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CORRELATIONS BETWEEN VEGETATION AND HYDROECOLOGY IN THE SANDY GRASSLANDS OF KISKÚNSÁG NATIONAL PARK

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Summary

In 1978—1979 investigations were performed on vegetation and soil-ecology in Bugac puszta area of Kiskúnság National Park on the assotiations *Festucetum vaginatae danubiale* Soó 29, *Potentillo (arenariae)-Festucetum pseudovinae danubiale* Bodrk. 59, *Lolio-Potentilletum anserinae* (Rpcs 27) KNAPP 46, and *Molinio-Salicetum rosmarinifoliae* (MAGYAR 33) Soó 57. It was established that in each stands due to inland drainage and increased zoogenic effects species with a wider ecological adaptability became dominant forming subassociations with *Festuca pseudovina*. The expansion of meso-xerophyta was observed. Correlation was established in number and dominancy between species of the higher cenological units and those of different hydroecological groups. It was established that in the studied area the vegetation largely lost the typical species-combinations due to increasing anthropogenic and zoogenic effects. It would be desirable to inhibit further degradation.

Introduction

In January 1975 was established the second National Park of Hungary, the Kiskúnság National Park. Upon the managements request complex ecological investigations were commenced on the Bugac puszta area in cooperation with the Department of Botany and Department of Zoology of the Attila József University, Szeged. Authors' investigations were performed within this frame.

Materials and Methods

For synecological investigations of the characteristic sandy grassland between the Danube and Tisza in the range of Bócsa—Bugac offers an adequate study area in which the characteristic stands are situated nearby. Authors' aim was to establish the consequences of changes of ecological (including soil-ecological and biogeneous) factors and the mutual influences between the adjacent associations. During the vegetation periods of 1978 and 1979 phytocenological investigations were monthly performed with the aid of refined evaluation methods. In the summarized evaluation the averaged results of the spring, summer and fall aspects were used in respect of species number and dominancy values as well. The species of the different associations were distributed into hydroecological groups and subgroups as follows: helo-hygrophyta (hhg), hygrophyta (hg), meso-hygrophyta (mhg), mesophyta (m), xero-mesophyta (xm), meso-xerophyta (mx), asteno-xerophyta (ax), and steno-xerophyta (sx) (BODROGKÖZY, 1977).

For the investigation of the soil-ecological factors (supposed to be the decisive) soil profiles were exposed. If a soilgenetical stratification could be established sampling was performed according

to the layers. In the laboratory pH, $CaCO_3$ and organic matter determination as well as mechanical analysis were performed. The latter is an important factor in the nutrition and water supply. According to the methods of the Guide Book of Soil Investigation were performed the basic investigations. For the mechanical analysis partly sieves, parthly the lithium carbonate method, the A-hydrometer and as control the pipette method were used. The separation of the following fractions was reasonable:

0.4 mm	0.1—0.02 mm
0.2—0.4 mm sand	0.02 mm
0.1—0.2 mm	

In favour of lucidity, instead of tables, the data of soil investigations were presented in three-dimensional diagrams showing also the height of the vegetation.

The vegetation on the sand is decisively influenced by the humudity of the soil. In connection with this, investigations were performed in the fall of 1979 when precipitation was meagre. Using different methods different results may be obtained. From these usually only one is taken into consideration — which does not give always a real picture. Authors consider as successful the graphical evaluation of the soil humidity as per cent of of dry weight, as per cent of wet weight and as water volume in soil volume (l/dm³) (BODROGKÖZY, 1978).

In the hydroecological grouping of the species the following groups and subgroups were distinguished: helo-hygrophyta (hhg), hygrophyta (hg), meso-hygrophyta (mhg), mesophyta (m), xeo-mesophyta (xm), asteno-xerophyta (ax), and steno-xerophyta (sx). In the cenological tables these groups were used instead of the usual groups of cenosystematics (BODROGKÖZY, 1978). To make easier the surway a graphic method was used instead of tabulating numerical data.

