Tiscia (Szeged) Vol. XXIII, pp. 3—12 (1988)

CENOLOGICAL RELATIONS OF MUD VEGETATION OF A HYPERTROPHIC LAKE IN THE TISZAALPÁR BASIN

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(Received October 10, 1988)

Abstract

The paper deals with the description of mud vegetation of a meander lake found in the area of the contemplated Alpár Reservoir. It has a floristical importance because it describes a new habitat of Eleocharis ovata in the Great Hungarian Plain. A cenological characterization of mud vegetation is given as well for the stands of Eleocharis ovata in the Tisza Valley not described previously.

The stands of Eleocharis ovata can be regarded as a considerably modified Eleocharito-Caricetum bohemicae association, influenced in its cenological structure by the high nutrient content of the sediment of the lake. Modification of the cenological structure is caused by the strong competitive ability of the Bidentetea (incl. Ranunculetum scelerati and Polygono-Bidentetum) species.

Introduction

The subsoil water gushes forth in several places in the contact zone of the Tiszaalpár Basin and the sand dunes of Kiskunság. In the event of appropriate relief relations, these little sources feed temporary lakes and bogs (SZALMA and LÉVAI 1987). A long meander along the border of sand dunes collects the water from such a source. This meander was formed by the receding water after the flooding of the Tisza River had ceased (Fig. 1). A small part of the meander was isolated by means of building lanes. Thus, the water of the source is sufficient to keep the lake inundated throughout the year. The water quality is considerably influenced by slop water, originating from a sheep fold which was built near the lake. The slop water flows to the lake without being cleaned.

These specific effects have caused the development of a curious habitat which has been subject to many kinds of research in recent years. The aquatic macrophyton vegetation of the meander lake has been studied — in connection with the chemical relations of the sediment and the water — by SZALMA and BODROGKÖZY (1985). Several pieces of algological data of KISS (1985) refer to this lake. Moreover, there is information on the radioactive element content of the mud (KEDVES and SZEDERKÉNYI 1986).

After this, a necessary step was to perform a detailed study on the mud vegetation of the lake. An advantageous occasion was offered in 1985 when the lake almost completely dried out. Therefore, extensive mud vegetation developed on the bottom.

