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COENOLOGICAL DATA ON TEMPERATE SEMIDESERT SANDY GRASSLANDS IN HUNGARY

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A neighbouring-quadrate transect study was conducted in order to examine the possible relationship between small scale topography and coenotaxa occurrence and cover in subassociations of *Festucetum vaginatae* Rapaics ex Soó 1929 sandy grassland plant community near Fülöpháza. These investigations served as a starting point in later soil seed bank studies. Cover of species was recorded in three transects of different exposition starting on the top of different dunes and ending in the depressions.

Subassociations and facies forming species of the community occurred in all investigated transects. Parts of the transects could not have been classified unambiguously into any of the coenotaxa mentioned in the literature. In these zones the characteristic species of the different subassociations and facies were occurring together. These patches are probably also the ones where changes in dominance relations and simultaneous spread of a species can relatively easily happen, as it is the case with *Cleistogenes serotina.* Annual vegetation of the open sandy grassland, on the other hand, has occurred only in the transition zones, between the subassociations or facies. In these transects moss-lichen synusia were present usually in the subassociation *Festucetum vaginatae stipetosum pennatae* Kerner 1863.

Key words: *Festucetum vaginatae* Rapaics ex Soó 1929, association, sandy grassland, subassociations and facies forming species

INTRODUCTION

The *Festucetum vaginatae* Rapaics ex Soó 1929 (Borhidi 1996) grassland is widely distributed throughout the Danube Basin and as a "paraclimax" community it develops on loose calcareous sandy soils. This perennial grassland shows some semidesert characteristics for edaphic reasons. Variation in species composition is apparently linked to small-scale topographical diversity of this area.

First coenological records of the community have been published by Rapaics (1923) with emphasis placed on the introduction of the Hult–Sernander method for estimating cover values, rather than on the description of the community, subsequently referred to by Soó (1929), who di-

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vided the *Festuca vaginata* association into vicariant types of *danubiale, tibescense* and *deliblaticum*, presenting the table of the coenological records and the A-D and K values.

In later works possible successional series have also been dealt with (Magyar 1933, Hargitai 1940, Zsolt 1943, Pócs 1954, Zólyomi 1958, Fekete 1992). A successional scheme concerning the whole xeroseries on the neighbouring sandy areas is suggested by Hargitai (1940). The *Festucetum vaginatae danubiale* community was considered diverse in its development too, therefore several subassociations and within them more facies have been distinguished. Magyar (1933) has described four subassociations acknowledged in most of the works published in this topic later, although as much as ten different subassociations have also been reported (Soó 1964). A detailed description of the species composition is presented by Kárpáti and Kárpáti (1954), and Fekete *et al.* (1976). Additional important information on the local vegetation is presented by Szodfridt (1969).

Features arising from the mosaic composition of the vegetation on the sand dunes and the stressful environment have inspired studies of different aspects, too. Surveys have been conducted on the photosynthetic activity (Fekete and Tuba 1982) and reproductive allocation (Fekete and Melkó 1981, Fekete *et al.* 1988) in the species of the *Festucetum vaginatae danubiale* community at different successional stages. Invasion of the grassland by *Cleistogenes serotina* has been studied by Bagi (1996, 1997).

One possible method to test the assumed relationship between particular microtopographical features and the occurrence of subassociations of the *Festucetum vaginatae danubiale* community is to record the species cover by using transects consisting of several adjacent quadrates and stretching over a distance enough to embody substantial variation in small scale topography of the area (*e.g.* along an incline). By this way, it is also possible to characterise the vegetation of the transition zones in the transects lying between the subassociations, or equally, to verify the existence of sharp boundaries of these assemblages. This approach also provides the opportunity to investigate, whether the occurrence of moss and lichen synusia is linked to a particular coenotaxon or rather, are related to the small-scale morphological variation of the surface. Further aim of the present work was also to report the actual coenological records on the open sandy grassland subassociations around the Fehér-hegy. This study served as a starting point in a subsequent soil seed bank survey.

MATERIALS AND METHODS

The study area is situated *ca* 25 km W of Kecskemét in the Hungarian Great Plain (Kiskunság National Park, near Fülöpháza). The sand hills are covered by grasslands. The mean annual precipitation is about 450 mm. The vegetation cover is maximum 50–60%, and the total species number is low (40–50). As to geographical distribution and life form, the constituent species are mainly continental, Pontic, Ponto-Pannonian hemicryptophytes and therophytes, but some chamaephytes and geophytes also occur. A special feature is the presence of numerous endemic taxa characteristic of the habitat.