General charachterisation of the area

The study area is situated in the middle of Praematricum, the third floristic part of the Great Hungarian Plain. The succession can be followed from *Festucetum vaginatae* on the sand hill ridges till the sandy forests (BODROGKÖZY, 1957). Formerely, large sand meadows and pastures occupied the area but from the last century the greater part was drawn into agronomical cultivation. Beautiful examples of the remains of the original forest-steppe are found in Csévharaszt, Pusztavacs and Bugac.

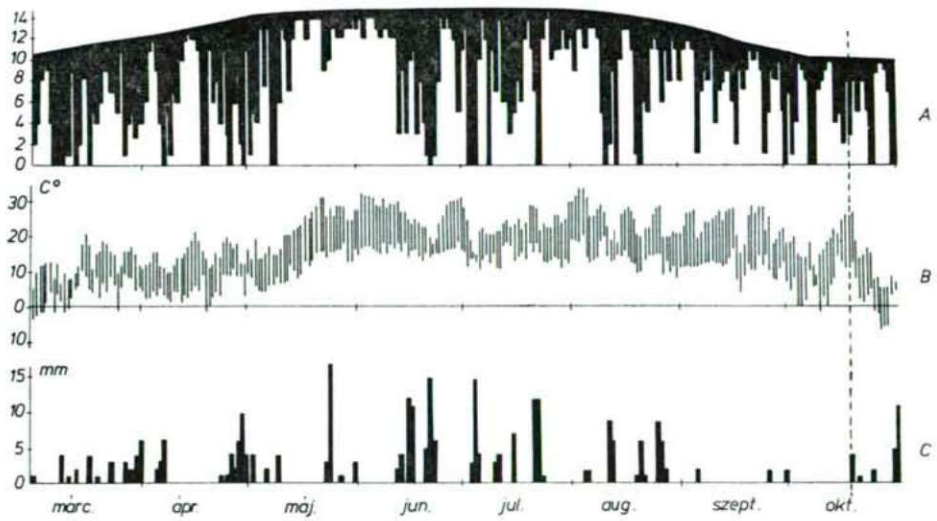


Fig. 1. Weather conditions during the vegetation period in the second year of investigations.

There are wellknown the phytocenological and production biological investigations of Simon and coworkers (SIMON and KOVÁCS-LÁNG, 1964; KOVÁCS-LÁNG and SZABÓ, 1971; VERSEGHY and KOVÁCS-LÁNG, 1971; SZABÓ, 1975).

From climatoloaical point of view it is characteristic of this area (which is one of the most sunlighted area of the country) that the yeraly mean of cloud covering is about 50 per cent; the number of sunny hours may surpass 2000. It is the hottest area of the country even in the vegetation period (Fig. 1). Composition of the vegetation is also influenced by the fact, that it is the area with short winters and long summers in Hungary.

Wind, an important factor in ecology, is also decisive in the formation of the surface. Direction of the stronger winds (8 m sec^{-1}) is in 20 per cent NW and in 19 per cent WNW. Accordingly are situated the sand hills and the hollows between them.

At the same time this area is the most arid part of the country: the yearly precipitation is 500—550 mm. From this, in the vegetation period (April—September) falls 300—350 mm. Drought occurring in summers, which may continue till the early fall too, is the consequence of unsettledness of weather.

On the area the base rock of the blown sand consists mostly of coarse quartz-sand containing less than 5 per cent particles below 0.2 mm. On the ridges the soil profiles are homogeneous, genetical layers can hardly be distinguished. All investigated profiles contain $CaCO_3$ in different quantities. This can have considerable physiological effects. According to KREYBIG the $CaCO_3$ content considerably influences the absorption capacity of the soil particles. In the case of high $CaCO_3$ content the soil can retain humudity in a degree that inhibits water uptake by plants. Different productivity of sandy soils is due to their different supply in organic matter and nutrients. Nutrient uptake is enhenced by physical characteristics of the soil. Their physico-chemical characterization is given by SZABÓ (1975).

