opinion the subdivision of the species on subspecies level is not justified, being based on the small differences of carapace outline.

Dimensions. L= 1.1-1.6 mm, H= 0.55-0.73 mm, L/H= 2-2.19.

Occurrence. Dobrogea (Romania): Early Anisian (Crasquin-Soleau & Gradinaru 1996), Felsőörs (Hungary): Anisian (Kozur 1970a, 1971c, 1972b), Felsőörs, Litér quarry (Hungary): Ladinian (this paper), West Carpathians (Romania): Triassic (Salaj & Jendrejáková 1984).

Acanthoscapha veghae Kozur, 1970

Pl. 4, figs 12-13

1970a *Acanthoscapha veghae* n. sp. – Kozur, pp. 392-393, pl. 1, figs 13-17, pl. 2, fig. 2.

1972b *Acanthoscapha veghae* Kozur – Kozur, pl. 1, fig. 2.

1996 *Acanthoscapha veghae* Kozur – Crasquin-Soleau & Gradinaru, pl. 6, figs 10-11.

Remarks. The posterior and anterior spines show intraspecific variability in their orientation.

Dimensions. L= 0.7-0.93 mm, H= 0.34-0.44 mm, L/H= 2.06-2.11.

Occurrences. Dobrogea (Romania): Early Anisian (Crasquin-Soleau & Gradinaru 1996); Felsőörs (Hungary): Late Anisian (Kozur 1970a, 1972b), Litér quarry (Hungary): Ladinian (this paper).

Superfamily Cytheroidea Baird, 1850

Family Tricorninidae Blumenstengel, 1965

Genus *Nagyella* Kozur, 1970a

Type species: *Nagyella longispinosa* Kozur, 1970

Nagyella longispinosa Kozur, 1970

Pl. 4, figs 3-4

1970a *Nagyella longispinosa* n. sp. – Kozur, p. 394, pl. 1, figs 1-3, 5-6.

1972b *Nagyella longispinosa* Kozur – Kozur, pl. 1, fig. 7.

1996 *Nagyella longispinosa* Kozur – Crasquin-Soleau & Gradinaru, pl. 8, figs 4-6.

Remarks. A few silicified specimens display a fine polygonal granular reticulation. There are long dorsal and anterior spines, a medioventral spine, and a median sulcus. Juveniles bear three to five smaller spines in dorsal, anterior and medioventral positions instead of one distinct spine.

Dimensions. L= 0.74-0.78 mm, H= 0.26-0.32 mm, L/H= 2.85-2.44.

Occurrence. Dobrogea (Romania): Early Anisian (Crasquin-Soleau & Gradinaru 1996), Felsőörs (Hungary): Anisian (Kozur 1970a, 1972b), Litér quarry (Hungary): Ladinian (this paper).

Suborder **Cypridocopina** Jones, 1901

Superfamily Cypridoidea Baird, 1845

Genus *Spinocypris* Kozur, 1971

Type species: *Spinocypris vulgaris* Kozur, 1971

Spinocypris vulgaris Kozur, 1971

Pl. 3, fig. 11

1971 *Spinocypris vulgaris* n. sp. – Bunza & Kozur, pp. 17-18, pl. 2, figs 3-5.

1971 *Spinocypris nepalensis* n. sp. – Bunza & Kozur, p. 18, pl. 2, figs 1-2.

non 1984 *Spinocypris* cf. *vulgaris* Kozur – Salaj & Jendrejáková, pl. 2, fig. 5.

1995? *Spinocypris vulgaris* Kozur – Monostori, p. 46, pl. 5, fig. 4.

1996 *Spinocypris vulgaris* Kozur – Crasquin-Soleau & Gradinaru, pp. 87-88, pl. 7, figs 9-14.

2006? *Spinocypris vulgaris* Kozur – Crasquin et al., pp. 63-64, pl. 3, fig. 14.

2011 *Spinocypris vulgaris* Kozur – Forel & Crasquin, p. 251, fig. 3M.

Remarks. The species displays high intraspecific variability with regard to the length/height ratio of the valves and in the outline of the acute posterior end.

Dimensions. L= 0.45 mm, H= 0.23 mm, L/H= 1.95.

Occurrences. South Tibet: Early Triassic (Spathian) (Forel & Crasquin 2011), Öfenbachgraben, Saalfelden (Austria): Anisian (Bunza & Kozur 1971), Felsőörs (Hungary): Anisian (Monostori 1995), Dobrogea (Romania): Early Anisian (Crasquin Soleau & Gradinaru 1996), Litér quarry (Hungary): Ladinian (this paper).