The investigated vegetational area covers the territory of our soil seed bank study. Soil seed bank sample areas have been selected in the *Festucetum vaginatae danubiale* (Soó 1929) 1933 community's subassociations and facies around the Fehér-hegy. Coenological recording has been made in adjacent 2 m × 2 m quadrates giving transects (Whittaker 1956, 1967) stretching from the top of the different sand dunes to SE, NE and SW directions along the slopes and consisting of 36, 15 and 16 quadrates, respectively.

The first (SE) transect included subassociations *Festucetum vaginatae festucetosum vaginatae* Magyar 1933 and *stipetosum pennatae* Kerner 1863, and also the facies *Poa bulbosa*. The second (NE) transect included subassociations *Festucetum vaginatae stipetosum pennatae* Kerner 1863 and *fumanetosum* Magyar 1933 also the facies *Poa bulbosa* and *Cleistogenes serotina*. The third (SW) transect stretched along *Euphorbia seguieriana* and *Koeleria glauca* facies of the subassociation *Festucetum vaginatae stipetosum pennatae* Kerner 1863. Coenological data (percentage cover) have been recorded in 12 May and 30 September, 1993. The reported data presented in tables and cover graphs (Whittaker 1967, Krebb 1983, Penksza *et al.* 1994) are the sums from these two occasions.

Species names and life forms follow Simon (1992), community nomenclature was adapted from Soó (1964). Borhidi's (1993, 1995) system was followed to identify social behaviour. Cluster analysis was carried out on presence-absence data (Euclidean distance) using the SYN-TAX package (Podani 1993).

Table 1

Cover values (%) and life forms for species occurring in the first transect (LF = life form)

LF	Quadrates in the first transect	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
	Festuco-Brometea species																																				
G	*Asparagus officinalis*																				3																
H	*Bothriochloa ischaemum*																						5	10	10	10	15	10	10	10	2	3	4				
Th	*Bromus mollis*																													1							6
Th	*Erophila verna*		3	1	1	1	1		1	1	1	1	1											1	1	1											
Th	*Holosteum umbellatum*			1	1	1																1	3	3	2	3										
H	*Linaria genistifolia*																					3	2			2											
Th	*Medicago minima*																					2	2	1	3	2	2	2	6	3	6	5	5	10	6	8	10
H	*Poa bulbosa*																						5	6		6	6	5	5	5	20	20	25	15	20	20	15
H	*Scabiosa ochroleuca*					2			2		2	2																									
	Festucetalia vaginatae species																																				
Th	*Arenaria serpyllifolia*	5	5	5	3	3	3	2	1		1										3	3	5	5			5	8	6	5	5	5	5	6	8	10	10
Th	*Bromus tectorum*		3														1	3	5	10	10																
M	*Juniperus communis*														2																						
	Festucion vaginatae species																																				
H	*Alkanna tinctoria*																																				3
H	*Centaurea arenaria*									3																											
H	*Festuca vaginata*	15	20	15	20	15	10	20	20	15	15	20	20	15	20	20	20	15	15	10	15	40	35	25	20	25	10	20	15	5							
H	*Koeleria glauca*	5	5	5	5															3				10	15	8	5	5	5	10		5	5	4			5
Th	*Polygonum arenarium*	1	3			1				3			2	1			1			1	3	3		2						5	5	5				
Th	*Secale sylvestre*	5	5															3	3	5	8	5															3
Th	*Silene conica*																2												2	2			2	1	1		
H	*Stipa borysthenica*																				5	5	10	15	15	10	20	15	15	15	8	15	20	20	25	10	10
H	*Tragopogon floccosus*									3					3						3																
	Brometum tectorum species																																				
Th	*Kochia laniflora*	3			1				2	2	1	1											1	4	3	3	5	3	2	2		2					
	Festucion valesiacae-vaginatae s.																																				
Ch	*Alyssum tortuosum*	1		3	3	3	3	3																													
N	*Fumana procumbens*																							5	5	5	5	10	5		5	5		2		3	6
	Festucetalia valesiacae-vaginatae s.																																				Th
	Bromus squarrosus																															5	5	3	2		10
G	*Carex liparicarpos*																						1				2			2						3	
H	*Euphorbia seguieriana*	25	10	5	15	5	5	5		3											5	3				4											

Table 1 (continued)