In the evolution of the associations on the sands between the Danube and Tisza a correlation can be supposed with the water table in the soil. This is wellknown in connection with the forests. The connections with forestry were investigated by SZODFRIDT and FARANGÓ (1968). SZODFRIDT published data about infiltration of water, about the course of water moving in sandy soils (1971) and about the connections between natural plant associations and hydrology of these soils (1974). He also pointed out the importance of the evaluation of the water content in volume, weight in connection with water-economy of sandy soils.

Connections between hydroecology of vegetation and soil conditions

On the basis of the data averaged from two vegetation periods connections between the distribution of species' hydro-ecological groups and characters of the soils were established as follows:

Festucetum vaginatae danubiale (Rpcs. 23) Soó 29

This association occurs on the highest parts of the sand hill ridges of the study area. In consequence of the extreme ecological situation, the excessive pasturing and the drop of the water table after inland drainage resulted in a specific phytocenological and soil-ecological situation.

Soil-ecology. The soil profile of the blown sand is without expressed soil-genetical layers. Organic matter content in layer A (layer of the roots) is 1.4 per cent, higer than measured in other sites of the association, assuring a better nutrients supply. According to its $CaCO_3$ content and pH (6.4—6.7) it may be considered as an acidic blown sand (Fig. 2) reflected also in the spectrum of species. The fraction smaller than 0.1 mm is 6.37—7.95 per cent, so it may be considered as a little bit fixed type of blown sand (Fig. 2).

Humudity (measured in October 1979) as expressed in per cent of dry weight and per cent of wet weight showed nearly identical curves; not exceeding 5 per cent even in the zone of the roots.

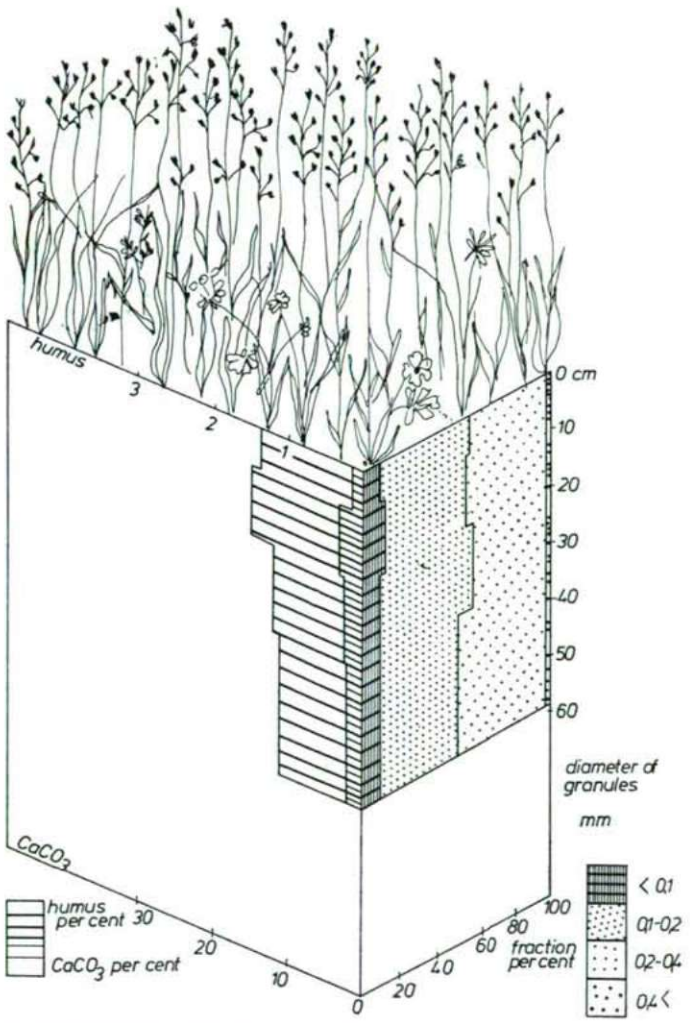


Fig. 2. Characters of soil profile of *Festucetum vaginatae*.

