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Quartermalacological examinations at the vicinity of Vörs, Máriaasszonysziget emphasis on environmental reconstruction

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Abstract: The article introduce the examination of the malacological material of Late Quaternary sediments carried out at Lake Kis-Balaton during the past couple of years. The preliminary results have been published in 2001. Recently the examination of the malacological materials of the archaeological sites occurring at the locality is in progress.
Key words: Kis-Balaton, Hungary, holocene

During the examinations which have began in 1998 numerous sample have been collected from the surface and also lot of shallow boreholes have been deepened. Analyses of their malacological material significantly enlarged our knowledge about the Pleistocene and Holocene molluscan faunas of the territory. Its importance is shown by the fact, that in spite of the formation of the basin of Lake Balaton is subject of many publications there are only few data available in connection of the Pleistocene development of Lake Kis-Balaton. During the systematic quartermalacological examinations numerous borings have been carried out.

1.	Kis-Balaton – Diás-sziget	1 sample
2.	Kis-Balaton Vörs II.	1 sample
3.	Kis-Balaton: (Ingói-cs.)	14 samples
4.	Kis-Balaton: (Sekély-tavak)	21 samples
5.	Kis-Balaton: Fenékpuszta	13 samples
6.	Kis-Balaton: Főnyed I.	1 sample
7.	Kis-Balaton: Főnyed II. (FÖM)	8 samples
8.	Kis-Balaton: Ingói-csatorna (I.B)	10 samples
9.	Kis-Balaton: Ingói-csatorna (I.C)	5 samples
10.	Kis-Balaton: Vörs I.	9 samples
11.	Kis-Balaton: Vörs: Máriaasszony-sziget I. (archaeology)	16 samples
12.	Kis-Balaton: Vörs: Máriaasszony-sziget II. (archaeology)	17 samples
13.	Kis-Balaton: Vörs: Máriaasszony-sziget III. (archaeology)	31 samples
14.	Kis-Balaton: Vörsi-berek I.	4 samples
15.	Kis-Balaton: Vörsi-berek II.	5 samples
16.	Kis-Balaton: Vörsi-berek III.	7 samples
17.	Kis-Balaton: Zala-vízmű	5 samples

Good deals of the examinations have been granted by the National Scientific Research Fund /OTKA/ (T 026123) which results have been partly published already (Fűköh, L. 2001). Nowadays the examination of the malacological material of Vörs, Máriaasszonysziget archae-

ological site is carried out (Zs. Medzihradszky, L. Fűköh, B. Berzsényi & K. T-Biró 2006). This project is also granted by OTKA (T-04297).