LF	Quadrates in the first transect	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Th	*Minuartia glomerata*																								3		3	2									
H-Ch	*Minuartia verna*																									2	3	2	3								
H	*Silene otites*	5	5	5	5	8	5	4	4	5	10	4	2	5	3																						
	Festucetalia vaginatae species																																				
H	*Stipa capillata*																					5	3		3		8						5	5			
	Brometalia species																																				
G	*Cleistogenes serotina*																											3	5		5					10	20
	Quercetea pubescenti-petraeae s.																																				
M	*Berberis vulgaris*																	10																			
	Corynetalia species																																				
Th	*Cerastium semidecandrum*																							1	1	1	1				1				1		
	Prunion spinosae species																																				
M	*Crataegus monogyna*																1																				
	Secalietea-Chenopodietea species																																				
Th	*Crepis rhoeadifolia*			3						2																											
Th-TH	*Erigeron canadensis*																													2		2		1		5	4
Th-TH	*Lithospermum arvense*																									1											
Th	*Salsola kali*						1	1	2	1	1	1	1	1			1	2					1														
Th-TH	*Senecio vernalis*														2		1																		1		
H	*Solidago virga-aurea*		2														3																				
Th	*Tragus racemosus*																														6						
	Alno-Padion species																																				
MM-M	*Populus alba*																					4							3	2							
	Lichen-moss species																																				
	Cladonia convoluta																														2	4	3	2			
	Cladonia furcata																															5	3				
	Tortula ruralis																				10	10	10	10	10	2	10	25	30	25	35	20	30	30	20	20	20

RESULTS AND DISCUSSION

Characteristics of the vegetation in the transects

Sample quadrates 1–20 of the first transect (Table 1) are characterised by species of the subassociation *festucetosum vaginatae* of the *Festucetum vaginatae danubiale* community. Cover values by *Stipa borysthenica* were as high as those by *Festuca vaginata* in quadrates 20–29. High cover values by *Bothriochloa ischaemum* considered as facies forming species here and as a separate subassociation elsewhere (Soó 1964) that caused difficulties in coenosystematic identification. Subassociation forming species (*Stipa capillata, Fumana procumbens*) and facies forming species like *Cleistogenes serotina*, *Koeleria glauca* were also present in this zone, while the next part of the transect (quadrates 30–39) clearly belonged to *Festucetum vaginatae stipetosum pennatae*, with the presence of the facies forming *Poa bulbosa*. Characteristic annual species of the open sandy grasslands (*Bromus tectorum,*

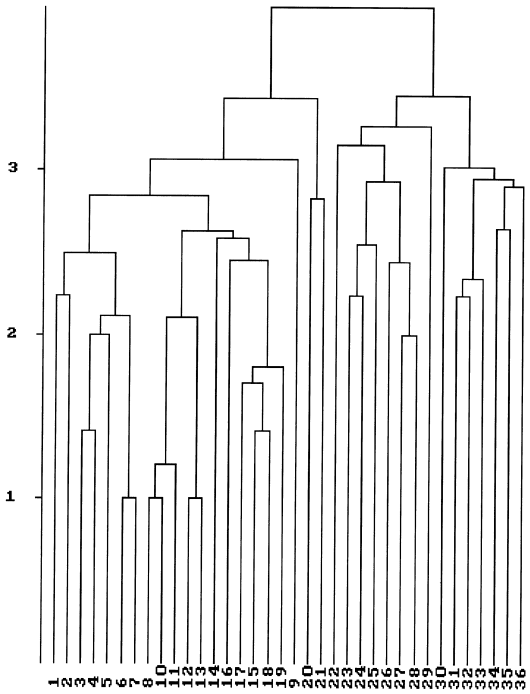

Fig. 1. Dendrogram of the cluster analysis carried out on species presence-absence data in the 1st transect. Quadrates in the transect are noted by numbers, the transect starting from the top of the dune

Secale sylvestre) occurred on the top of the dune (qts 1–2) and in the transition zone (qts 15–20) between the first two zones. Occurrence of the moss and lichen synusia were typical from the twentieth quadrate downwards the slope. Separation of the three zones is illustrated by the dendrogram (Fig. 1).

Table 2

Cover values (%) and life forms for species occurring in the second transect (LF = life form)

