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THE VEGETATION OF THE MARSH MEADOW OF ZÁKÁNYSZÉK

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Abstract. The marsh meadow of Zákányszék is a valuable semi-natural grass. During its mapping survey ten protected plant species were found. The area contains marsh meadows and sand dunes uprising from them. The vegetation is mosaic-like in accordance with the variable microrelief. Among the valuable vegetation types of the area there are typical and transitional types as well. Altogether eleven vegetation units can be differentiated. Three of them are transitional ones that don't only cover transitional stripes but also extended areas. Numerical methods also validated these vegetation types.

Keywords: grasslands, indirect gradient analysis, marshes, numerical methods, vegetation mapping

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Introduction

In the southern Kiskunság Rapaics (1927) was the first to deal with the research of plant communities. Bodrogközy (1961) summarized the results of his habitat ecological researches made in the southern Kiskunság and described the plant communities. He made vegetation maps of many grasslands including the marsh meadow of Zákányszék. In the 1990s Gaskó (1995, manuscript) revealed the botanical values of numerous semi-natural grasslands in the southern Kiskunság and also gave recommendations for protection of some areas. The nearest area to the marsh meadow of Zákányszék which he recommended for protection is the Zákányi Basin that is north to it. Owing to his work and the realization of its preciousness the research of the grasslands of southern Kiskunság was started. Csete (1997) made the botanical description of the Ásotthalmi marsh meadow nature conservation area. With its 22 protected plant species this is the most valuable marsh meadow in the area. At the end of the 90s Margóczi *et al.* (1998) made coenological researches on more than 30 grasslands in the Dorozsma-Majsai-sand plateau geographical area. During their researches they found many grasslands including the marsh-meadow of Zákányszék with valuable vegetation and populations of protected plant species. They focused on two plant communities from the point of view of nature conservation, these are the *Succiso-Molinietum hungaricae* and the *Astragalo austriacae- Festucetum sulcatae* associations. They aimed to do further coenological researches on the grasses. In the D-TMap 1996-2000 project Margóczi (1998) made a habitat map of the sample area Nr. 35 that involves the marsh meadow of Zákányszék. She signed mostly a mosaic of *Succiso-Molinietum hungaricae*, sand-steppe meadow and salt-affected meadows, and some salt-affected marshes and sand-steppe meadow in the area of the marsh meadow of Zákányszék. Urbán (1999) carried out coenological and pedological researches on the sand-steppe meadow stands of some meadows (including the marsh meadow of Zákányszék) in the southern Kiskunság, Madarász (2000) made similar researches on the *Succiso- Molinietum hungaricae* stands of the same meadows. Németh (2000) made the vegetation map of the enlargement of the Ásotthalmi Láprét, Papp (2000) made it for the marsh meadow called Halászka.

The marsh meadow of Zákányszék is one of the depressions between the sand dunes of Kiskunság that were formed by the most frequent NW direction wind and have an orientation in a NW-SE direction. It is characterized by heterogeneous microrelief conditions; it contains sand dunes, wet depressions and the transitional levels between them.

Consequently the vegetation is diverse and mosaic-like, it is partly composed of transitional stands that cannot be identified with vegetation types written in the literature (Borhidi and Sánta 1999, Fekete *et al.* 1997). Recent anthropogenic impacts (drying out as a result of the canalization and grazing) could have played an important role in the formation of these stands.

The nature of transitional stands is one of the main topics of the coenology of today (Bagi 1998, Körmöczi *et al.* 2002, Zalatnai and Körmöczi 2002); it gives the actuality of my researches. The investigation of the marsh meadow of Zákányszék is a part of the research that was aimed by Margóczi *et al.* (1998) and it is important also from the point of view of nature conservation. It can contribute to the protection of its valuable vegetation. It is a value also as a wetland with its flora and fauna. Its value is also increased by the sand-steppe meadow that can be found only in small patches today and is threatened by disappearing.