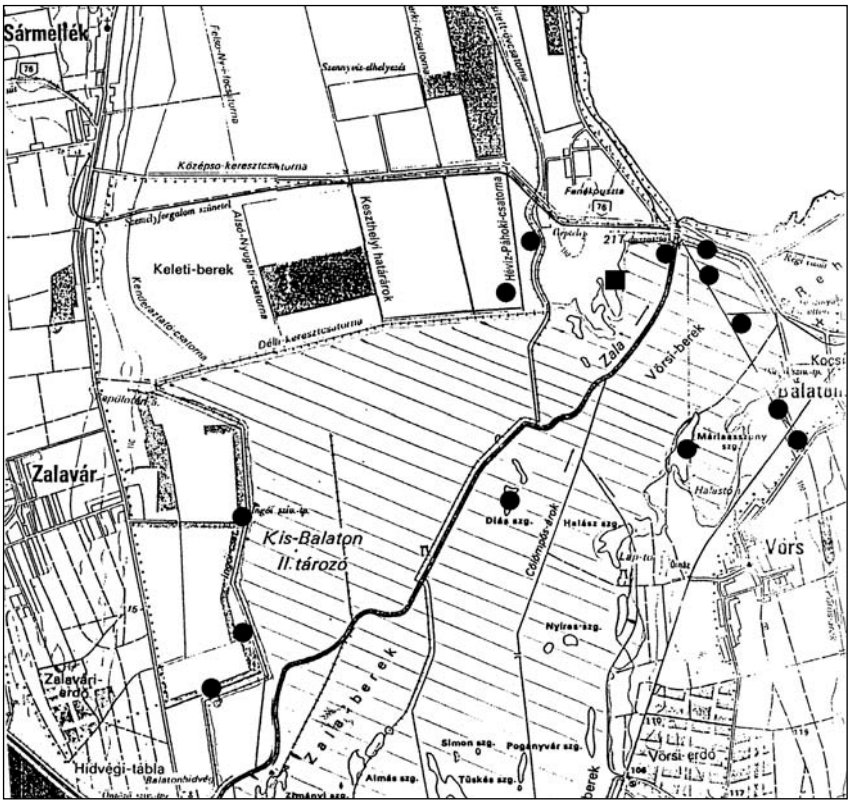

Figure 1: The geographical position of borings at Vörsi-berek

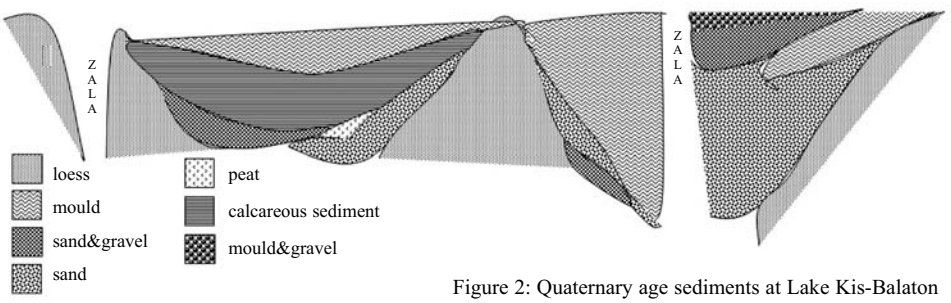

Figure 2: Quaternary age sediments at Lake Kis-Balaton

The aim of this publication to introduce the unpublished faunal analyses of the Holocene age excavations (with the exception of the malacological material of the archaeological sites), which enlarge our knowledge about the development of the territory, comparing with the previous published data.

On the basis of the previous data it was possible to make the geological profile of the territory (Fig. 2.).

Zala Waterworks (ZVM)

It is situated SW to the pump yard approximately 20 m to the railway embankment into the direction of the swampy area. Sampling has begun at 120 cm depth because of the filling. The upper samples came out from peaty mould. The first significant change took place at 180 cm depth, where mould was followed by grey coloured sandy sediments which contained shells of *Lithoglyphus naticoides* in great abundance. The above mentioned sandy material could be traced until 380 cm depth where the borer seized in a gravel rich layer.

The faunal composition of the samples is shown by the following table:

Kis-Balaton: Zala-Vízművek	**ZVM1**	**ZVM2**	**ZVM3**	**ZVM4**	**ZVM5**	**ZVM6**
Aquatic species						
Acroloxus lacustris	1					
Anisus spirorbis	1				1	
Bithynia tentaculata		2	3	2	1	
Bithynia tentaculata op.		46		27	22	9
Gyraulus albus		2				
Gyeaulus laevis				1		
Gyraulus crista	1					1
Hyppeutis complanatus					1	
Lithoglyphus naticoides	3	57	14	25	38	22
Lymnaea peregra	3	6		5	3	2
Lymnaea stagnalis		4	1	3		2
Pisidium sp.	1	13	4	9	10	11
Planorbis planorbis	4	8	2	5	3	1
Valvata cristata		2	1		4	4
Valvata piscinalis		3	2		12	13
Terrestrial species						
Carychium minimum	1					
Cepaea vindobonensis					1	
Chondrula tridens			1		1	
Oxyloma elegans	1				1	
Perforatella rubiginosa				1		
Pupilla muscorum				1		
Succinea oblonga	3	2	5	4	2	1
Vallonia enniensis	2	3	2	1	6	1