Analysing the species combination a connection can be established between pH, nutrients supply, hydrological characters and qualitative and quantitative occurrence of the different species groups. Occurrence of Trifolium arvense can be connected with low pH and low $CaCO_2$ content. The relatively favourable organic matter content reflects in the high number of species and high grade of covering.

Considering the distribution of the composing species into hydro-ecological groups, asteno-xerophyta and steno-xerophyta surpasse in number the xero-mesophyta and meso-xerophyta (Table 1); this can be connected with the favourable nutrient supply. Considering dominancy the picture is invers: the fourth of the meso-xerophyta occurs only by threads of remained only with a very low dominancy (Table 3).

A correlation was also established between the species components of the higher cenological units and the corresponding hydro-ecological groups and subgroups

Table 1. Festubetum vaginatae danubiale

	spring	summer	fall
	aspects		
Grass-level			
MESOPHYTA			
Lotus corniculatus (Molinio-Arrhenath.)		·····	·····
Anagallis arvensis (Chenop.-Scleranthea)			·····
XERO-MESOPHYTA			
Veronica verna (Festuco-Brometea)	·····		
Senecio vernalis (Chenopodietea)	·····	·····	
Poa compressa (Festuco-Brometea)		·····	·····
Cerastium semidecandrum (Festuco-Bromea)	·····	·····	
Hordeum murinum (Chenopodietea)		·····	·····
Euphorbia cyparissias (Fest.-Brometea)	·····	▬▬	▬▬
MESO-XEROPHYTA			
Achillea collina (Festuco-Bromea)	▬▬	▬▬	▬▬
Arenaria serpyllifolia (Festuco-Bromea)		▬▬	▬▬
Medicago minima (Festucetalia vag.)	·····	·····	
Echium vulgare (Festuco-Brometea)		·····	·····
Erysimum diffusum (Festucetalia vales.)	·····	·····	
Asparagus officinalis (Fest.-Brometea)		·····	▬▬
Anthemis austriaca (Chenop.-Scleranth.)	·····	·····	
Cynodon dactylon (Festuco-Bromea)	·····	▬▬	▬▬
Scabiosa ochroleuca (Fest.-Brometea)	·····	▬▬	▬▬
Thymus serpyllum (Fest.-Brometea)	▬▬	▬▬	▬▬
Poa bulbosa (Festuco-Brometea)	▬▬	▬▬	▬▬
Bromus tectorum (Festuco-Bromea)	▬▬	▬▬	▬▬
Galium verum (Festuco-Bromea)	▬▬	▬▬	▬▬
Potentilla arenaria (Festucetalia val.)	·····	·····	·····
Festuca pseudovina (Festucion rupicolae)	·····	·····	·····
Eryngium campestre (Festuco-Brometea)	▬▬	▬▬	▬▬
Marrubium peregrinum (Onopordion)	▬▬	▬▬	▬▬