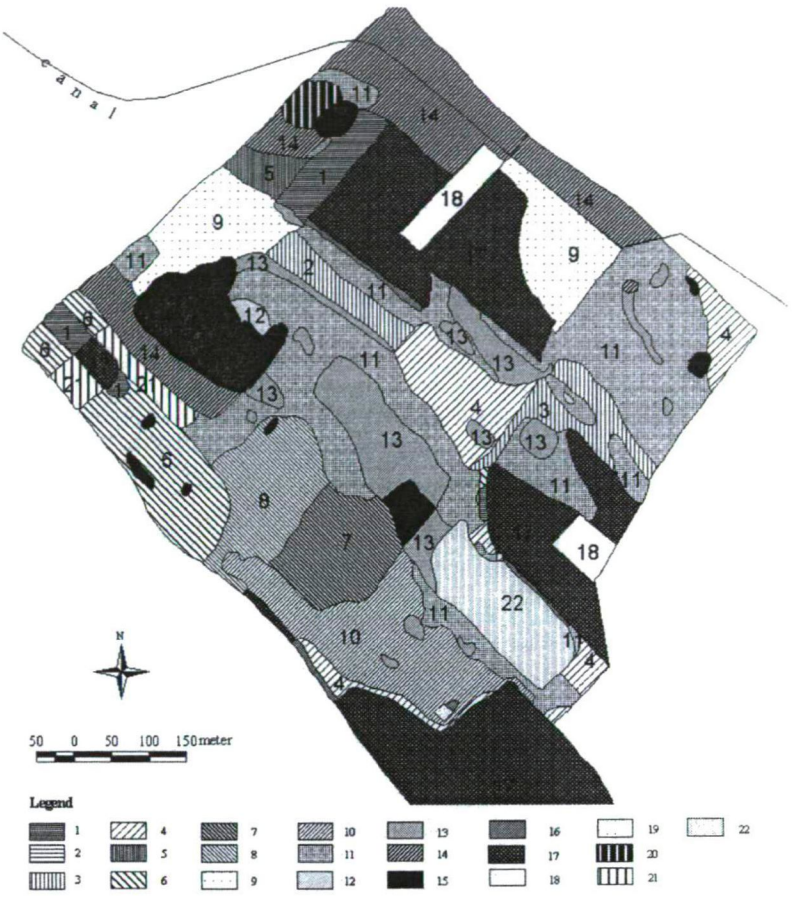

Fig. 1. The vegetation map of the marsh-meadow of Zákányszék (2001)
1: *Rhinanthus* type of *Astragalo austriacae-Festucetum sulcatae*, 2: *Genista* type of *Astragalo austriacae-Festucetum sulcatae*, 3: *Anacamptis* type of *Astragalo austriacae-Festucetum sulcatae*, 4: *Dactylis* type of *Astragalo austriacae-Festucetum sulcatae*, 5: transitional unit between *Astragalo austriacae-Festucetum sulcatae* and *Succiso-Molinietum hungaricae*, 6: transitional unit between *Agrostio-Caricetum distantis* and *Astragalo austriacae-Festucetum sulcatae*, 7: *Festuca pratensis* type of transitional unit between *Agrostio-Caricetum distantis* and *Astragalo austriacae-Festucetum sulcatae*, 8: transitional unit between *Agrostio-Caricetum distantis* and *Succiso-Molinietum hungaricae*, 9: *Succiso-Molinietum hungaricae*, 10: *Carex flacca* type of *Succiso-Molinietum hungaricae*, 11: *Agrostio-Caricetum distantis*, 12: *Lepidio crassifolii-Puccinellietum limosae*, 13: salt-affected marshes (*Schoenoplectetum tabernaemontani* and *Bolboschoenetum maritimi*), 14: large sedge communities (*Caricetum acutiformis* and *Caricetum ripariae*), 15: dry reed beds (*Phragmitetum communis* and *Bolboschoeno–Phragmitetum*), 16: weed vegetation, 17: ploughland, 18: farm, 19: pit for loam-mining, 20: mosaic of *Succiso-Molinietum hungaricae* and salt-affected marshes, 21: mosaic of large sedge communities and *Agrostio-Caricetum distantis*, 22: mosaic of dry reed beds and salt-affected marshes

Methods

The marsh meadow of Zákányszék is in the southern Kiskunság, in the geographical area called Dorozsma–Majsai–sand plateau, in the outskirts of Zákányszék. It belongs to the floristic region of the Eupannonicum (Great Plain), within it to the flora district of them Praematricum (Duna–Tisza köze). It's area is 115 ha and the mapped part is 56 ha.

According to Urbán (1999), the soil of the investigated steppe meadow stands within the marsh meadow of Zákányszék is slightly heavy, the upper layer is loam-sandy loam, below rather sand, coarse sand. The soil is slightly salt-affected, the sodium content is low.

The soil of the marsh analysed by Urbán (1999) is heavy, the heaviness figures are the highest in the upper layer and gradually going deeper the water retention and the loam content of the soil decreases (Madarász 2000). Its humus content is high.

The vegetation map (Fig. 1) was made on the basis of EOTR map (1978) on scale 1:10000 and a black and white aerial photograph (1989) on scale 1:10000 (Seregélyes and Csomós 1995). The scale of the map is 1:5000. It was elaborated in 2001. In the paper the denomination of vegetation units is in accordace with the literature (Borhidi and Sánta 1999) if it is possible but I did not categorized the transitional units and the units below the association level. On a small part of the area we fixed points using teodolite for making a test; the points fitted to the map created by spacing with an error of maximum 5 m.

In order to make objective sampling I made coenological quadrats of 5×5 m that were placed on homogenous sites representing vegetation types distinguished by the field experience. 44 relevés were made in May and June in 2000. I made classification and principal components analysis (PCA) based on correlation matrices. In the classification process the Ward-method was used as fusion algorithm. This method combines groups well at low difference level but the increasing of the hierarchical levels doesn't carry information about the structure of data. The Manhattan-metrics („city block"-metrics) was used as comparative function (Podani 1997).

The average of possibly relevant ecological indicator values weighted with the cover of species as variables were calculated for every plot. These indicator values are the followings: the indicator values of the relative groundwater and soil moisture (WB), the relative values of the nitrogen demand (NB), the relative values of the soil reaction (pH) (RB) and the average scale values for signing the halophyte and halophilous plants (SB) (Borhidi 1993). I calculated correlation between the PCA coordinates of plots and their average indicator values (indirect gradient analysis, Podani 1997) using a non-parametric test, the Spearman rank correlation (Barta *et al.* 2000). Because of using more than one rank correlation with the given variables in order to decrease the first order deviation. I made Bonferroni correction: I divided the $\alpha = 0.05$ significance level by the number of tests (12). The new significance level was $\alpha = 0.00417$. I correlated the ecological indicator values with each other using the same method. The significance level after the Bonferroni correction was $\alpha = 0.00625$.