The examined fauna consists of 22 species; 14 aquatic and 8 terrestrial ones. (The *Pisidium* sp. hasn't been determined an species level, yet.) The amalgamations of the species from different environments refer to near-bank sedimentation. It is shown by the fact that the rate of the terrestrial elements is only 8,7 percent. If the members of the Succineidae family is

also ranked among the aquatic species, because of their life habit and other oecological characteristics the above mentioned difference becomes more conspicuous ("… sometimes these can be collected as really aquatic gastropods" written by Richnovszky, A. & Pintér, L. (1979) about Succineidae). In this case the rate of terrestrial elements decreases into 4,8 percent. The rate of *Lithoglyphus naticoides* is 34,5 percent. This means the one third of the total number of individuals. The dominance of this species refers to agitated, near-bank environment. The agitated water is also shown by the great abundance of *Bithynia tentaculata* opercula (22, 6 percent). According to the exposed sediments (Fig. 3.) and their faunae a near bank bar complex can be presumed. The *Valvata piscinalis* is also abundant in the fauna of the deepest sediments which is in good accordance with the sandy layers.

Vörsi-berek (VB II.)

The locality is situated at a small island eastward to the River Zala, approximately 200 m from the railway embankment into the direction of the reed. Even the surface has been covered by pebbles (Fig. 3.). The uppermost sample of the profile was a gravel mixed mould. Presumably after the total closure of the basin the moor formation took place on the gravely surface.

It is also proved by the fact that the mould disappeared in 50 cm depth; grey sand and lot of pebbles could be observed with numerous *Lithoglyphus naticoides* shells. It was followed by finegrained grey mud at 90 cm and greyish blue finegrained sand at 110 cm. Further sampling has been impossible because of intensive water entry.

The identified mollusc fauna of the samples is shown by the table below:

Kis-Balaton: Vörsi-berek II. (VB II.)	**VB II/1**	**VB II/2**	**VB II/3**	**VB II/4**	**VB II/5**	**VB II/6**
Aquatic species						
Anisus spirorbis	6					
Bithynia tentaculata op.				1	3	1
Bithynia tentaculata				1		1
Gyraulus albus						
Gyraulus crista				1		
Lithoglyphus naticoides	38	13	42	60	67	34
Lymnaea peregra				1		1
Lymnaea stagnalis	6	2		5	7	4
Pisidium sp		1		6	2	3
Planorbis planorbis	1			2	4	3
Valvata cristata				1		
Valvata piscinalis		1	3	8	13	4
Terrestrial species						
Carychium minimum	12					
Chondrula tridens	1					1
Cochlicopa lubrica	8					
Nesovitrea hammonis	2					
Perforatella rubiginosa	5					

Kis-Balaton: Vörsi-berek II. (VB II.)	VB II/1	VB II/2	VB II/3	VB II/4	VB II/5	VB II/6
Terrestrial species						
Pupilla muscorum	4					
Succinea oblonga				1	1	
Vallonia enniensis	49					
Vertigo pygmaea	3					

The fauna consists of 20 species (11 aquatic and 9 terrestrial ones). Only 20,1 percent of the total number of individuals is terrestrial. Characteristic the dominance of *Lithoglyphus naticoides* (58,7 percent). *Valvata piscinalis* is also abundant. On the basis of the fauna a near-bank, pebbly bar environment with agitated water is presumable.

Vörsi-berek III. (VB III.)

The sampling place is situated approximately 100 m from the previous one into the direction of the main road. The surface is covered by mould. It is followed by finegrained grey sand with pebbles at 30 cm depth. While in 50 cm depth the number of pebbles decrease. *Lithoglyphus naticoides* shells occurred in the sediment. At 90 cm depth only sand could have observed. Sampling has been finished at 200 cm (sample 7.).