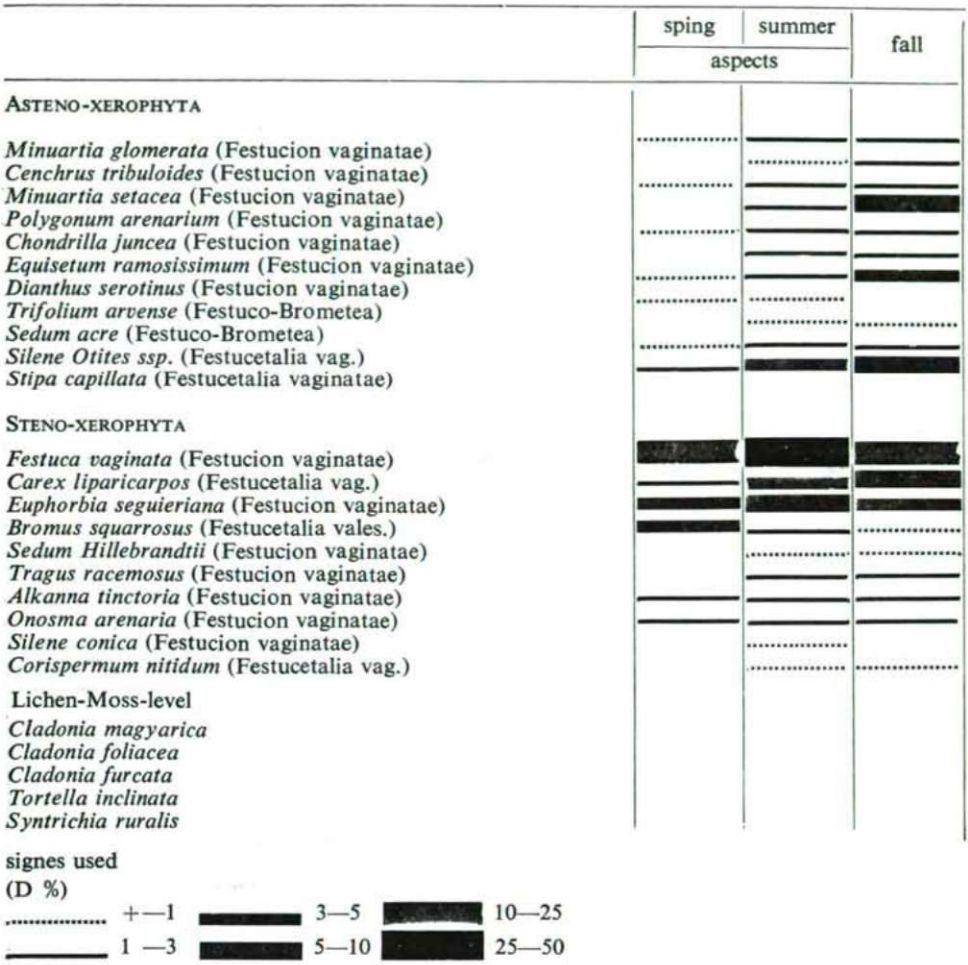


Table 2. Distribution according to number of species

number of species			per cent	number of species			per cent
Molinio-Arrhenatheretea	1	1	2.2	m	2	2	4
Festucetalia valesiacae	4			xm	6		
Festuco-Brometea	11	26	56.4	mx	17	23	50
Festuco-Bromea							
Onopordion. Chenopodietea	11						
Chenop.-Scleranthea							
Fesucion vaginatae	15	19	41.4	ax	11		
Festucetalia vaginatae	4			sx	10	21	46

Table 3. Distribution of the species of *Festucetum vaginatae* into cenosystematic and hydroecologic groups according to dominancy in the three aspects.

	spring	summer	fall		spring	summer	fall
					aspect		
Mol.-Arrhenatheretea	0.5	0.5		m	1.0	0.5	
Festucetalia valesiacae	4.0	8.5	2.0	xm	3.5	6.0	3.0
Festuco-Brometea Festuco-Bromea	14.0	21.5	25.0	mx	16.0	24.0	21.0
Chenopodietea Onopordion Chen.-Scleranthea	2.5	3.5	1.5				
Festucetalia vaginatae	9.5	11.5	12.0	ax	7.5	10.0	14.0
Festucion vaginatae	19.5	28.5	34.5	sx	22.0	32.5	36.5

Occurrence of the *Festucetalia vaginatae* species is neraly the same as that of the asteno-xerophyta. This is the situation in the case of *Festucion vaginatae, Festuco-Brometea, Festuco-Bromea,* and *Festucetalia valesiacae* (numerical data in Table 3).