I carried out the statistical analysis using the STATISTICA for Windows 5.0 (StatSoft Inc. 1984-1995) software.

Results and Discussion

Vegetation units

Based on the field experiences I distinguished the vegetation units as follows:

Astragalo austriacae-Festucetum sulcatae Soó 1957 (AF),

Succiso-Molinietum hungaricae (Komlódi 1958) Soó 1969 (SM),

Agrostio-Caricetum distantis (Rapaics ex Soó 1938) (AC),

Scorzonero parviflorae-Juncetum gerardii (Wenzl 1934) Wendelberger 1933,

Lepidio crassifolii-Puccinellietum limosae Soó (1947) 1957,

salt-affected marshes (*Schoenoplectetum tabernae-montani* Soó 1947 and *Bolboschoenetum maritimi* Eggler 1933),

Caricetum acutiformis Eggler 1933 and *Caricetum ripariae* Soó 1928 (CA),

Phragmitetum communis Soó 1927 em. Schmale 1939,

Bolboschoeno–Phragmitetum Borhidi et Balogh 1970,

transitional unit between *Agrostio-Caricetum distantis* and *Astragalo austriacae-Festucetum sulcatae* (AC-AF),

transitional unit between *Astragalo austriacae-Festucetum sulcatae* and *Succiso-Molinietum hungaricae* (AF-SM),

transitional unit between *Agrostio-Caricetum distantis* and *Succiso-Molinietum hungaricae* (AC-SM).

Astragalo austriacae-Festucetum sulcatae (AF)

The highest relieves of the sand dunes are covered by plough-lands. Around them the sand-steppe meadow (AF) association is characteristic. Its coverage is about 90 %. The dominant species are *Festuca rupicola* and *Festuca pseudovina* in the lower, thick level, *Chrysopogon gryllus, Dactylis glomerata* and *Festuca pratensis* in the upper level (Table 1).

The present sand-steppe meadows can be classified as so called 'lake steppes', formed from *Succiso-Molinietum hungaricae* association by dehydration and is characterized by the dominant and constant species *Chrysopogon gryllus* within AF. They were congruent also with the description of the sand-steppe meadows formed from SM by drying out (Molnár and Varga 1997, Rédei 1999). The present species of tall herb humid meadows and hay meadows (*Genista tinctoria, Orchis coriophora, Polygala comosa, Poa pratensis, Ranunculus acris,*

Table 1. Relevés of AF with the coverage percents of plant species.

number of relevés	2	4	5	7	10	11	14	19	30
Achillea asplenifolia	0.1		1	0.1		0.1		30	2
Achillea pannonica		0.1	8	0.1	0.1				
Agropyron repens		5	0.1	0.1				3	15
Anacamptis pyramidalis					1	0.5			
Centaurea sadlariana	0.1				2	1			
Chrysopogon gryllus	0.1	15		2	30	10			4
Coronilla varia	5	5	0.1	30	5	4			1
Cynodon dactylon	2			0.1					
Dactylis glomerata	20	30	40	15	30	30	40	5	25
Festuca pratensis	10		15	15			10	30	30
Festuca pseudovina	0.1		5						
Festuca rupicola						10	8	15	30
Filipendula vulgaris						8			
Galium verum		3	0.1				2	3	3
Genista tinctoria		12	8					0.1	
Holoschoenus romanus		0.1		2	1	3			1
Hypochoeris maculatum	0.1	0.1			20	8			
Knautia arvensis	1				0.1	0.1			
Koeleria cristata	15	1	0.1			5			
Linum perenne	5	0.1		3	0.1	0.1	10	0.1	0.1
Lotus corniculatus	0.1	0.1				4		1	0.1
Ononis spinosa	10	5		5	5	4	3	3	3
Plantago lanceolata	3	5			1	0.1			0.1
Poa angustifolia		0.1		0.1		5		5	2
Polygala comosa	10	0.1				0.1			
Rhinantus minor	10	0.1	8	10		0.1		0.1	0.1
Salvia pratensis		10		10	3	3			
Silene vulgaris	0.1	0.1	0.1	0.1	0.1		1	0.1	
Taraxacum officinalis	1		0.1	1	0.1	0.1			

Species with a coverage of 0.1 % in one or more relevés: *Anthyllis vulneraria, Arenaria serpillifolia, Bromus arvensis, Bromus mollis, Campanula sibirica, Carex cariophyllea, Carex distans, Carex flacca, Centaurea pannonica, Dianthus pontederae, Lathyrus silvestris, Medicago falcata, Medicago lupulina, Molinia arundinacea, Muscari botryoides, Ophrys sphecodes, Orchis coriophora, Ornithogalum umbellatum, Pastinaca sativa, Plantago maritima, Poa pratensis, Podospermum canum, Ranunculus acris, Rumex acetosa, Verbascum phoeniceum, Vicia angustifolia.*

Ophrys sphecodes) also refer to marsh origin. Most of the other characteristic species were absent, such as the *Astragalus austriaca* that is included in the name of the association.