The fauna of the sediments are as follows:

Kis-Balaton: Vörsi-berek	VB III/1	VB III/2	VB III/3	VB III/4	VB III/5	VB III/6	VB III/7
Aquatic species							
Anisus spirorbis			1				
Bithynia tentaculata	1	1	3	1		2	14
Gyraulus albus		2		1	1	1	
Gyraulus crista			3			1	
Lithoglyphus naticoides	24	51	78	48	55	58	94
Lymnaea peregra	2	3					5
Lymnaea stagnalis						2	1
Lymnaea truncatula	1						
Lymnaeidae indet.			5	6		2	
Pisidium sp.	2	12	42	29	39	25	37
Planorbis planorbis	9	1	2	4	1	5	8
Planorbarius corneus			1		5		1
Segmentina nitida					1		
Valvata cristata	4	3	6	4	3	5	
Valvata piscinalis		14	19	12	14	28	14
Viviparus contectus							1
Terrestrial species							
Carychium minimum	3						
Cochlicopa lubrica	11						

Kis-Balaton: Vörsi-berek	VB III/1	VB III/2	VB III/3	VB III/4	VB III/5	VB III/6	VB III/7
Terrestrial species							
Helicidae indet.			1	1			1
Nesovitrea hammonis	1						
Perforatella rubiginosa	14						
Pupilla muscorum	12						
Succinea oblonga	47	1				1	
Trichia hispida	1						
Vallonia enniensis	123	2	3	3			1
Vertigo pusilla	1						
Vertigo pygmaea	15	1					

There have been 16 aquatic and 11 terrestrial species identified in the fauna. The total number of individuals is 1061. The number of individuals of aquatic species is 818 (77, 1 percent), while the number of terrestrial specimens is 243 (22, 9 percent).

Comparing with the previous samples high rate of the unidentified *Pisidium* sp. can be observed (17, 5 percent). *Valvata piscinalis* is also abundant in the fauna (9, 5 percent).

Lithoglyphus naticoides is the most abundant (38, 5 percent). Among the terrestrial species the rate of the *Vallonia enniensis* is the highest (12, 4 percent). The greatest abundance of the species in the upper, so called mould sample can be observed (11,6 percent).

The fauna of the sample represents a near-bank gravely-sandy environment, where during the up-filling (VB III./1 sample) moor formation took place followed by temporary dry periods; desiccation.

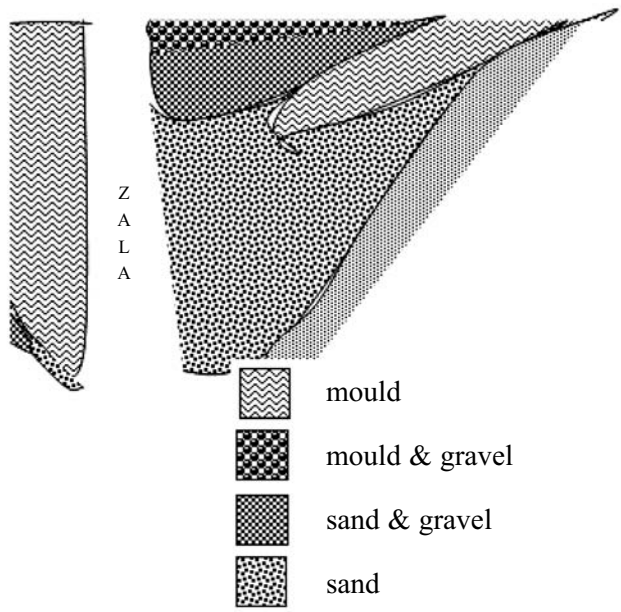

Figure 3: Profile of the northern part of Vörsi-berek (Fűköh, L. 2001)