LF	Quadrates in the second transect	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Festuco-Brometea species															
H	*Bothriochloa ischaemum*											2	3			
Th	*Erophila verna*							2								
Th	*Holosteum umbellatum*	1	2	2	2					1	2	3	4	3		
Th-TH	*Medicago lupulina*							4								
Th	*Medicago minima*								5	5	5	2				
H	*Poa bulbosa*			4	6	8	1	1	2	2	25	15	5			
Th	*Saxifraga tridactylites*						2	1	5	5	5	5	5			
H	*Scabiosa ochroleuca*															2
	Festucetalia vaginatae species															
Th	*Arenaria serpyllifolia*	1	1	1	1	1	8	8	1	1	1	1	1	1	8	1
H	*Helichrysum arenarium*										8	7	5		2	
	Festucion vaginatae species															
H	*Alkanna tinctoria*				4	4	4									
H	*Astragalus varius*								5							
H	*Festuca vaginata*	5	5	5			3	2					3	4		
G (Ch)	*Gypsophila fastigiata*	3	5	5												
H	*Koeleria glauca*	6				4							1	6	4	4
Th	*Silene conica*	1								2			1	5		
H	*Stipa borysthenica*	1	15	2	15	3	3	3	1	15	2	35	35	25	25	35
H	*Syrenia cana*	1	1	1	1							4				
	Brometum tectorum species															
Th	*Kochia laniflora*	1	2	1	1	1	1			1						
	Festucion valesiacae-vaginatae s.															
Ch	*Alyssum tortuosum*		3	2												
N	*Fumana procumbens*	3	25	2	25	15	5	8					5	8	15	15
	Festucetalia valesiacae-vaginatae s.															
Th	*Bromus squarrosus*							1								
G	*Carex liparicarpos*		2	8	8	4	2	2								
H-Ch	*Minuartia verna*			2	2	2										
	Brometalia species															
G	*Cleistogenes serotina*				5	2	8	5	15	15	1			2		
	Corynetalia species															
Th	*Cerastium semidecandrum*	1		1	2	2	4	5	5	5	5	5	8	8	8	1
	Secalietea-Chenopodietea species															
Th	*Crepis rhoeadifolia*										3	3				
Th	*Erigeron canadensis*														1	2
Th-TH	*Lithospermum arvense*						1	1					2	2		
Th-TH	*Senecio vernalis*		1								1					1
	Lichen-moss species															
	Cladonia convoluta	2	2		3	3	2	4	3	1	5	5	2			
	Cladonia furcata		1	4												
	Tortula ruralis			1				5	5	5	8	11	1	1	4	8