The subunits of this unit are *Linum-Rhinanthus, Genista tinctoria, Anacamptis* and *Datylis-Festuca* pratensis types according to physiognomy and species combination. From these types the *Anacamptis* type fits most the description of AF association. It is similar to the *Salvia-Filipendula* type of the AF association described by Papp (2000) from Halászka, as well as to the *Centaurea* type of steppe grassland. The speciality of this subunit is the joint presence of *Ophrys sphecodes, Orchis coriophora* and *Anacamptis pyramidalis*, that has not been observed in other grasses in the southern Kiskunság. The *Dactylis-Festuca pratensis* type is degraded, the high dominance of monocotyledons (*Dactylis glomerata* and *Festuca pratensis*, mostly) and the taller vegetation distinguish this type from others. Its stands are mowed regularly, the high dominance of *Festuca pratensis* and *Dactylis glomerata* can be the result of sowing.

Succiso-Molinietum hungaricae (SM)

On a bit deeper relief patches of calcareous purple moorgrass meadow (SM) develop (Table 2). Most of them are not typical SM stands. The *Deschampsia* type of SM corresponds to the descriptions in the literature. The *Carex flacca* type of SM association corresponds to the *Molinietum serratuletosum tinctoriae* subassociation, the driest one described by Bodrogközy (1961).

The typical SM stands can be characterized by the high dominance of *Molinia hungarica.*

The *Carex flacca* type of SM association has a coverage of 90-100 %. Its dominant and characteristic species are the *Molinia hungarica* and *Carex flacca.*

Table 2. Relevés of SM with the coverage percents of plant species.

number of relevés	8	26	28	29	32	33	35	37	45
Achillea asplenifolia				1	2	1	1		0.1
Agropyron repens	0.1						15		
Agrostis alba	5		2						
Bromus arvensis							3		
Carex distans	0.1	5		2	2		4		
Carex flacca			30	60	70	70	20	60	
Carex panicea	0.1	5	30	20	1		2	10	
Carex tomentosa	5						1		
Carex vulpina		5					5	2	
Centaurea pannonica	0.1	0.1	0.1	0.1	1	1	0.1	0.1	0.1
Deschampsia caespitosa	40	40					40		
Festuca pratensis	30						2		
Festuca pseudovina					10				
Festuca pseudovina and F. rupicola						10			
Festuca rupicola									10
Festuca sp. (pseudovina or rupicola)				40					
Galium verum			0.1	1	2	1			0.1
Holoschoenus romanus			0.1	2		3	5		
Juncus articulatus	3	1	1				1		
Juncus compressus	3							1	
Koeleria cristata								15	
Molinia arundinacea						5			
Molinia hungarica				0.1			0.1		75
Ononis spinosa		1		3	1	2	0.1		
Poa angustifolia								2	
Ranunculus acris	2	5			0.1	0.1	0.1	0.1	
Sanguisorba officinalis	0.1		6	5	4	2	2		
Serratula tinctoria			2	5	1	1	0.1	3	1

Other species in the relevés: *Carex hirta, Cynodon dactylon, Dactylis glomerata, Linum perenne, Lotus siliquosus, Lysimachia vulgaris, Orchis laxiflora ssp. Palustris, Phragmites australis, Plantago lanceolata, Plantago major, Plantago maritima, Potentilla anserina, Potentilla reptans, Silene multiflorum, Taraxacum officinalis, Thalictrum flavum, Trifolium pratense, Triglochin maritima.*

The *Succiso-Molinietum hungaricae deschampsietum* subassociation can be distinguished obviously based on the high coverage of *Deschampsia caespitosa* that is a characteristic species of tall herb humid meadows and hay meadows (Simon 1999) and its presence here refers to degradation. The characteristic species of AC are also present but only with much lower coverage than in AC-SM.

Agrostio-Caricetum distantis (AC)

In similar relief AC covers large areas where low water coverage is present in spring. Within the stands the *Carex distans* and *Agrostis stolonifera* dominate in varying proportion, therefore the vegetation is patchy (Table 3). The joint coverage of this two species is about 50-70%, the total coverage is 60-80 %. It is poor in species which can refer to secondary formation as according to Molnár (1997) a big part of AC stands were formed from marshes secondarily (with the getting of vegetation zones in deeper relieves after water management works) and this has resulted the decreased species richness. There are species characteristic or frequent in salt-affected associations. The presence of *Festuca pseudovina, Festuca arundinacea, Plantago maritima, Linum perenne, Potentilla reptans, Poa angustifolia* and *Cynodon dactylon* refers to degradation or drying out (Molnár in Fekete *et al.* 1997). *Schoenoplectetum tabernae-montani* patches can be found in some of its dips. In deeper relieves *Agrostis stolonifera* dominates rather than *Carex distans* and *Bolboschoenus maritimus* can be dominant as well. These stands are closer to the *Agrostidetum stoloniferae* Soó (1940) 1968 association but I have not separated them on the map because of their small extent. They are poorer in species than the AC stands and *Cirsium brachycephalum* appears beside *Bolboschoenus maritimus*. In deeper relief this unit is substituted by *Lepidio crassifolii-Puccinellietum limosae* association. In the wettest parts *Eleocharis palustris* appears and becomes dominant. The types of AC above (types dominated by *Eleocharis palustris* and by *Agrostis stolonifera* and typical *Agrostio-Caricetum distantis*) and the *Festuca pratensis* type of the transitional unit between AC and AF can

correspond to the *Eleocharis palustris→ Agrostis alba→ Carex distans-Plantago maritima→ Festuca arundinacea-Carex distans* series (Rapaics 1927).