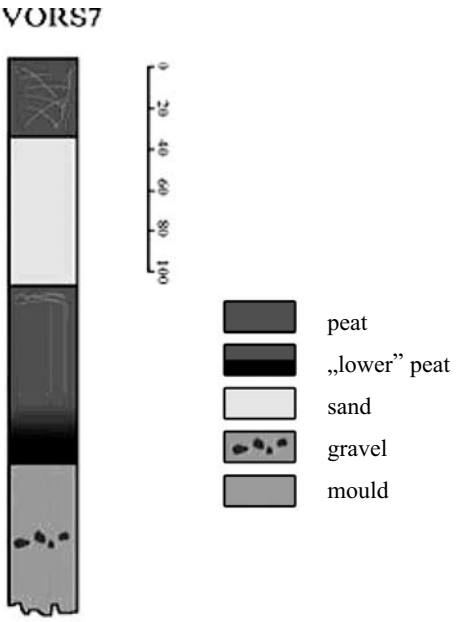

Figure 4: Sedimentological characteristics of the profile (by Bradák, B. 2007)

The exposed and faunistically analyzed profiles (ZVM, VB II., and VB III.) are in good accordance with that one which is introduced by Bradák (2007); the different sediments show excellent parallelism. Among the borings have been deepened for sedimentological examinations, the upper part of VORS6-7-8 profiles are described in the following way by Bradák: "Level, rich in organic material: the upper member of peat layers in the case of the lacustrine profiles (VORS6, 7, 8) contain good deal of organic debris and shell fragments (VORS 6/1; 6/3; 7/1; 7/3; 8/1; 8/4; 8/5)".

The above mentioned samples show similarities with the sediments of the borings deepened for malacological analyzes (VB II/1, 2; ZVM1, 2; VB III/1), and contain molluscan shells in great abundance (Fig. 4.).

Also remarkable similarity can be observed comparing the bottom sediments of the malacological borings VB II., VB III. and ZVM and the sedimentological borings VORS6-7-8. As it is written by Bradák: "The floor of the borings was dark grey coloured clayey-silty sand. In the grey coloured sediment of the VORS7 boring finegrained gravel layer have been exposed, which showed similarity to the terrestrial borings." (Bradák, 2007).

Vörs-berek

At the territory of Vörs-berek lot of borings have been deepened. The boring named VÖRS is situated in the vicinity of the village, at the left side of the channel, at the hectometre sign No. 114. It is only its fauna which were introduced previously (Fűköh, L. 2001). The other boring, named VB is situated a little bit further opposite to the Máriaasszonysziget (Figs. 5–6.).

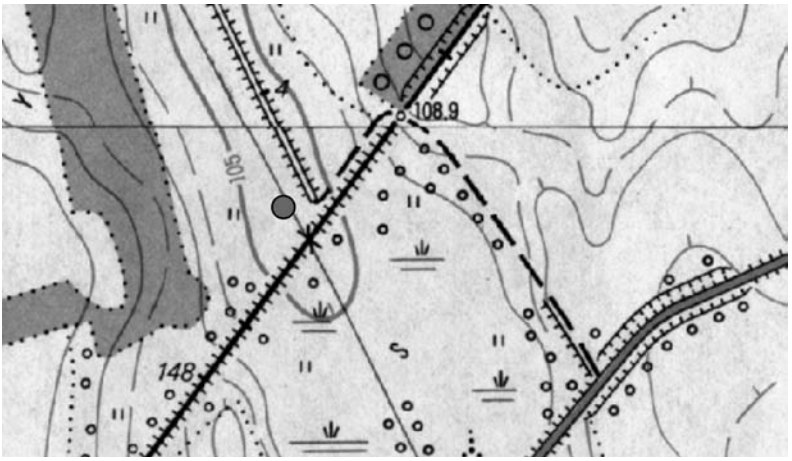

Figure 5: The geographical position of boring VÖRS; in the vicinity of the village