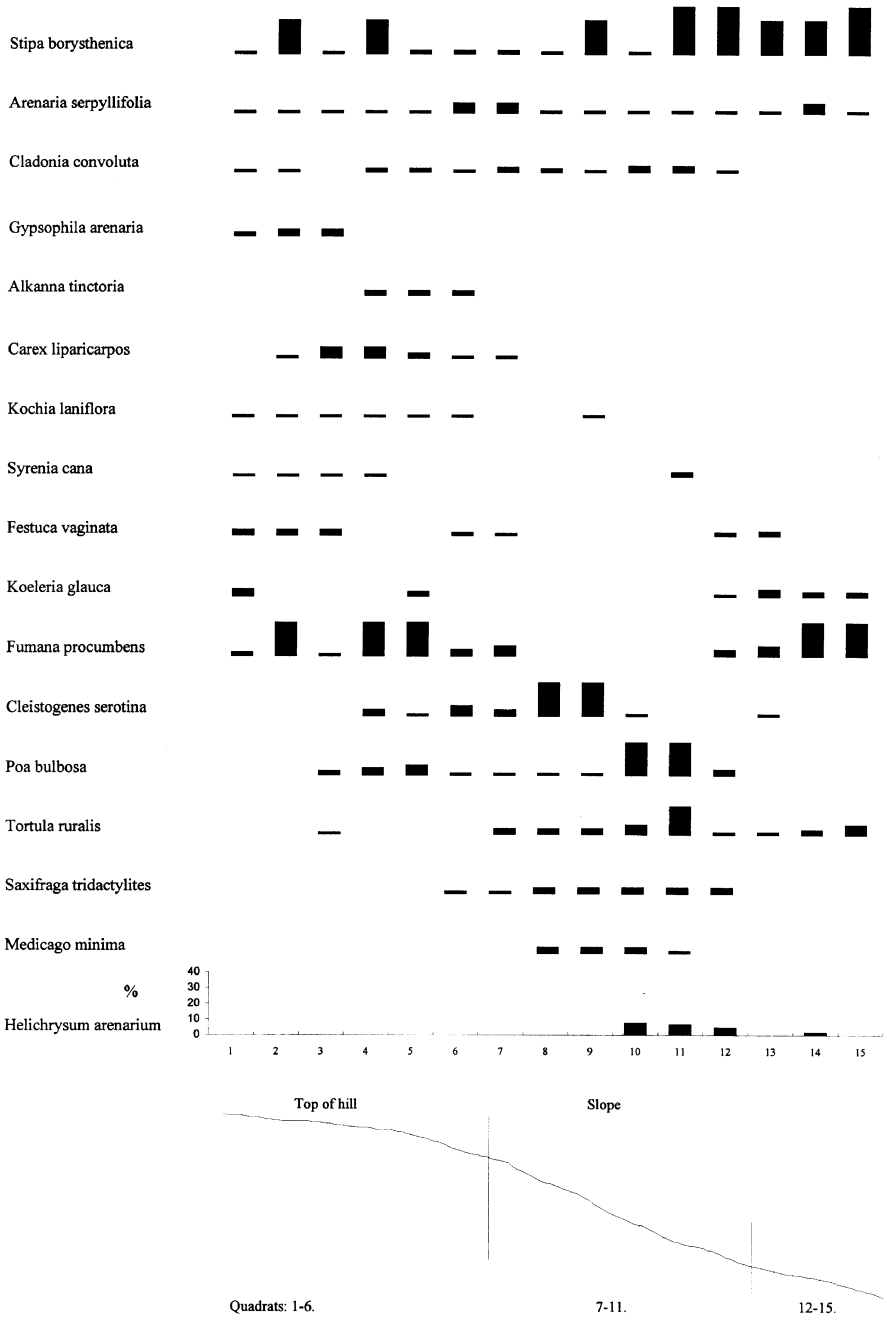

Fig. 2. Cover changes for selected species along the 2nd transect starting from the top (1st qt) of the sand dune

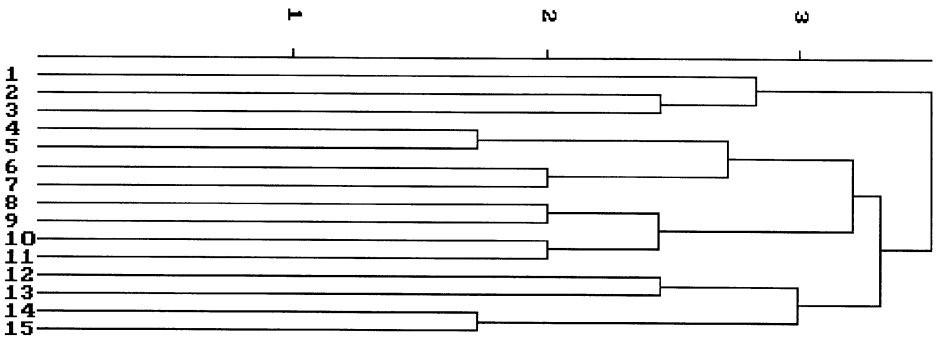

Fig. 3. Dendrogram of the cluster analysis carried out on species presence-absence data in the 2nd transect. Quadrates in the transect are noted by numbers, the transect starting from the top of the dune

Vegetation of the second transect comprised up from subassociations of the *Festucetum vaginatae stipetosum pennatae* and *fumanetosum* (Table 2, Fig. 2). On the top and in the bottom of the slope both species were present (qts 1–7 and 11–15, respectively), while *Fumana procumbens* was lacking from the middle transition zone (qts 8–11) where significant cover by *Cleistogenes serotina* and *Poa bulbosa* was recorded concurrently with the presence of *Helichrysum arenarium, Saxifraga tridactylites, Medicago minima,* and the moss species *Tortula ruralis.* Annual species of the open sandy grassland were not present, a fact that may be explained by the high cover of perennials although occurrence of the main species (*Festuca vaginata*) of the community was rather rare here. Quadrates containing *Festuca vaginata* (qts 1–3, 6–7 and 12–13) have separated from the remaining ones (Fig. 3) consisting of the *Poa bulbosa* (qts 10–11) and *Cleistogenes serotina* (qts 8–9) facies of the *stipetosum pennatae* subassociation.

Stipa borysthenica was present along the whole length of the third transect (Table 3, Fig. 4), hence this area was identified as *Festucetum vaginatae stipetosum pennatae* subassociation. Out of the subassociation forming species, *Fumana procumbens* and *Festuca vaginata* were present together with *Stipa borysthenica,* while out of the facies forming ones *Euphorbia seguieriana* (qts 1–9) and *Koeleria glauca* (qts 11–16) were found. Annual species were present between the two facies zones, moss-lichen synusia were present from qt. 9 to the end of the transect at the bottom of the slope. The two coenotaxa were separated from each other and the transition zone between the middle and the bottom of the slope (qts 9–10) also gave a distinct group (Fig. 5).