Table 3. Relevés of AC with the coverage percents of plant species.

number of relevés	13	18	31	34
Achillea asplenifolia			0.1	
Agrostis alba	10	40	30	70
Calystegia sepium		0.1		
Carex distans	50	10	20	1
Carex panicea				0.1
Eleocharis palustris				0.1
Euphorbia palustris	0.1			
Festuca arundinacea	5			
Festuca pratensis		2		
Festuca sp. (F. pseudovina or *F. rupicola)*			15	
Holoschoenus romanus			4	
Juncus articulatus				0.1
Juncus compressus	1			3
Juncus gerardii			0.1	
Lotus corniculatus			0.1	
Molinia arundinacea			1	
Orchis laxiflora ssp. palustris		0.1	0.1	
Plantago lanceolata		0.1		
Plantago maritima			0.1	
Potentilla anserina				0.1
Potentilla reptans				2
Sanguisorba officinalis			0.1	
Serratula tinctoria	0.1	0.1	0.1	
Thalictrum flavum		0.1		

Transitional unit between Agrostio-Caricetum distantis and Astragalo austriacae-Festucetum sulcatae (AC-AF)

The AC-AF can be found in similar relief. Species of the AC and the AF associations and in patches of the SM are mixed in them (Table 4). The high dominance of *Carex distans* is characteristic. It shows similarity with the *Potentillo-Festucetum pseudovinae* typicum *caricosum distantis* subassociation described by Bodrogközy (1961) but it is not equal with it. The *Festuca pratensis* type of this unit is marked on the vegetation map. It can be characterized by high dominance of the *Festuca pratensis* and as a result the different phisiognomy (taller and denser grass).

Transitional stand between Astragalo austriacae-Festucetum sulcatae and Succiso-Molinietum hungaricae (AF-SM)

An AF-SM stand can be found next to one of the AF stands, in a bit deeper relief. It is dense and mosaic-like. The mosaic is created by patches dominated by *Festucion* and *Molinion* species (Table 5). Based on its species composition it is closer to the *Linum-Rhinanthus* type of sand-steppe meadow, but *Molinia hungarica* appears and the *Molinion* species have higher coverage. The largest population of *Ophrys sphecodes* can be found here, partly spread across to the neighbouring AF (*Linum-Rhinanthus* type) stand. It can be observed that from the SM towards the AF the *Orchis laxiflora* subsp. *palustris*, the *Ophrys sphecodes* and the *Orchis coriophora* appear by turns (Molnár and Varga 1999).

Table 4. Relevés of AC-AF with the coverage percents of plant species.

number of relevés	6	17	20	24	25	36	38
Achillea asplenifolia	5	0.1	20	10	3	10	4
Agrostis alba			5				
Carex cariophyllea		8					
Carex distans	40	30	30	25	60	40	12
Chrysopogon gryllus	10	12	3	2			20
Coronilla varia		2					
Cynodon dactylon	0.1				1	10	
Dactylis glomerata		3	1			1	8
Festuca pratensis	10	2	10	5	5	10	20
Festuca pseudovina	6				10		
Festuca rupicola		12	10			10	8
Festuca sp. (F. pseudovina or F. rupicola)				8			
Galium verum		0.1	0.1	0.1	0.1	4	3
Koeleria cristata						3	5
Linum perenne	8	1	0.1	3	2	3	
Lotus corniculatus	0.1	2	0.1	0.1	0.1	0.1	
Molinia hungarica	2			2			
Ononis spinosa	0.1	1	2	2		1	3
Plantago lanceolata		8	0.1				0.1
Rhinantus minor	5	5	1	0.1		0.1	4
Serratula tinctoria		0.1		5		0.1	

Other species in the relevés: *Achillea pannonica, Bromus arvensis, Campanula sibirica, Carex panicea, Centaurea pannonica, Centaurium erythraea, Euphrasia tatarica, Knautia arvensis, Linum catarticum, Lotus siliquosus, Molinia arundinacea, Orchis coriophora, Plantago maritima, Podospermum canum, Polygala comosa, Puccinellia limosa, Scorzonera parviflora, Taraxacum officinalis.*

Transitional unit between Agrostio-Caricetum distantis and Succiso-Molinietum hungaricae (AC-SM)

The stand of AC-SM is denser than the AC stands. Some species of marshes occur in it but the dominant species is Carex distans so considering the species composition it is closer to the AC association (Table 6). The other characteristic species of the AC association, Agrostis stolonifera occurs only with low coverage. This unit can be equal with the salt-affected meadow with Molinia (Bodrogközy, 1961), it is close to the Serratula tinctoria facies of this unit.