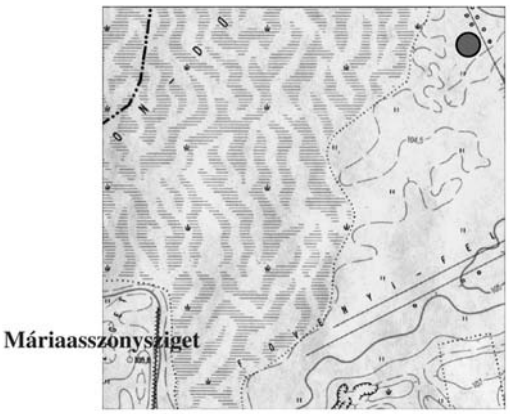

Figure 6: The geological position of the boring at Vörs-berek

Vörs

(Situated in the vicinity of the village, at the left side of the channel.)

The undisturbed sediments began at 50 cm depth. The upper 100 cm is mould. Here the transition into grey calcareous sediments can be observed. Greyish-blue sand appear at 200 cm depth. Finegrained gravel layer can be detected in the sand at 270 cm (samples VS-10).

Vörs (falu előtt)	V1	V2	V3	V4	V5	V6	V7	V8	V9
Aquatic species									
Acroloxus lacustris	1		1						
Anisus vortex		2							
Anisus vorticulus	2	10							
Aplexa hypnorum	1								
Bathyomphalus cont.	2	1							
Bithynia leachi	10	20					1		
Bithynia tent. op.		42				2			
Bithynia tentaculata	57	116	8	1		6	1	1	1
Gyraulus albus		9				1	1		
Gyraulus crista	3	45				1	1	3	1
Gyraulus laevis			4				1		
Hippeutis complanatus		9				1			1
Lymnaea palustris	8	24					1		
Lymnaea peregra	40	10	1			7			
Lymnaea stagnalis		12				1			1
Lymnaea truncatula	3	10	1		1		1	2	
Lymnaea aggl.		77							
Pisidium sp.	17	42	1					1	
Planorbis planorbis	22	110	5	6	1	9		2	2
Planorbarius corneus		3							
Segmentina nitida	2	3				1			
Valvata cristata	321	653	16	8	4	26	8		5
Valvata piscinalis		1	1(p)				1		
Viviparus contectus	4	4							
Terrestrial species									
Carychium minimum	163	41	1			1			
Chondrula tridens	1	2	4			1			1
Cochlicopa lubrica	23	8	1						
Euconulus fulvus	4	1				1			
Granaria frumentum	–	4	11	1	1	8	1	3	1
Nesovitrea hammonis	21	1							
Limacidae ind.	–	1							
Oxyloma elegans	12	17	1				2		
Pupilla muscorum	6	–							
Perforatella rubiginosa	27	–							
Succinea oblonga	159	105	10	3	1	14		1	1
Truncatellina cylindrica	–	4							
Vallonia costata	16	18	2			2			
Vallonia enniensis	120	177	2			4	2	1	2
Vallonia pulchella	7	66	43	6	6	20	4	2	3
Vertigo antivertigo	38	58	5	2	2	1	1		
Vertigo angustior	37	–			–	–			
Vertigo pygmaea	18	30	7		1	–			
Vertigo pusilla	–	20			–	–			
Vertigo moulinsiana	–	1			–	1			

There have been 22 aquatic and 20 terrestrial species identified in the sample. The total number of individuals is 3239 specimens. The rate of aquatic species is 56,9 percent (1845 specimens), while this number in the case of terrestrial 43,1 percent (1394 specimens). The distribution of the two groups is almost half and half. The result is the same if the oecological analyzes of the fauna is examined/carried out.

We can say that only the fauna of the upper part of the moor sediments can be evaluated. It enables us for the following environmental reconstruction: wet, Moorish territory with small, dry islands and temporary higher water-level. The highest water-level according to the fauna of V2 sample can be assumed, without significant continuous flooded surfaces. The fauna of the deeper sandy deposits shows the similar environmental features.