Table 3
Cover values (%) and life forms for species occurring in the third transect (LF = life form)

LF	Quadrates in the third transect	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	Festuco-Brometea species																
Th-TH	*Alyssum alyssoides*												1				
Th	*Erophila verna*			3	2	2											
Th	*Holosteum umbellatum*									2				2		5	5
H	*Linaria genistifolia*							2									
Th	*Medicago minima*									1	3	5	5	5			
H	*Poa bulbosa*											5					
	Festucetalia vaginatae species																
Th	*Arenaria serpyllifolia*							4	1	1	15	15	15	1	5	5	5
Th	*Bromus tectorum*							5	1	1	1	5					
	Festucion vaginatae species																
H	*Astragalus varius*																4
H	*Festuca vaginata*							2	5								
H	*Koeleria glauca*											2	2	15	15		3
Th	*Polygonum arenarium*	3		4	5	4	5	5	5			3					
Th	*Secale sylvestre*	5	5	5	5	1	5	5	1	2	2	15					
Th	*Silene conica*								1	5			4		2	2	
H	*Stipa borysthenica*	8	1	1	15	1	8	8	3			5	1	1	15	2	25
H	*Syrenia cana*	1		2	2	3		3									
Th	*Tribulus terrestris*											5					
	Brometum tectorum species																
Th	*Kochia laniflora*	1	5		5	5	4	3									
	Festucion valesiacae-vaginatae s.																
Ch	*Alyssum tortuosum*		8	5	5	8	1	4			2	5					
N	*Fumana procumbens*	25	1		8	8							6	1	25	2	2
	Festucetalia valesiacae-vaginatae s.																
Th	*Bromus squarrosus*										5	1					
G	*Carex liparicarpos*														1		
H	*Chondrilla juncea*						2							2			
H	*Euphorbia seguieriana*	8	25	2	2	15	2	15	15	5							
Th	*Minuartia glomerata*						2										
Th-TH	*Minuartia verna*														2		
H	*Silene otites*				4												
	Corynetalia species																
Th	*Cerastium semidecandrum*								4	5		2	4	2	2		
	Secalietea-Chenopodietea species																
Th	*Crepis rhoeadifolia*						2										
Th	*Erigeron canadensis*							2			4	5					
Th-TH	*Lithospermum arvense*											4	2	2	2		
Th	*Salsola kali*		4	4		2											
	Corynephoretalia species																
Th	*Veronica dillenii*												1				
Th	*Veronica verna*										1	5					
	Lichen-moss species																
	Cladonia convoluta									4	4	5	5	5	5	5	5
	Cladonia furcata										3	4	5	5	2	3	5
	Tortula ruralis									5	15	1	3	5	4	4	5