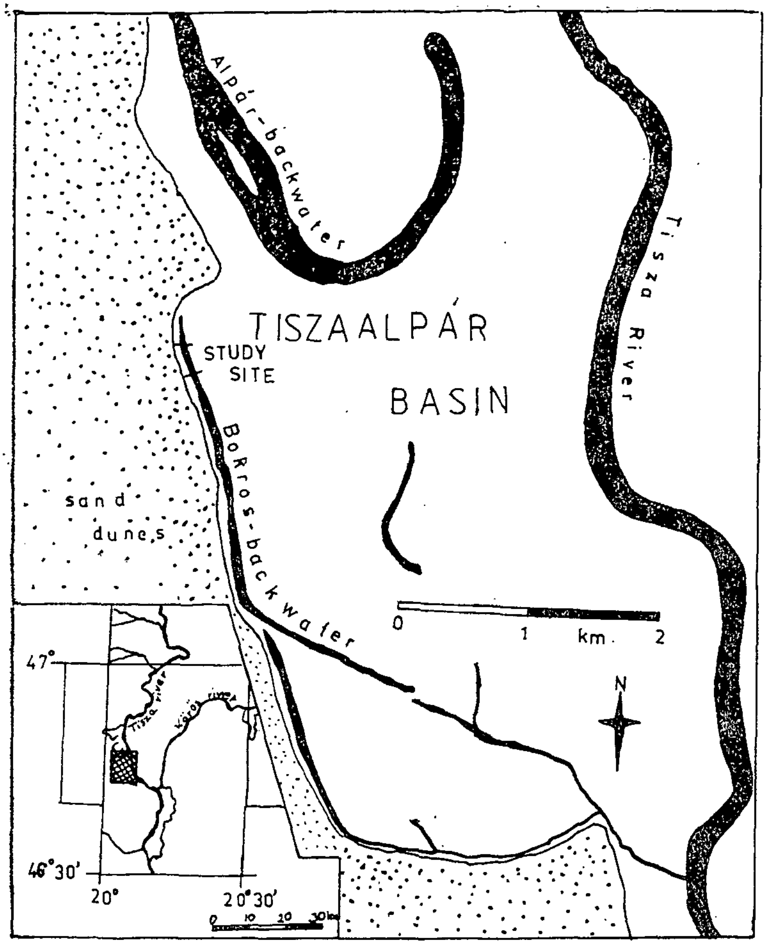

Fig. 1. Geographical location of the study area

Materials and Methods

37 cenological relevés were taken on the territory of the meander lake. The cenological table gives the relative cover of the species as a percentage. The plotted areas follow the cenologically homogeneous units of vegetation.

Therefore, the extent of the plots is different: it is between 15 and 25 m². Covering data of 20, most dominant, species were used in numerical classification of relevés.

The soil studies were performed by means of methods laid down in valid Hungarian standards. The soil samples were taken from typical units of vegetation.

Results

Characterization of the mud vegetation

1. Cenological approach

Table 1 comprises the cenological data of the relevés. A significant part of the species may be classed among four higher cenotaxa: Phragmitetea TX. et PRSG. 42, Isoëto-Nanojuncetea BR.-BL. et TX. 43, Bidentetea TX., LOHM., PRSG. 50 and Molinio-Juncetea BR.-BL. 49, 51. Species belonging to these cenotaxa cover 95% of the area (Table 1.)

Considering the cenological table, the vegetation of stands may be characterized as an *Eleocharito-Caricetum bohemicae* KLIKA 35 em. PIETSCH (61) 63 association, which was modified by the high nutrient content of the soil. The *Carex bohemica* is absent from the cenological relevés because the study site is outside the area where this species is found. In spite of this, the association structure corresponds, in many details, with those described by PIETSCH and MÜLLER—STOLL (1968) as *Eleocharito-Caricetum bohemicae.*

The description of the new habitat of *Eleocharis ovata* is significant floristically as well because this is the third occurrence of the species in the Tisza Valley (i.e. after Tiszaföldvár and Hódmezővásárhely). Its cenological relations have not yet been clarified in Hungary (SOÓ 1973).

Comparing the stands of the meander lake with cenological relevés taken by PIETSCH and MÜLLER—STOLL, it can be determined that the somewhat similar Phragmitetea *(Glyceria fluitans, Alisma plantago-aquatica, Oenanthe aquatica, Phragmites australis, Rumex hydrolapathum)*, Bidentetea *(Bidens cernua, Bidens tripartita, Leersia oryzoides, Chenopodium rubrum)*, Molinio-Juncetea *(Agrostis stolonifera)* species associate with a typical Isoëto-Nanojuncetea associatoin. A difference is shown in the essentially higher coverage of *Carex serotina, Bidens cernua, Polygonum lapathifolium, Atriplex oblongifolia* and *Ranunculus sceleratus*. The *Carex serotina* substitues for the role of *Carex bohemica* in the formation of association structure. This explains the higher dominance of *Carex serotina.* The high nutrient content of the soil explains the greater dominance of the above-mentioned Bidentetea species. Thus, the vegetation shows a transition to *Polygono-Bidentetum* FELFÖLDY, 43 and *Ranunculetum scelerati* SISSINGH in R. TX. 50. associations.

The other Isoëto-Nanojuncetea species — *Cyperus fuscus*, *Juncus articulatus* and *Juncus bufonius* — relate to the cyperetosum fusci subassociation of the *Elechari-Caricetum bohemicae* association. The *Juncus articulatus* has similar dominance relations, as in the relevés of the Centaurium pulchellum variant described by PIETSCH and MÜLLER—STOLL. Therefore, the stand of *Carex serotina* and *Juncus articulatus* mentioned by POLGÁR (1937) may be regarded as a modified Eleocharito-Caricetum association; it does not belong to the *Cypero-Juncetum* association (c.f. SOÓ 1973).