Vörsi-berek (VB)

At the top of the profile block mould can be found until 100 cm depth. It is followed by yellowish-grey sand (130 cm), and yellow coloured sand (150 cm). The faunae of the boring are shown by the following table:

Kis-Balaton: Vörsi-berek (VB)	**VB1**	**VB2**	**VB3**	**VB4**
Aquatic species				
Acroloxus lacustris		1		
Anisus spirorbis	5			
Bithynia leachi			18	
Bithynia tentaculata op.	5	1	11	
Bithynia tentaculata	3			1
Gyraulus albus			1	
Gyraulus crista			2	
Gyraulus laevis			1	
Hippeutis complanatus	1			
Lithoglyphus naticoides				1
Lymnaea peregra			3	
Lymnaea stagnalis			4	
Lymnaea aggr.	8			
Pisidium sp			10	
Planorbarius corneus			2	
Planorbis planorbis	16		12	
Segmentina nitida			2	
Valvata cristata	1	1	131	
Valvata piscinalis			16	
Valvata pulchella				1
Terrestrial species				
Carychium minimum	87		10	
Chondrula tridens	1		5	
Cochlicopa lubrica	23	1	2	
Euconulus fulvus	1			
Nesovitrea hammonis	6		1	

Kis-Balaton: Vörsi-berek (VB)	VB1	VB2	VB3	VB4
Terrestrial species				
Pupilla muscorum	79	5	5	
Succinea oblonga	31		10	
Truncatellina cylindrica	1		1	
Vallonia costata	64	1	2	
Vallonia enniensis	38	2		
Vallonia pulchella	35	4	6	
Vertigo antivertigo	2			
Vertigo angustior	31			
Vertigo pygmaea	35		5	

The faunae of the samples contains 33 species which can be divided into 18 aquatic one and 15 terrestrial one (Pisididae are unidentified). The total number of individuals is 753 specimens. The rate of the aquatic species is 34,3 percent (258 specimens) while the rate of terrestrial species is 65,7 percent (495 specimens).

The latter group of molluscs is almost double of the aquatic ones.

Regarding the fauna of the samples one by one gradual moor formation can be observed, while in the lowermost yellowish-grey coloured sandy sediments two rheophillous species occurred *(Lithoglyphus naticoides and Valvata pulchella),* the number of terrestrial species is only one.

Similar environmental conditions are proved by the faunae of the "younger" sediments. In the fauna of the VB3 sample the rate of the aquatic species is 81,3 percent. Regarding the total fauna of the sample the rate of the *Valvata cristata* is 50,4 percent. Significant change of the fauna can be seen in the uppermost sample. The rate of the terrestrial species is 90,9 percent. On the basis of the almost 10 percent rate of aquatic species we cannot conclude on even temporary water cover of the territory. The fauna is similar to the fauna of near-water dry meadow association.

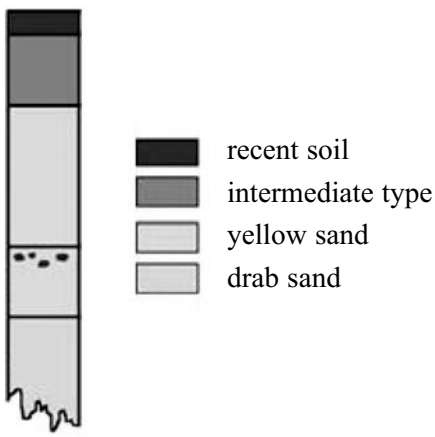

Figure 7: The profile of boring VORSBB2 (by Bradák 2007)

The fauna bearing sediments of the boring VÖRS (in the vicinity of the village, at the left side of the channel) and the boring Vörsi-berek can be well-correlated with the "bank sediments" of the profile named VORSBB2 in Bradák's publication (2007) (Fig. 7.).