Seasonal dynamics of phytomass production was also investigated (KÖRMÖCZI et al., 1980). Phytomass production of the moss and lichen synusium was investigated in the IBP (VERSEGHY et al., 1971).

Potentillo-Festucetum pseudovinae danubiale BODRK. 59

In the Hungarian Plain this association covers the pastures on sand soils of the brown (chernozem) type (BODROGKÖZY, 1959). Two possibilities of its origin may be considered. The *Potentillo-Festucetum pseudovinae danubiale* BODRK. 59 can be taken as a degraded *Festucetum vaginatae danubiale* Soó 29 degraded by biotic factors: excessive grazing which increase the effectivity other injuring factors (SIMON, 1971). But it can be considered also as a result of a positive succession. Due to favourable ecological processes species with competitive superiority entered *Festucetum vaginatae danubiale* and so its characteristic species have been ousted.

The study area was very adequate to clear the problem. In transitory cenoses *Festucion vaginatae* and *Festucetalia vaginatae* species still occur. Humus content in the layer A is about 2 per cent and till 40 cm it remains over 1 per cent. In the mechanical analysis also a fraction of smaller than 0.02 mm could be demonstrated (Fig. 3).

In Bugac the most common variant of the association is the *Potentillo-Festucetum pseudovinae cynodontetosum* Soó 55.

Soil-ecology. On the basis of investigation of two profiles it was established that its nutrient and water supply is more favourable than that of the former, transitory type. Layer A contains no $CaCO_3$ and the $CaCO_3$ content of the deeper layers is also low. In the profile No. 2. at 40 cm a buried humus containing layer was established. Taking into consideration the changes of organic matter in the profile it can be supposed that here the sand hills were formed gradually through a long period. The for-

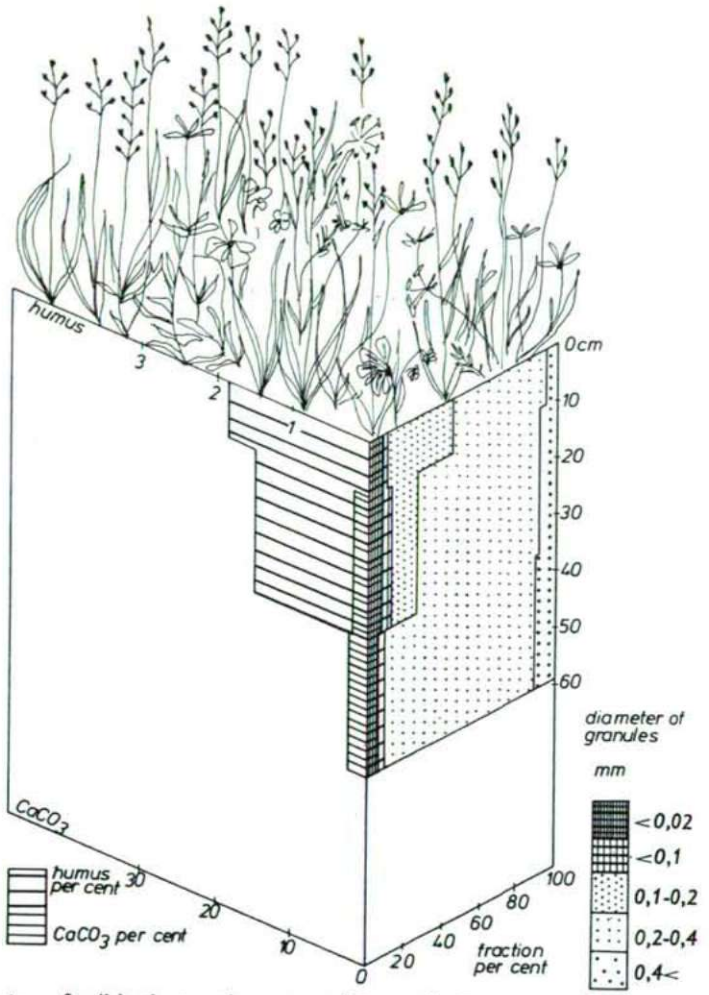


Fig. 3. Characters of soil in the transitory type of *Potentillo-Festucetum speudovinae*.