The meander lake, in its eastern part, connects with the Molinio-Juncetea associations. The migration of Molino-Juncetea elements has a significant influence on the cenological relations of the lake. The higher coverage of *Agrostis stolonifera* and Poa trivialis is characteristic of the contact zone.

The traditional classification of relevés — based on character species — is not entirely satisfactory. Cenological judgement of several species may be manifold. For example, the *Ranunculus sceleratus* may be regarded as an Isoëto-Nanojuncetea species, as well as a Bidentetea, being similar to the *Juncus articulatus*. The *Agrostis stolonifera* has an aquatic form in the 7th and 8th relevés. It has a Phragmitetea rather than an Agrostion character. It is expedient that classification of such complicated association complexes be preformed by application of numerical methods.

Table 1. *Cenological data of relevés*

Number of stand:	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
Total covering (%):	70	50	60	99	99	40	50	50	60	40	50	30	99	99	99	45
PHRAGMITETEA																
Alisma plantago-aquatica			+				10	10	1			4		+	1	+
Butomus umbellatus		+												+		+
Oenanthe aquatica (terrestris)	1	10	5	10	7	6	16	10	10	3	8	8	3	1	5	4
Rumex stenophyllus		+	+	1	2			1								
Glyceria maxima	+	8	1	5	1	2	+	3	3		1	4	2	1		1
Glyceria fluitans		+			+									+	+	
Rumex hydrolapathum													1	1	+	
Typha latifolia														+		1
Mentha aquatica	3		+							+						
Lythrum salicaria				+										1		1
Lycopus europaeus			+	3	5				+	1			1	5	3	2
ISOETO-NANOJUNCETEA																
Eleocharis ovata	1	3	8	+		6			5	4	1	4	4	1		2
Carex serotina	6	13	13	5	11	9	4	8	6	8	6	19	10	6	10	17
Juncus articulatus	1	4	8		1	8			3	25	20	6	3	2	+	4
Cyperus fuscus	2	5	2	2	1	5	+		1	1	6	4		5	6	3
Juncus bufonius	2	2	1		2	+	2			1	6	2	1	2	1	
Veronica beccabunga				1							1			1		2
BIDENTETEA																
Ranunculus sceleratus	8	10	15	8	15	10	8	8	16	30	40	35	50	40	30	28
Bidens cernua	6	3	4	12	15	4	20	22	25	10	6	2	2	20	15	15
Leersia oryzoides	1		1	2	2	6	4	4	3	2	3	8	15	3	5	6
Polygonum lapathifolium		2	1	3	5	2	2	3	1		+		1		5	
Bidens tripartita	1	+	+	+	1	2	2	1		+	1	+		2	2	1
Atriplex oblongifolia			+	1	1			+	1	2			2	1	2	4
Chenopodium rubrum			+			+								+		1
Chenopodium polyspermum				+						+			+		+	+
Xanthium italicum	+	+	3	1	+					+						+
Polygonum hydropiper				+			+							+		
Solanum dulcamara										+			2	+	1	6
Solanum nigrum	+		+								+	+		+	1	
MOLINIO-JUNCETEA																
Agrostis stolonifera	12	10	15	20	15	40	30	30	25	10	+	4	+	+		+
Poa trivialis	45	30	22	25	15					3						
OTHER SPECIES																
Echinochloa crus-galli					+			+					1	+	8	
Rumex crispus	1	+	+	+	1		2			+	1			1	1	2
Salix triandra (juv.)					+	+	+	+	+			+	1	2	2	
Plantago major	1		+		+					+			1			
Cirsium arvense	+			+	+							+			+	1
Sonchus arvensis					+	+					+			+		+
Malva neglecta	6	+	1				1			+		+				
Batrachium aquatile											+					2