Table 5. Relevés of AF-SM with the coverage percents of plant species.

number of relevés	3	27
Achillea asplenifolia	1	
Carex cariophyllea	10	
Carex flacca	10	40
Centaurea sadlariana	0.1	2
Chrysopogon gryllus	30	0.1
Cynodon dactylon	5	
Dactylis glomerata	3	8
Festuca pratensis	0.1	10
Galium verum	0.1	1
Holoschoenus romanus	3	0.1
Linum perenne	2	
Lotus corniculatus	3	0.1
Molinia arundinacea		5
Ononis spinosa	10	5
Orchis coriophora	0.5	
Salvia pratensis	10	0.1

Species with a coverage of 0.1 % in one or more relevés: *Achillea pannonica, Agropyron repens, Agrostis alba, Carex panicea, Dianthus pontederae, Euphrasia tatarica, Festuca sp., Genista tinctoria, Juncus gerardii, Linum catarticum, Lotus siliquosus, Muscari botryoides, Ornithogalum umbellatum, Plantago lanceolata, Polygala comosa, Ranunculus acris, Rhinantus minor, Rumex acetosa, Silene vulgaris, Taraxacum officinalis, Thalictrum lucidum.*

Table 6. Relevés of AC-SM with the coverage percents of plant species.

number of relevés	9	15	23	39	44
Agrostis alba		15	5	30	
Carex distans	30	30	30	10	60
Festuca pratensis	0.1		1	20	
Festuca pseudovina	1		1		
Festuca rupicola				20	
Galium verum			0.1		2
Holoschoenus romanus	10				4
Molinia arundinacea	40				
Molinia arundinacea and *M. hungarica*		15			
Molinia hungarica			30	15	15
Ononis spinosa	8		0.1		4
Sanguisorba officinalis	2	5		5	
Serratula tinctoria	5	5	3	3	1
Triglochin maritimum				2	

Other species in the relevés: *Achillea asplenifolia Agropyron repens Carex panicea Centaurea pannonica Cynodon dactylon Euphorbia palustris Genista tinctoria Iris pseudacorus Juncus gerardii Linum perenne Lotus corniculatus Lotus siliquosus Orchis laxiflora ssp. palustris Plantago maritima Podospermum canum Ranunculus acris Silene vulgaris Taraxacum officinalis.*

Scorzonero parviflorae-Juncetum gerardii

The *Scorzonero parviflorae-Juncetum gerardii* (Wenzl 1934) Wendelberger 1933 association occurs in small patches inserted in large sedge communities and AC stands. I haven't draw these patches on the map because of their small extend. The high dominance of *Juncus gerardii* is characteristic. Other frequent species: *Festuca arundinacea, Orchis laxiflora* subsp. *palustris, Serratula tinctoria* and *Euphorbia palustris.*

Lepidio crassifolii- Puccinellietum limosae

The *Lepidio crassifolii-Puccinellietum limosae* Soó (1947) 1957 stands are poor in species and have low coverage. Characteristic species: *Puccinellia limosa, Lepidium crassifolium, Aster tripolium subsp. pannonicus.*

Salt-affected marshes

In the deepest relieves, in natural depressions with water coverage in spring and in pits used for loam-mining salt-affected marshes (*Schoenoplectetum tabernaemontani* Soó 1947 and *Bolboschoenetum maritimi* Eggler 1933) covers large areas. Its stands are poor in species, the dominant species cover almost the whole area (Table 7). Total coverage is 45-70 %. The alternating of dominant species makes the vegetation mosaic-like (see Bagi 1999a, b, 1997).

Table 7. Relevés of salt-affected marshes with the coverage percents of plant species.

number of relevés	12	22	41	42	43
Agrostis alba		10			
Bolboschoenus maritimus	15	20	15	35	
Calystegia sepium			0.1	0.1	0.1
Carex distans		0.1			
Eleocharis palustris	15	20	25	4	20
Euphorbia palustris					0.1
Galium palustre					0.1
Juncus gerardii		0.1			0.1
Lysimachia vulgaris			0.1		
Lythrum salicaria					0.1
Phragmites australis					2
Schoenoplectus tabernae-montani	15	1	25	10	30
Thalictrum flavum					0.1
Triglochin maritimum			1	0.1	

Different types of salt-affected marshes according to the dominant species are the following:

Schoenoplectus tabernae-montani type that is equal with the *Schoenoplectetum tabernaemontani* (Soó 1947) association,

Bolboschoenus maritimus type that is equal to the *Bolboschoenetum maritimi* (Eggler 1933) association,

Schoenoplectus tabernaemontani-Bolboschoenus maritimus type – the species of the two associations are frequently mixed also according to Bagi (1999a,b),

Bolboschoenus maritimus-Eleocharis palustris type that is equal to the *Bolboschoenetum maritimi* (Eggler 1933) association with the codominant species of *Eleocharis palustris*,

Bolboschoenus maritimus-Agrostis stolonifera type,

Bolboschoenus maritimus-Agrostis stolonifera-Eleocharis palustris type,

Bolboschoenus maritimus-Juncus gerardii type that is equal with the *Bolboschoenetum maritimi* (Eggler 1933) association but *Juncus gerardii* became codominant.

The *Schoenoplectetum tabernaemontani* Soó 1947 and the *Bolboschoenetum maritimi* Eggler 1933 associations are not isolated on the map, because they create a mosaic with each other on a smaller scale. The stands cannot be grouped in the subassociations described by Bodrogközy (1961).