Family Candonidae Kaufmann 1900

Genus *Aglaiocypris* Sylvester-Bradley, 1947

Type species: *Aglaia pulchella* Brady, 1868

Aglaiocypris? aequalis Kozur, 1970

Pl. 4, fig. 11

1970b *Aglaiocypris? aequalis* n. sp. – Kozur, p. 445, pl. 4, figs 1-3.

Remarks. The species represented by a single valve which has similar outline with the specimen illustrated on fig. 2a by Kozur (1970b).

Dimensions. L= 0.54 mm, H= 0.28 mm, L/H= 1.93.

Occurrences. Germany: Anisian (Kozur 1970b), Litér quarry (Hungary): Ladinian (this paper).

Superfamily Macrocypridoidea Müller, 1912

Family Macrocyprididae Müller, 1912

Genus *Praemacrocypris* Kozur, 1971c

Type species: *Praemacrocypris mocki* Kozur, 1971

Praemacrocypris literense n. sp.

Pl. 4, fig. 8

Derivatio nominis: After the name of the locality.

Holotype: Carapace, Eötvös Museum of Natural History, EMNH 1.2011.1.8.5.11., figured pl. 4, fig. 8.

Locus typicus: Litér quarry.

Stratum typicum: Bed 1, Ladinian.

Material: 6 valves, 5 carapaces.

Diagnosis: Very elongate and arched form with upward-directed pointed posterior end.

Description. Anterior margin of the right valve asymmetrically rounded; dorsal margin arched with a break to the anterior end; posterior end pointed and upward-directed; ventral margin concave; valve surface smooth; eyespots absent.

Dimensions. L= 0.85-1.12 mm, H= 0.23-0.34 mm, L/H= 3.29-3.69.

Comparison. Similar to *Praemacrocypris mocki* Kozur, 1971 (particularly to specimen of fig. 1f in Kozur (1971c)) in the pointed upward-directed anterior end and in L/H ratio of the carapace. However, the posterior end of our specimens is upward-directed and the carapace isn't open posteriorly contrary to that of Kozur's specimens.

Occurrence. Litér quarry (Hungary): Ladinian (this paper).

Praemacrocypris mocki Kozur, 1971

Pl. 4, figs 5-7

1971c *Praemacrocypris mocki* n. sp. – Kozur, p. 13-14, fig. 1F, H.

Remarks. The arcuate shape with an elongate and pointed posterior end is very characteristic in this species. At the posterior end the valves diverge, the carapace is open. Variable angulation at the anterodorsal margin.

Dimensions. L= 1.08-1.8 mm, H= 0.23-0.5 mm, L/H= 3.6-4.69.

Occurrences. Hungary, Slovakia: Late Anisian (Kozur 1971c), Felsőörs, Litér quarry (Hungary): Ladinian (this paper).

Discussion on the characteristics and palaeoecological significance of Ladinian ostracod faunas from the Balaton Highland

Ostracods with low-magnesium calcite carapaces are preserved with fine details in the studied material of Litér quarry. Due to the uniform distribution of organic matter in carapaces, the preservation rate of ostracods are higher than other calcitic microfaunal elements. Thus the ostracod fauna is characterized by high diversity and abundance of specimens in contrast to the foraminifera fauna in the studied material. The reason for this peculiar preservation of valves and carapaces is the partial or complete silicification of the carbonate skeletons and host limestone. In marine environments dissolved silica derives mainly from rivers, from volcanic/hydrothermal sources and from siliceous organisms (Butts & Briggs 2010). The sources of silica in Litér may be dissolution of radiolarian tests and devitrified volcanic ash. This interpretation is supported by the presence of tuffaceous interbeds in the pelagic, cherty

carbonate succession (Buchenstein Fm.) and poorly preserved, corroded radiolarian shells in most of the studied layers. The submarine volcanism provided tuffs was the result of repeated volcanotectonic activity (manifested by neptunian dykes) during the middle Longobardian (Late Ladinian) in Southern Bakony, coevally with volcanic eruptions, as in the Dolomites (Budai & Vörös 2006). The degree of silicification of the ostracod valves is very similar in the complete studied section (Buchenstein Fm.) that suggests similar depositional conditions and similar changes in pore water geochemistry during the Gredleri and Archelaus zones. The preservation of the Ladinian macro- and microfauna (e.g. ammonite internal molds without original shells) shows early silicification which occurred after aragonite dissolution.The fine-scale textural silicification is also enhanced by lithology (open marine limestones), mineralogy, and distribution of organic material within the shells. The high abundance of the extracted ostracod specimens is produced by the different silicification rate of the valves and the host limestone.