Althaea officinalis 34+, 35+; *Chenopodium album* 3+, 33+, 43+, 35+; *Chlorocyperus glomeratus* 19+, 20+; *Conium maculatum* 5:1; *Eleocharis palustris* 14:2, 15:1, 35+; *Equisetum fluviatile* 14:2, 15:1, 18+, 30+; *Galium palustre* 1+, 16+; *Heleochloa alopecuroides* 35+; *Lycopus exaltatus* 5+, 15+, 16:2, 31+; *Lysimachia nummularia* 1+; *Matricaria maritima* 3+; *Myosotis palustris* 16+, 31+; *Phragmites australis* 14+, 21+; *Polygonum aviculare* 1+; *Potentilla reptans* 18+; *Potentilla supina* 14:1, 27:1, 36+; *Rorippa amphibia* 15+; *Rorippa sylvestris* 20+; *Sonchus asper* 18+, 28+, 29+; *Sonchus oleraceus* 16+, 31+, 33+; *Taraxacum officinale* 18+; *Teucrium scordium* 16+; *Trifolium repens* 2+, 3+, 27+.

17 60	18 60	19 50	20 80	21 40	22 40	23 60	24 30	25 40	26 40	27 40	28 60	29 40	30 60	31 90	32 30	33 40	34 40	35 45	36 65	37 40
1			4			13		+	+	1	+	2				1		1		1
		+						4				+						+		
5	8	2	3	4	18	10	10	6		8	3	4	5	5	5	+	5	2	10	
								+	+	1				1			1		1	
1	1				1	13	8	10	10	5	6	1		1		3	1	4	12	1
+	+				+	+	+		+										+	
	1												5							
+	1												+			+			+	
		+																+	+	
1	3		+		1					+		+					1	+		+
2	4	6	+	+									5	1		+	1	1	4	+
4	1	6	10	2	4	3	5	2	4	8	10	2	5	+	5	30	25	23	20	50
6	11	3	3	4	14	5	6	18	15	12	14	38	15	18	18	4	12	12	14	13
10	12	13	14	15	10	10	20	20	15	15	25	15	7	6	7	25	12	10	2	3
1	5	4	7	18	10	10	10	10	5	4	10	10		6	2			2	+	2
4		3	4	4	1	1	5	2	3	2	15	2	17	14	17	1	1			
+	1			2					+	1	+		3				+			+
5	12	13	10	10	18	15	10	10	13	10	10	5	17	20	7	6	15	10	10	10
12	20	35	30	18	4	10	6	2	6	10	1	2	10	11	10	8	10	15	10	10
12	3	+	+	10	5	3	10	10	10	10	3	10	5	+	2	6	+	2	8	5
+				2	2	2	4	2	5	1		1	1	6	2	2	3	2	2	
1	1	+				1		+	+					1		+		+	+	
1	1	2	+	+	1		+	+	2			2	1	+			1	1	1	1
		1	2		1		2	1	1	+	+						1			
+		+			+							+							+	
	1							+		+	+		+	2	+				+	
1		+		+					+					+		+			1	
+	1							+					3			+	1	+	+	+
+											+	+	+			+	1			
6	4	6	8	+	6		4		6	8	+	3	+	1	17	5	3	10	+	3
6							+		2					3	8	5	7	1	2	
9	3	4	4	4	2	1	+		+	+	+			+		2		1		
2	3	1	1	4	3		2	2	+	+	+	2		1		1		1	2	1
4	1					+	+		2	1	3	+	1							
	1	1	1								+			+	+	+		+		
+	+			1					1	+	+		+	1						
	+			+	+					+	+		+				+	+		
+	+				+								+	1			+	+	1	
6		1							+		+	+		+				+		

2. Numerical classification of the mud vegetation

The numerical classification of the relevés forms six clusters (Podani 1980) (Fig. 2).