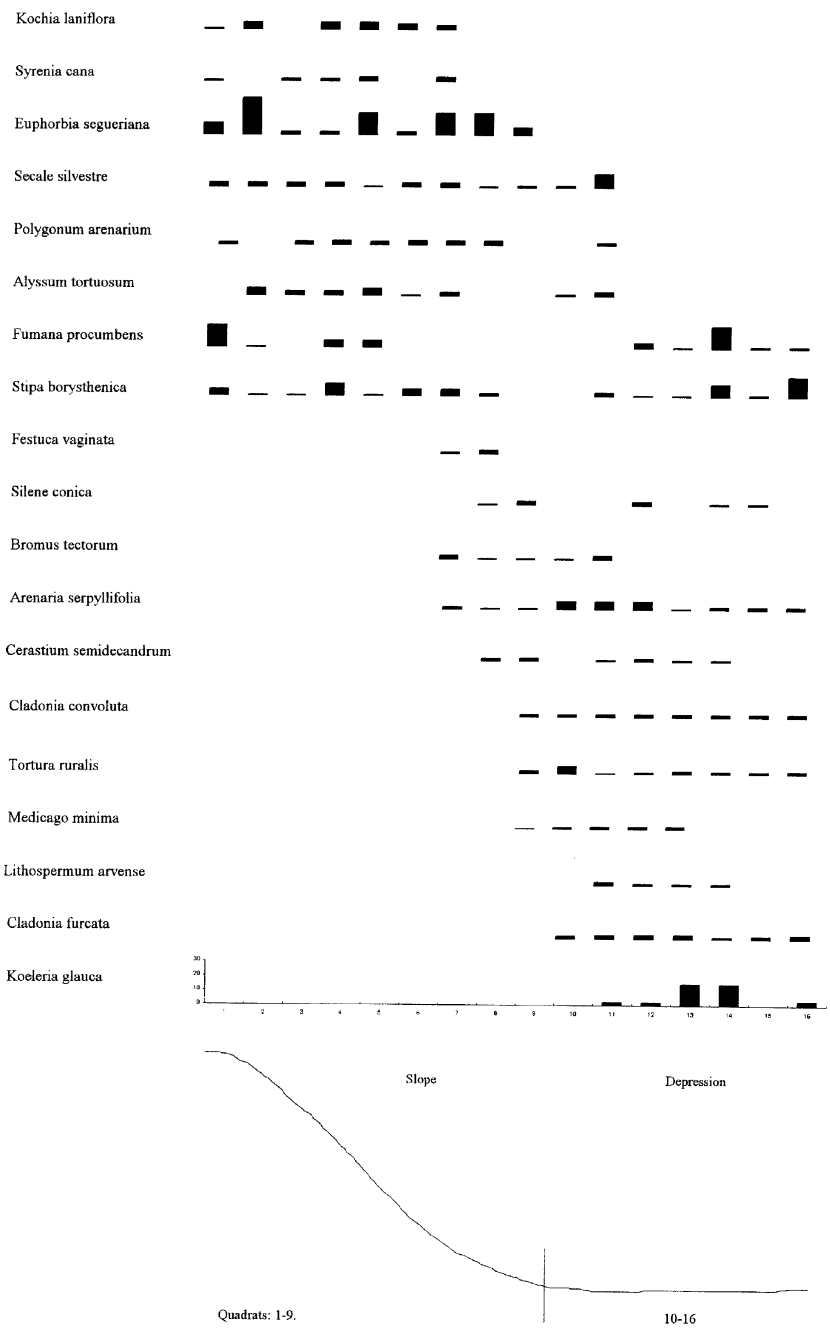

Fig. 4. Cover changes for selected species along the 3rd transect starting from the top (1st qt) of the sand dune

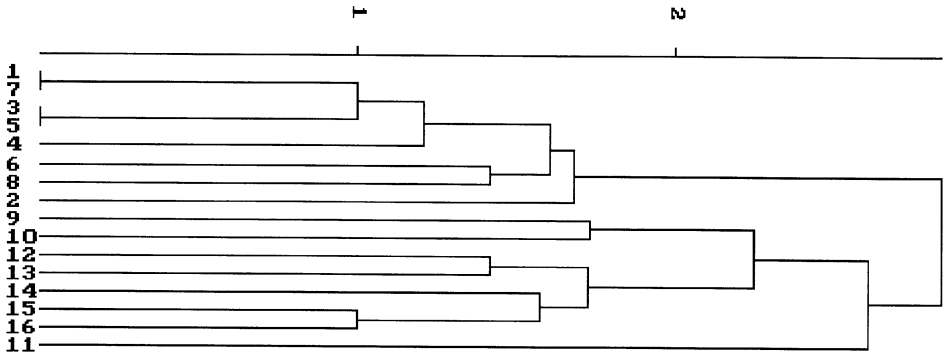

Fig. 5. Dendrogram of the cluster analysis carried out on species presence-absence data in the 3rd transect. Quadrates in the transect are noted by numbers, the transect starting from the top of the dune

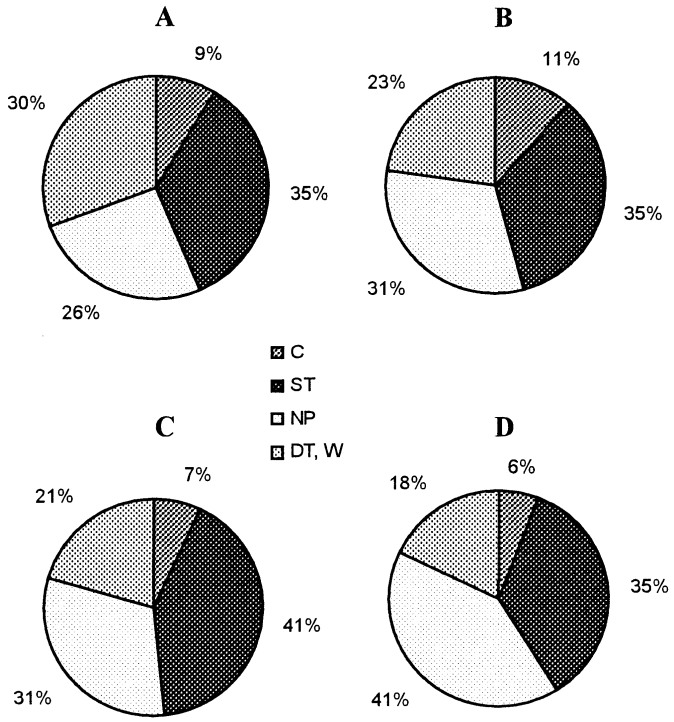

Fig. 6. Proportions of the species falling into different social behaviour types (after Borhidi 1993, 1995). A: 1st transect: *Festucetum vaginatae festucetosum vaginatae* subassociation. B: 1st transect: *Festucetum vaginatae stipetosum pennatae* subassociation. C: 2nd transect: *Festucetum vaginatae stipetosum pennatae* subassociation. D: 3rd transect: *Festucetum vaginatae stipetosum pennatae* subassociation. Explanation: C = competitors, ST = stress tolerant, NP = natural pioneers, DT = disturbance tolerants, W = weeds

Coenogroups and social behaviour

Most of the species found in the three transects belong to similar coenogroups (Tables 1–3), except for the members of the Festucion vaginatae association group, where grouping occurred according to subassociations. Cover of species belonging to the *Festuco-Brometea* grasslands is rather small on the top of the dunes, while their cover is increasing downwards along the transect together with that of *Cleistogenes serotina*. These zones may be considered as more degraded ones, although the presence of subassociation and facies forming species are also characteristic here.