Ladinian deposits of Litér, Felsőörs and Nemesvámos are characterized by similar diverse podocopid ostracod faunas (23 species) beside strongly ornamented and smooth myodocopid (Polycopoidea) (5 species) (Tab. 1). Because of the extraordinary preservation of the ostracod valves and carapaces, few poorly fossilized thin-shelled cypridinelliformoid (Myodocopa) ostracods could be found in the material of Litér quarry, also. These peculiar myodocopids will be treated in detail elsewhere. Four new species could be designated namely *Polycope arcuatocosta* n. sp., *P. densoreticulata* n. sp., *Ptychobairdia tenuiornata* n. sp. and *Praemacrocypris literense* n. sp. The majority of the identified ostracod species was known from the Middle Triassic (11 species) or Middle to Late Triassic (8 species). Only *Bairdiacypris anisica* was described from Permian section of South China (Crasquin et al. 2011; Forel & Crasquin 2011). The ranges of two polycopid species (*Polycope cincinnata* and *P. pelta*) extended up to the Toarcian.

In the studied Ladinian sections of Balaton Highland the distribution in faunal composition of ostracods in each beds is very similar, there are no significant trend in the changes of diversity and in the ratio of different taxa.

The association of the studied benthic fauna – dominance of smooth-shelled bairdiaceans and metacopids (*Hungarella*), appearance of elongated *Acratia*, *Acanthoscapha* and Tricorninidae (*Nagyella)* – shows high similarity to the so-called Thuringian assemblages (sensu Becker in Bandel & Becker 1975) which occurred mainly in Devonian and Carboniferous sediments (Bandel & Becker 1975; Becker 1982; Becker & Bless 1990) and also in the Permian (e. g. Bless 1987; Gründel & Kozur 1975; Kozur 1991). The Thuringian-type ostracods are thin-shelled, often smooth podocopids possessing long spines, without eye-tubercles. The specimens of the genera *Acanthoscapha* and *Acratia* are very characteristic elements of these faunas from the Late Ordovician/Silurian to the Middle Triassic (e. g. Becker 1982; Bandel & Becker 1975; Gründel 1962; Kristan-Tollmann 1991). *Acanthoscapha* was described by Bolz (1971) and Kristan-Tollmann (1973) also from Norian/Rhaetian beds of the Southern Alps and *Acratia* from the Lower Jurassic (e.g. Harloff & Jäger 1994; Beutler et al. 1996) but they are very rare in these sediments. Moreover the specimens of *Nagyella longispinosa* described from the studied Hungarian sections are ones of the latest representatives of family Tricorninidae.

The term Thuringian Ecotype was firstly applied by Bandel & Becker (1975) to basinal ostracod assemblages which occurred in Paleozoic calcareous-argillaceous, hemipelagic facies. Later these assemblages was found in an Upper Devonian succession deposited in shallow water environment with calm water conditions in the Montagne Noire (Becker 1982). According to

PLATE 4

Fig. 1-2 - *Acratia goemoeryi* (Kozur, 1970). 1) RV in lateral view, Litér quarry, sample 14, EMNH 1.2011.2.5.2. 2) LV in lateral view, Litér quarry, sample 11, EMNH 1.2011.2.1.5.

Figs 3-4 - *Nagyella longispinosa* Kozur, 1970. 3) LV of a juvenile specimen in lateral view, Litér quarry, sample 18, EMNH 1.2011.2.4.3. 4) LV in lateral view, sample 9, EMNH 1.2011.2.5.8.

Figs 5-7 - *Praemacrocypris mocki* Kozur, 1971. 5) RV in lateral view, Litér quarry, sample 4, EMNH 1.2011.1.9.2. 6) LV in lateral view, Litér quarry, sample 2, EMNH 1.2011.1.6.10. 7) LV in inner view, Litér quarry, sample 15, EMNH 1.2011.2.2.2.