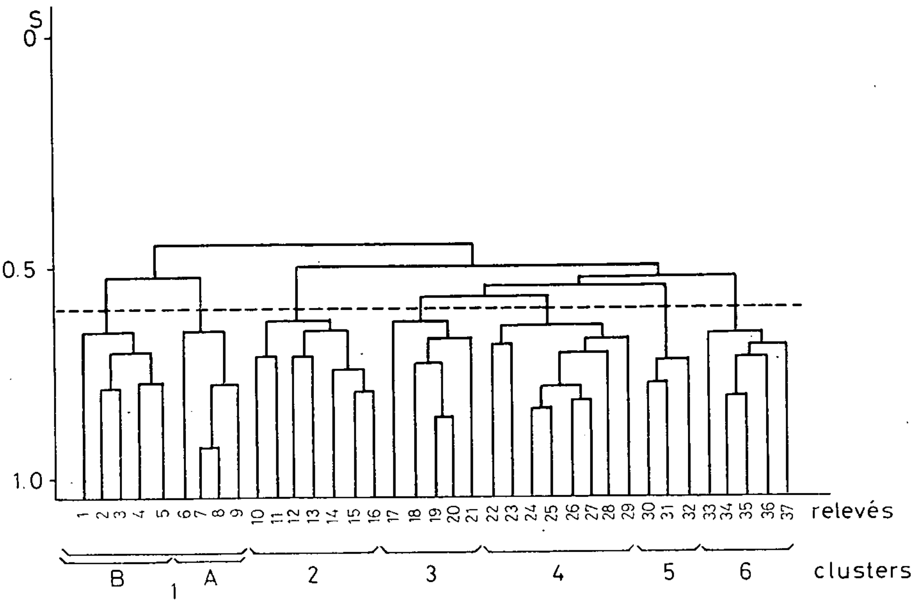

Fig. 2. Dendrogram of the 37 relevés based on Renkonen similarity index and simple average linkage. Dotted line shows the division level of groups

The first cluster links with the others on the lowest similarity level. The cluster may be divided into two subclusters. In the "A" subcluster, the *Agrostis stolonifera* and the *Bidens cernua* are dominant. In the "B" subcluster, the *Agrostis stolonifera* and the *Bidens cernua* are dominant. In the "B" subcluster, the *Agrostis stolonifera* associates with the *Poa trivialis*. The divided cluster supports the double character of the *Agrostis stolonifera*. The ratio of the Isoëto-Nanojuncetea species is the lowest in this cluster.

In the second cluster, the Bidentetea species are prevalent, covering 50—60% of the plotted areas. First is the *Ranunculus sceleratus* which has the highest ratio (28—50%). These relevés may be regarded as being close, typical representatives of the association *Ranunculetum scelerati*. The soil parameters of these vegetational units are shown in Table 2. As singularly high nitrogen content is characteristic of the soil; its value is more than 0.5% in the soil samples collected from a depth of 0—30 cm. High humidity content and soluble salt and nutrient concentration are features of the root zone (Soil sample I).

The ratio of the Isoëto-Nanojuncetea species increases in the third cluster. The most dominant species are the *Bidens cernua* and the *Juncus articulatus*. The dominance of *Juncus articulatus* and *Cyperus fuscus* is characteristic of the fourth cluster. The *Juncus articulatus* is a dominant species in the 3rd and 4th clusters as well. Therefore, its transition character between the Isoëto-Nanojuncetea and the Biden-