Table 8. Relevés of large sedge communities with the coverage percents of plant species.

number of relevés	1	16	21	40
Agrostis alba	10	15		12
Caltha palustris	4		8	
Carex acutiformis			50	
Carex distans		2		10
Carex panicea	0.1	2		0.1
Carex riparia	20	30		30
Carex vulpina			2	
Deschampsia caespitosa	10			
Equisetum palustre	20			
Euphorbia palustris	0.1	0.1		7
Festuca pratensis				5
Festuca rupicola				10
Holoschoenus romanus		4		2
Juncus articulatus	10		0.1	
Juncus compressus	10			
Lysimachia vulgaris	2		8	
Mentha aquatica	1			
Molinia arundinacea		10		
Ranunculus acris	0.1	0.1	5	0.1
Sanguisorba officinalis	0.1	8	15	6
Serratula tinctoria		8		3
Thalictrum flavum	1	0.1		0.1

Species that occur in some relevés with 0.1 % coverage: *Calystegia sepium, Centaurea pannonica, Galium palustre, Galium verum, Iris pseudacorus, Juncus gerardii, Lotus corniculatus, Orchis laxiflora ssp. Palustris, Poa angustifolia, Poa pratensis, Thalictrum lucidum, Vicia cracca.*

Large sedge communities

The large sedge communities (*Caricetum acutiformis* Eggler 1933, *Caricetum ripariae* Soó 1928) also cover large areas in deep relieves. Its stands are dense, the height is about 100 cm. The dominant sedge species are *Carex riparia* and *Carex acutiformis* (Table 8). The stands can be grouped in the *Caricetum acutiformis-ripariae eleocharetosum palustris* (Soó 1927) subassociation. The stand next to a reed stand is a transition towards *Agrostio-Caricetum distantis* association. This transitional stand differs from both units considering its physiognomy. *Carex distans* and *Carex acutiformis* mix in it with equal coverage.

Dry reed beds

In the deepest relieves dry reed beds (*Phragmitetum communis* Soó 1927 em. Schmale 1939 and *Bolboschoeno–Phragmitetum* Borhidi et Balogh 1970) cover some smaller and larger patches. The two reed associations are not separated from each other sharply, usually the *Phragmitetum communis* is characteristic in the centre of the reed stands, and the *Bolboschoeno–Phragmitetum* at the edges. They form clumps in patches, on the clumps *Agrostis stolonifera, Lythrum salicaria* and *Calystegia sepium* have settled. Other frequent species: *Mentha aquatica, Utricularia vulgaris, Galium palustre, Lythrum salicaria, Equisetum palustre, Caltha palustris.* Gradual transition can be observed from the *Agrostio-Caricetum distantis* towards the *Bolboschoeno–Phragmitetum.*

Protected plant species

We have found one strictly protected plant species and nine protected species in the area (Table 9).

The relationships between vegetation units

The described three transitional units are not in transitional stripes but create separate, extended stands. They are probably temporal transitions. Their patchiness can be the result of abiotic heterogeneity (Bagi 1998). The formation of the temporal transitions can mainly be the result of the drying out, the changing of the water table level and with this the level of salinity. The joint presence of certain species of the different vegetation units shows that the characteristic species of certain associations can colonize in other associations. If the drying out of the area continues it can be expected that the AF-SM stand would turn into AF association.

As a result of the cluster analysis (Fig. 2) the coenological samples of the *Bolboschoenetum maritimi*, the *Deschampsia* type of SM, *Carex flacca* type of SM and the AF were grouped obviously in separate clusters. There are separate clusters of the relevés of large sedge communities, AC, and from the transitional units the two transitions of the AC but some samples of them got to other groups. A mixed cluster has also formed. It includes the plots of the latter units which indicates that there are not

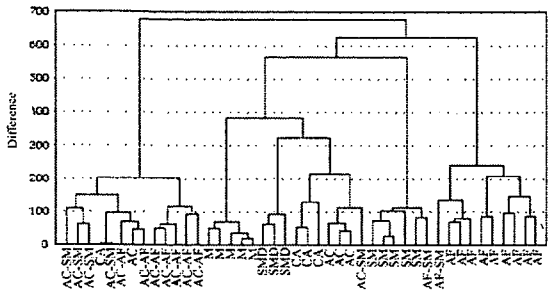

Fig. 2. The result of cluster analysis of 44 coenological relevés. The abbreviations mean: AC-SM: transitional unit between *Agrostio-Caricetum distantis* and *Succiso-Molinietum hungaricae*, CA: large sedge communities (*Caricetum acutiformis* and *Caricetum ripariae*), AC-AF: transitional unit between *Agrostio-Caricetum distantis* and *Astragalo austriacae-Festucetum sulcatae*, M: salt-affected marshes (*Schoenoplectetum tabernaemontani* and *Bolboschoenetum maritimi*), SMD: *Succiso-Molinietum hungaricae deschampsieostum*, AC: *Agrostio-Caricetum distantis*, SM: *Succiso-Molinietum hungaricae Carex flacca* type, AF-SM: transitional unit between *Astragalo austriacae-Festucetum sulcatae* and *Succiso-Molinietum hungaricae*, AF: *Astragalo austriacae-Festucetum sulcatae*.

sharp differences between them. One of the samples of the AF-SM got into the cluster of the *Carex flacca* type of SM, the other into the cluster of the AF so this method did not confirm the independence of this transitional unit. The cause of it can be that this unit is mosaic-like, the different patches within the stands are distinguished by the dominance of the species of the two 'clear' unit, and the relevés were made in these patches. The cluster analysis has confirmed the independence of all the vegetation units that were distinguished by the field experience also the transitional units except the AF-SM.