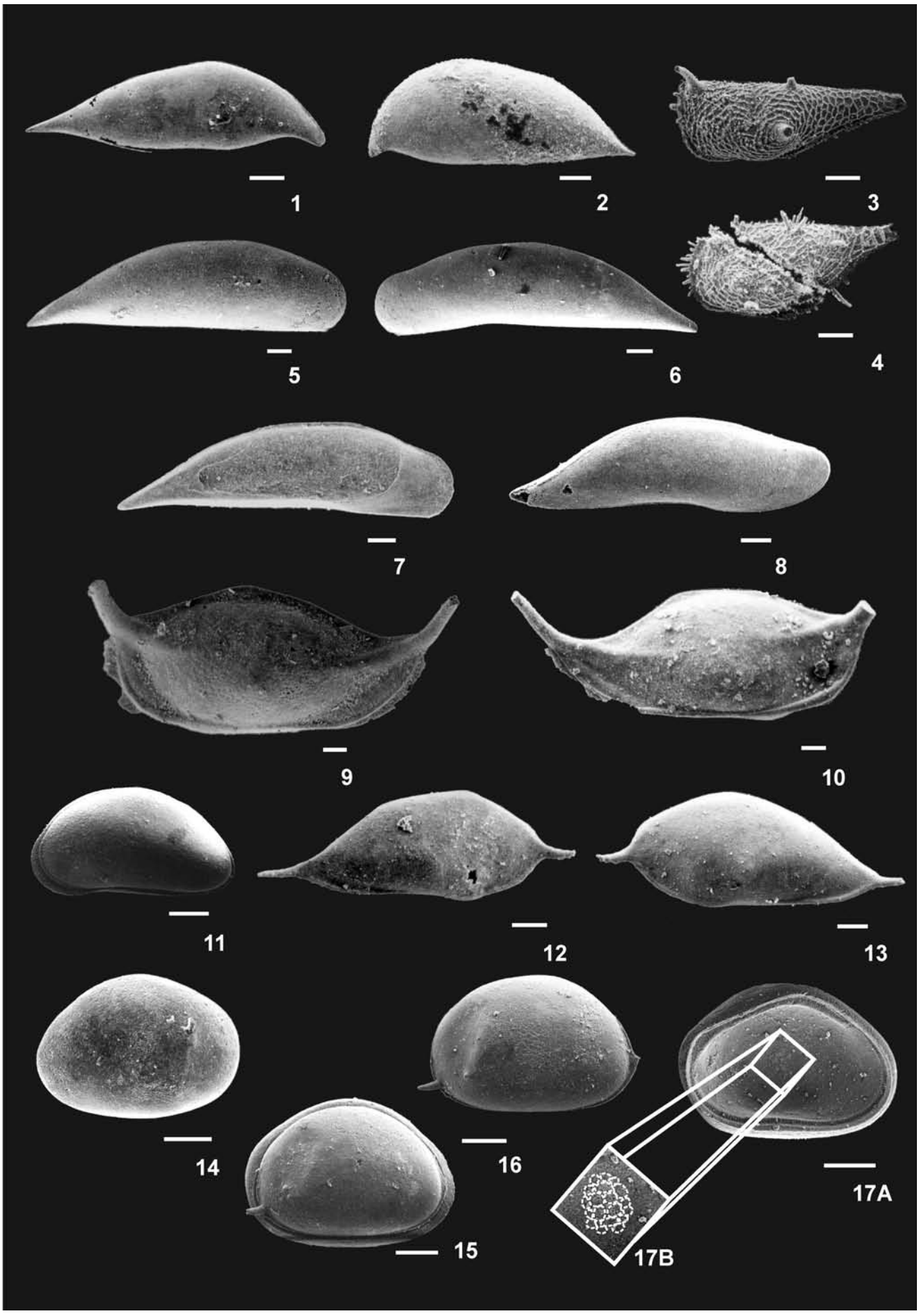
Fig. 8 - *Praemacrocypris literense* n. sp. RV in lateral view, Litér quarry, sample 1, EMNH 1.2011.1.5.11.

Figs 9-10 - *Acantoscapha bogschi* Kozur, 1970. 9) RV in lateral view, Litér quarry, sample 6, EMNH 1.2011.1.10.3. 10) LV in lateral view, Litér quarry, sample 1, EMNH 1.2011.1.3.1.

Fig. 11 - *Aglaiocypris*? *aequalis* Kozur, 1970. LV in lateral view, Litér quarry, sample 1, EMNH 1.2011.1.5.14.

Figs 12-13 - *Acantoscapha veghae* Kozur, 1970. 12) RV in lateral view, Litér quarry, sample 4, EMNH 1.2011.1.9.13. 13) LV in lateral view, Litér quarry, sample 2, EMNH 1.2011.1.6.11.

Figs 14-17 - *Hungarella problematica* (Méhes, 1911). 14) LV in lateral view, Litér quarry, sample 1, 1.2011.1.6.1. 13. 15) C in left view, Litér quarry, sample 2, EMNH 1.2011.1.9.13. 16) RV in lateral view, Litér quarry, sample 2, EMNH 1.2011.1.7.9. 17A) LV in inner view, Litér quarry, sample 4, EMNH 1.2011.1.9.12. 17B) adductor muscle scars of LV, Litér quarry, sample 4.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Becker (2000) Thuringian Ecotype is indicative of marine, low-energy environments independent of water depth, so he used this expression in morphogroup sense.