Table 2. *Summary of soil analysis for the hypertrophic lake*

Soil sample	Depth cm	Humidity %	hy_1 %	K_A	Total salts (%)	pH (H_2O)	pH (nKCl)	$CaCO_3$ %	Organic matter %	Total nitrogen %	mgK_2O/100 g	mgP_2O_5/100 g	Na^+ mg/100 g	Mg^{2+} mg/100 g	Ca^{2+} mg/100 g	SO_4^{2-} mg/100 g	HCO_3^- mg/100 g
I.	0—10	62.2	5.45	92	0.171	7.41	7.08	15.71	10.80	0.512	34.49	16.99	11.49	47.42	294.59	233.47	36.60
	10—20	59.8	4.65	79	0.160	7.31	7.03	10.56	10.75	0.535	20.09	15.98	8.62	23.10	190.38	107.93	47.58
	20—30	50.2	3.57	64	0.165	7.04	6.76	10.22	7.17	0.526	15.11	11.74	5.75	13.38	108.22	75.47	76.25
	30—40	41.2	2.05	51	0.138	7.14	6.90	9.37	4.75	0.300	7.75	24.25	2.76	6.08	58.12	28.59	62.22
	40—50	51.1	3.65	64	0.139	7.16	6.80	8.44	6.70	0.333	11.82	9.53	4.14	8.51	74.15	62.61	79.91
	50—60	43.6	3.10	60	0.139	7.55	7.07	9.29	6.02	0.294	9.21	26.27	3.30	7.30	38.08	65.22	39.65
II.	0—10	51.4	2.55	75	0.248	7.16	7.09	8.61	7.07	0.322	16.47	23.09	9.54	35.26	280.56	281.61	45.75
	10—20	35.2	2.06	56	0.131	7.43	7.14	4.90	3.75	0.233	10.35	29.22	2.99	4.86	58.12	38.45	42.70
	20—30	37.2	3.95	64	0.110	7.42	7.01	6.50	6.28	0.277	11.37	19.02	2.99	4.86	34.07	18.85	43.92
	30—40	38.3	4.57	67	0.120	7.45	6.90	8.28	6.07	0.329	11.14	13.20	2.82	4.86	26.05	5.93	48.80
	40—50	37.5	4.39	65	0.120	7.03	6.57	4.48	6.59	0.375	11.48	35.60	2.36	4.86	30.06	12.45	56.12
	50—60	33.8	4.22	63	0.095	6.54	5.95	0.68	6.91	0.355	16.92	59.80	2.82	4.26	19.04	1.19	47.58
III.	0—10	43.7	1.63	59	0.160	7.31	7.09	7.85	4.70	0.239	15.33	47.29	6.09	14.42	99.00	169.29	56.12
	10—20	27.2	0.92	43	0.085	7.70	7.47	4.39	2.44	0.120	8.53	44.87	1.90	1.20	41.58	69.06	42.70
	20—30	24.2	0.89	47	0.065	7.79	7.57	4.81	2.54	0.113	8.31	41.24	1.43	1.56	27.72	45.43	39.65
	30—40	22.1	0.51	34	0.058	7.69	7.59	3.63	1.55	0.067	5.59	30.55	1.20	3.60	29.70	54.97	53.07
	40—50	34.8	1.44	47	0.092	7.46	7.27	4.56	2.39	0.135	16.81	42.45	1.90	4.81	29.70	65.77	73.20
	50—60	41.0	2.65	57	0.095	7.50	7.05	4.64	4.44	0.244	25.08	50.11	2.53	4.81	27.72	40.85	59.17
IV.	0—10	53.8	4.61	87	0.164	7.23	6.94	12.07	11.54	0.504	28.93	14.47	11.49	27.63	180.18	144.11	54.90
	10—20	35.6	4.90	74	0.141	7.44	6.96	10.22	7.17	0.350	21.34	12.75	6.32	10.81	53.46	43.64	50.02
	20—30	37.6	3.92	68	0.141	7.31	6.75	10.30	6.17	0.302	18.96	10.45	6.55	13.22	49.50	32.10	78.08
	30—40	30.0	4.00	63	0.098	7.60	6.94	11.57	4.23	0.240	12.27	10.31	3.91	6.01	19.80	15.26	61.00
	40—50	26.3	3.49	59	0.098	7.73	6.96	11.99	3.60	0.168	13.41	12.17	3.28	2.40	19.80	6.38	57.34
	50—60	29.7	3.50	53	0.102	7.36	6.65	8.28	2.44	0.144	12.27	12.75	4.36	6.61	29.70	25.86	80.52

tetea is emphasized. The *Eleocharis ovata* and *Carex serotina* are found for the first time in higher coverage in the 4th cluster. The humidity of the soil is lower, as is the binding of the soil, than in the previous sample. The soil contains less nitrogen and potassium, but more phosphorus than in the sample of the 2nd cluster (see Tab. 2, Soil sample II).

Three relevés may be classed in the fifth cluster. The separation of this cluster is caused by the high coverage of *Juncus bufonius*. The high coverage of *Juncus bufonius* is closely connected to the sandy soil of the stands. The decreased coverage of the Bidentetea species is in connection with the lower nitrogen content of the soil (see Table 2, soil sample III).