It is evident, because the borings have been deepened for malacological examinations are situated for near to the Island Máriaasszonysziget than the previously introduced ones representing an earlier period of the Holocene age where the sediments refer to a presumably water covered basin.

On the basis of the malacological material, and taking into consideration of the analyzes of the molluscs have been found at other localities of Lake Kis-Balaton and Lake Fenéki it is assumed that the gravely sediments containing *Lithoglyphus naticoides* have been deposited at the beginning of the Holocene age, when the extension of the lake could have been larger and the Island Máriaasszony situated closer to the open water than nowadays.

It is proved by that fact that the above mentioned species occur in the graves belonging into "starèevo culture" (see the description of the malacofauna of the archaeological material).

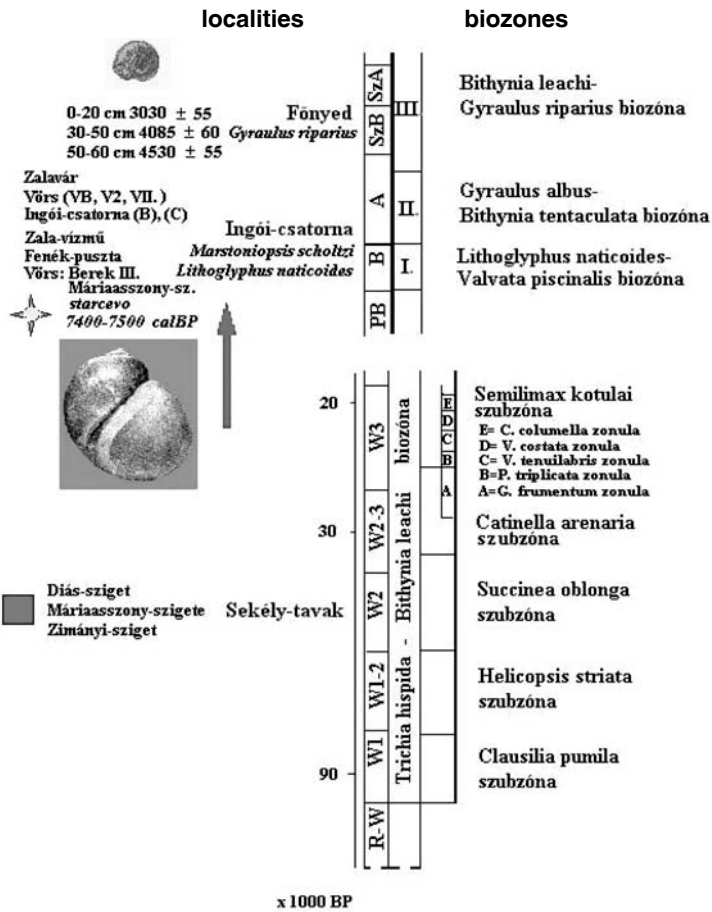

Figure 7: Biostratigraphic dissection of the sediment according to malacological material.

On the basis of these we can conclude on even well-oxygenated, flowing water around the evidently Pleistocene age island erected from the moor (Fűköh, L. 2001, 2002).

The earliest Holocene age is proved by the malacological material of the borings deepened between Főnyed and Szegerdő and also by the molluscan material of the borings of Medzihradszky situated also in the vicinity of Főnyed for the purposes of pollen analyzes. Since *Gyraulus riparus* occur in each material. In the sediments of Máriaasszonysziget malacological material has not been found (with the exception of the "culture layers"). It is why the relative age of these sediments are matter of estimation. According to the above mentioned facts the sediments are not older than the Late-Pleistocene (W2, *Trichia hispida-Bithynia leachi* biozone, *Succinea oblonga* subzone) and are not younger than the Holocene age subboreal *Bithynia leachi-Gyraulus riparius* zone, which can be understood if the malacological material of the archaeological sites of the island is taken into consideration (fig. 8.).

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