In the studied benthic Ladinian fauna the peculiar forms with archaic Thuringian – type morphological characters as elongated *Acratia, Acanthoscapha*, *Nagyella* and *Praemacrocypris* are present in low abundance (1-12%, average of 5%). Among the bairdiaceans the smooth forms are the dominant elements of the Ladinian faunas (7-54%, average of 28%). The ornamented bairdiaceans (*Ceratobairdia* and *Ptychobairdia*) indicating shallow marine environment are subordinate in the studied material (0.3-0.7%) (Fig. 3). Their occurrence can be explained by a transport from the platform environment into the eupelagic basin.

The studied Ladinian faunas can be interpreted as Thuringian Ecotype in original sense (Becker in Bandel & Becker 1975) indicating open marine, more than 200 m deep, bathyal environment with low energy conditions. It corresponds well to the sedimentological and macrofaunal data. The studied Ladinian faunas occurred in pelagic nodular argillaceous limestones similarly to the original Thuringian-type assemblages from eastern Thuringia described by Gründel (1961, 1962).

During the Ladinian (from the Fassanian till the late Longobardian) the studied tuffitic, often silicified limestones deposited in more or less starved eupelagic basin of the Southern Bakony based on the lithological, microfacies and macrofaunal characteristics (Budai & Vörös 2006; Vörös 2009). The macrofauna was dominated by ammonoids, the shelly benthos was of low diversity, bivalves represented exclusively by "flat clams" or "paper pectens" (the genus *Daonella*) and few brachiopods.

The starved basin character is very well supported by the great abundance of the specimens of healdiid *Hungarella* (more than 25-80%, average of 40%, Fig. 3). Lethiers & Whatley (1994) postulated that extinct metacopine – including healdiids – were filter-feeding ostracods based on similar morphological characters of hard parts to the recent platycopids. Thus their great abundance may indicate oxygen-depleted or oligotrophic water conditions (Forel et al. 2011). In this case the latter interpretation is preferred.

Similar Triassic assemblages are known from the Anisian of Felsőörs section (Hungary, Kozur 1970a) and Romania (Crasquin-Soleau & Gradinaru 1996). Kozur (1972b, 1991) introduced the term 'palaeopsychrosphaeric' ostracod faunas instead of the Thuringian Ecotype for the Silurian to Triassic assemblages. Kozur originated it from the term 'psychrosphaeric' based on morphological and ecological similarities with this kind of Neogene to Recent ostracods. These forms live in deep, calm, cold and dysoxic waters with a high amount of dissolved silica under the thermocline. Based on the material of Balaton Highland neither the cold water (the existence of the thermocline) nor the dysoxia can be proved. Because of this facts we used the Thuringian Ecotype expression.

The studied Ladinian ostracod faunas from Litér, Nemesvámos and Felsőörs are the youngest known Thuringian-type assemblages from the Western Tethyan realm.

Conclusions

Diverse Ladinian ostracod faunas are described from three Hungarian localities (Litér, Nemesvámos and Felsőörs) of the Balaton Highland. Due to the fine-scale textural silicification, the ostracod fauna of Litér quarry is far better preserved than any of the hitherto published Tethyan Middle Triassic faunas. Detailed systematic descriptions are given for 28 ostracod taxa (with 4 new species) belonging to 12 genera, 8 families, 5 suborders (Cladocopina, Bairdiocopina, Cytherocopina, Cypridocopina and Metacopina) and two orders (Halocyprida and Podocopida). Based on morphological and ecological characteristics the studied benthic ostracod assemblages are the latest occurrences of the Thuringian-type assemblages *sensu* Becker in Bandel & Becker 1975. This well corresponds to Anisian 'palaeopsychrosphaeric' fauna described from Felsőörs section (Hungary, Kozur 1970a) and Romania (Crasquin-Soleau & Gradinaru 1996). The composition of the Ladinian faunas completed with lithological, microfacies and macrofaunal data indicate open marine, more than 200 m deep, oligotrophic environment with low energy conditions.

The former conception that the final turnover of ostracods from Palaeozoic to Mesozoic faunas occurred in the Anisian (Crasquin-Soleau et al. 2007; Crasquin et al. 2008) is refined and completed by the presence of the Thuringian Ecotype with archaic elements (*Acratia, Acantiscapha, Nagyella* and *Praemacrocypris*) in the studied Ladinian fauna.

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