The Isoëto-Nanojuncetea species are dominant in the sixth cluster. These five relevés represent the *Eleocharito-Caricetum* association (but compare with the previous part of the paper). Constant Bidentetea species are the *Ranunculus sceleratus, Bidens cernua, Leersia oryzoides* and *Atriplex oblongifolia* (due to the high nitrogen content of the soil). These species have a high nitrogen demand (ELLENBERG 1979) (see Tab. 2, Soil sample IV).

Demonstration of the relationships between the soil and the vegetation need further detailed studies (MÜLLER—STOLL and PIETSCH, 1985).

Conclusions

The soil of the meander lake has developed by way of organogenic sedimentation. The thickness of the layers of high organic matter is deeper than the soil samples. The age of the lake and its constant humidity condition assured the survival and dispersion of the *Eleocharis ovata*. The propagules of *Eleocharis ovata*, in all probability, arrived with the inundation currents of the Tisza from the northern part of the Great Hungarian Plain.

In the special habitat, a modified variant of the *Eleocharito-Caricetum bohemicae* association developed. The association structure is under the influence of the Bidentetea species.

The competitive ability of them is increased by the high nutrient content of the soil (MARKOVIĆ 1973). Presumably the described stands of the *Eleocharito-Caricetum ovatea* association represent a more tolerant variant of the typical associations against nutrient loading.

The building of the Alpár Reservoir will cause the decay of the unique vegetation and destroy one of the few habitats of the Eleocharis ovata in the Great Hungarian Plain.

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Egy hipertróf bokrosi meandertó iszapnövényzetének fitocönológiai viszonyai

BAGI I.

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A dolgozat egy — a létesítendő alpári víztározó területén található — meander-tó iszapnövényzetét írja le. Jelentőséget az tulajdonít a vizsgálatoknak, hogy a tó az *Eleocharis ovata* egy új lelőhelye. Sor került az iszapnövényzet cönológiai feldolgozására is, amely az *Eleocharis ovata* Tisza völgyi termőhelyein mindeddig nem történt meg.

Társulástanilag a növényállomány az *Eleocharito-Caricetum bohemicae* társulás egy erősen módosult változatának tekinthető, melynek struktúráját a tó aljazatának magas tápanyagtartalma jelentősen befolyásolja. A cönológiai struktúra módosulását a Bidentetea *(Ranunculetum scelerati. Polygono-Bidentetum)* fajok fokozott kompetíciós képessége okozza.

Фитоценозные условия грязевой флоры в гиперотрофическом меандер-озере, Бассейн Тисаалпари

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Резюме

Работа описывает грязевую флору меандер-озера в области создаваемого водохранилища в Тисаалпари. Анализы значительные потому, что озеро является новым месторождением *Eleocharis ovata.*

Грязевая флора была и ценологически обработана, это был первый случай месторождения *Eleocharis ovata* в долине Тисы.

Что касается флоры, она является сильно модифицированным вариантом объединения *Eleocharito—Caricetum bohemicae*, на чью структуру значительно влияет высокое содержание питательного вещества озера.

Модифицирование ценологической структуры объясняется развитой компетиционной. способностью видов Bidentetea *(Ranunculetum scelerati, Polygono-Bidentetum).*

Fitocenološki odnosi vegetacije mulja ekstremno eutrofnog meandra jezera Bokros

BAGI I.

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Rad prikazuje vegetaciju mulja meanderskog jezera na području buduće akumulacije u kotlini Alpár. Ispitivanja imaju značaja u tome, što se u Panonskoj niziji ovo jezero javlja i kao novo nalazište vrste *Eleocharis ovata*. S druge strane ni fitocenološka obrada muljevite vegetacije na nalazištima *E. ovata* u dolini reke Tise dosada nije uradjena.

U cenotičkom pogledu zajdenica predstavlja modifikovanu *Eleocharito-Caricetum bohemicae* fitocenozu, čija je struktura pod bitnim uticajem visoke hranljive vrednosti jezerskog dna. Izmenjene strukturalne osobine uslovljene su pojačanim kompetetivnim sposobnostima članova Bidentetea zajednice *(Ranunculetum scelerati, Polygono-Bidentetum)*.