Majority (70–80%) of the species are characteristic of this habitat (Fig. 6). Ratio of competitors was the lowest in all coenogroups, while stress tolerants and natural pioneers received similar ratings. In *Euphorbia seguieriana* and *Koeleria glauca* facies of the *Festucetum vaginatae stipetosum pennatae* subassociation occupying warmest (SW) slope the share of natural pioneers was higher than that by stress tolerants. A smaller (20–30%) ratio of the species belonged to the disturbance tolerants and weeds of disturbed habitats.

Life form distributions along the transects

In all subassociations the number of perennial and annual species were nearly the same. The cover was higher for the perennial than for the annual species (Fig. 7).

CONCLUSIONS

In accordance with the literature (Magyar 1933, Hargitai 1940, Zsolt 1943, Pócs 1954, Zólyomi 1958), present study shows subassociations and facies forming species of the community to occur in all investigated transects. Patches formed according to the dominance structure may correspond to the subassociations and facies mentioned in the literature. Significant part of the quadrates could not have been classified into either of the coenotaxa mentioned in the literature. In these zones the characteristic species of the different subassociations and facies are occurring together.

These patches are probably also the ones where changes in dominance relations and simultaneous spread of a species can relatively easily hap-

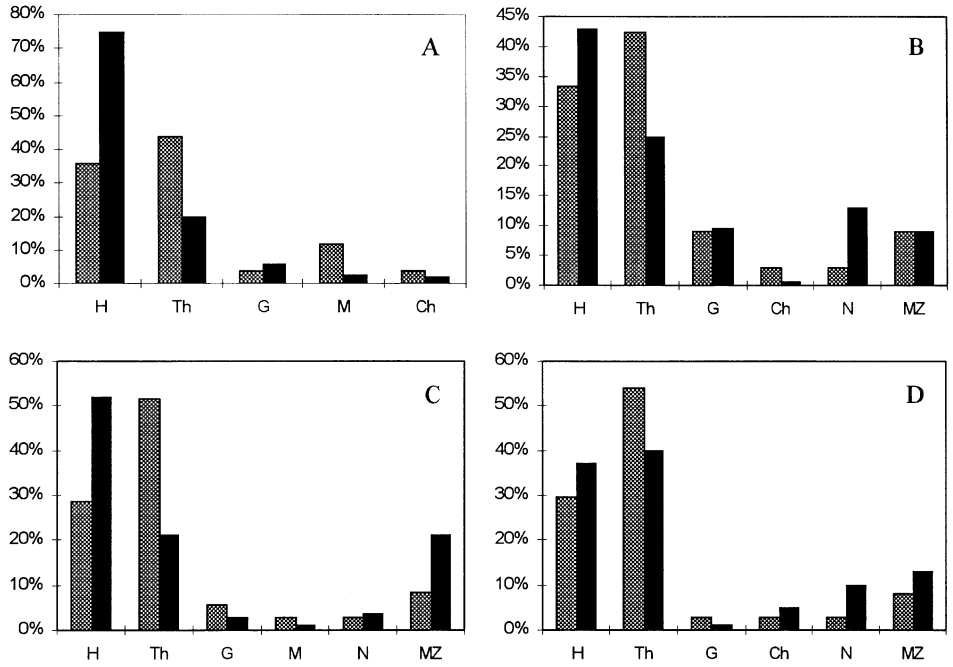

Fig. 7. Life form distributions and cover in the different subassociations. The first column shows the ratio of the species number (%), the second column shows the cover values of species (%). A: 1st transect: *Festucetum vaginatae festucetosum vaginatae* subassociation. B: 1st transect: *Festucetum vaginatae stipetosum pennatae* subassociation. C: 2nd transect: *Festucetum vaginatae stipetosum pennatae* subassociation. D: 3rd transect: *Festucetum vaginatae stipetosum pennatae* subassociation

pen, as it is the case with *Cleistogenes serotina*. Relation between small-scale topography and occurrence of any of the subassociations is at least ambiguous.

Annual vegetation of the open sandy grassland, on the other hand, has occurred only in the transition zones, between the subassociations or facies. In these transects moss-lichen synusia were present usually in the subassociation *Festucetum vaginatae stipetosum pennatae*.

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