As a result of the principal component analysis (Fig. 3) the relevés of the AF, the AF-SM, the two types of SM, the salt-affected marshes and the AC-AF were placed in separate clouds of points. Sample nr. 38 was made in an AF stand with *Carex distans* that's why it is separated from the group of AF relevés. The samples of the large sedge communities, and especially the AC and the AC-SM are segregated from each other more or less along the first axis, and are drawn apart along the second axis. This emphasizes the spatially variable rate of the marsh species in the case of the AC-SM. In the case of the AC the drawing apart can be related with the gradual changing of the proportion of the two dominant species. The patchiness resulted in the spatially (on scale of sampling) alternating dominance of the two dominant species is characteristic in AC stands, the used method emphasizes this. The samples of the AF-SM are between the relevés of AF and SM along the second axis. The relevés of the AC-AF are placed between the plots of the AC and the AF along the second axis and they are close to some of the relevés of the AC. The relevés of the AC-SM are close to the relevés of the AC along the first axes and to the SM along the second axis. The variance proportion for the first three components of the PCA is low (49.12914%) because of the large number of the

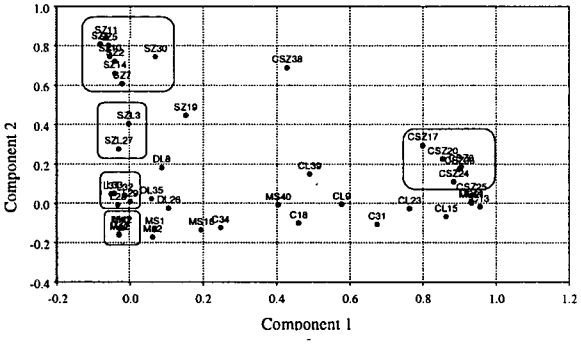

Fig. 3. The result of the principal component analysis of 44 relevés. The abbreviations mean: CL: transitional unit between *Agrostio-Caricetum distantis* and *Succiso-Molinietum hungaricae*, MS: large sedge communities (*Caricetum acutiformis* and *Caricetum ripariae*), CSZ: transitional unit between *Agrostio-Caricetum distantis* and *Astragalo austriacae-Festucetum sulcatae*, M-salt-affected marshes (*Schoenoplectetum tabernaemontani* and *Bolboschoenetum maritimi*), DL: Succiso-*Molinietum hungaricae deschampsietum*, C: *Agrostio-Caricetum distantis*, L: *Succiso-Molinietum hungaricae* Carex flacca type, SZL: transitional unit between *Astragalo austriacae-Festucetum sulcatae* and *Succiso-Molinietum hungaricae*, SZ: *Astragalo austriacae-Festucetum sulcatae*.

variables. For increasing this we made PCA separately for groups of vegetation units of which relationships are specially interesting – the transitions and the adequate 'clear' units. The coenological samples were placed in a similar way as in the case of the joint ordination, consequently the lower variance proportion explains well the relations of the coenological plots.As a result of the indirect gradient analysis the first component correlates with SB (R=0.699, p=0,0000001, N=44), the second component with WB (R= -0.846, p= 0.0000000, N=44) and with SB (R=-0.502, p=0.0005096, N=44). The third component shows correlation with NB (R=-0.502, p= 0.0005096, N= 44). WB correlates with SB. This result confirm that it is expectable that the soil moisture conditions controlled by the depth of the soil water table and the level of salinity plays a considerable role in the formation of the spatial pattern of the vegetation as in case of other grasses

Table 9. The protected plant species of the area.

Species	Population size (in 2000)	Habitat description
Ophrys sphegodes	578, 100, 200 (in 1999)	contact zone of calcareous purple moorgrass meadow and sand-steppe meadow; *Genista* and *Anacamptis* types of sand-steppe meadow
Anacamptis pyramidalis	800-1000	*Anacamptis* type of sand-steppe meadow
Blackstonia acuminata	5	in a pit covered by *Agrostio-Caricetum distantis* stand
Centaurea sadleriana	of order of 10000	
Dianthus superbus	1500	large sedge community
Iris sibirica	120	pits and patches of calcareous purple moorgrass meadow sporadically
Iris spuria	25	a pit covered by *Bolboschoenetum maritimi*
Muscari botryoides	105, 235, 2, 27000 (estimation), and 13500 (estimation) (in 1999), altogether 3000 stems (in 2000)	sand-steppe meadow
Orchis laxiflora subsp. *palustris*	of order of 10000	present in the whole area except the sand-steppe meadows
Orchis coriophora	350 and 250	sand-steppe meadow; transitional stand of sand-steppe meadow and calcareous purple moorgrass meadow

(for example see Mile *et al.*, 2001). Salt-affected vegetation units occur only in the depressions with temporary water coverage, halophyte species are not present in drier units or only with very low coverage. This explains the correlation between average values of WB and SB.

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