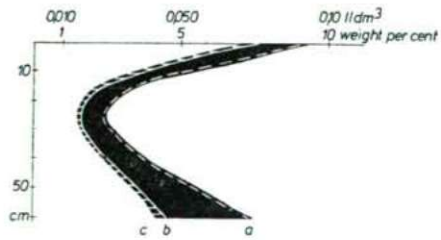


Fig. 4. Dynamics of soil humidity as expressed in weight per volume (a), in per cent of dry weight (b) and in per cent of wet weight (c) in the transitory type of *Potentillo-Festucetum pseudovinae*.

med and thereafter by blown sand buried grass stands resulted the humus containing layers. The mechanical analysis showed no significant differences in the different layers (Fig. 5. and 6).

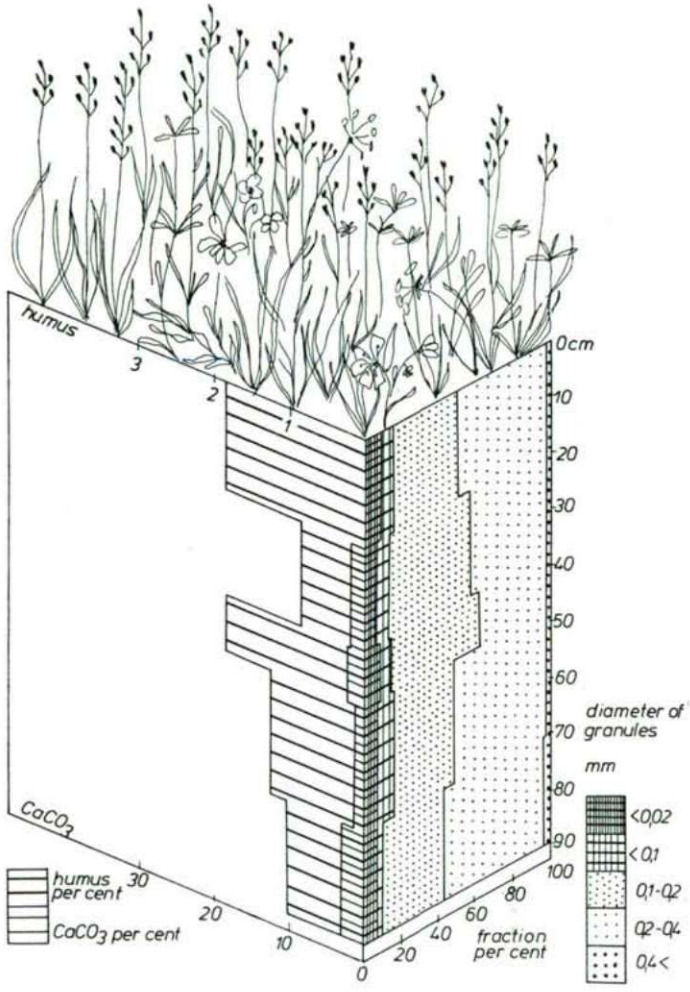


Fig. 5. Characters of the soil of a *Festuca pseudovina* stand with humus layer in the depth

The fall of 1979 scanty in rain fall showed its effect in water content of the different soil layers. In layer A (zone of the roots) it was nearly the double that of the soil of *Festucetum vaginatae* (Fig. 7).

Analysing the cenosystematical and hydro-ecological characters of the species it was established that also mesophyta and with low dominancy even meso-hygrophyta (*Molinio-Arrhenatheretea* and *Arrhenatheretalia* species) are represented. Meso-

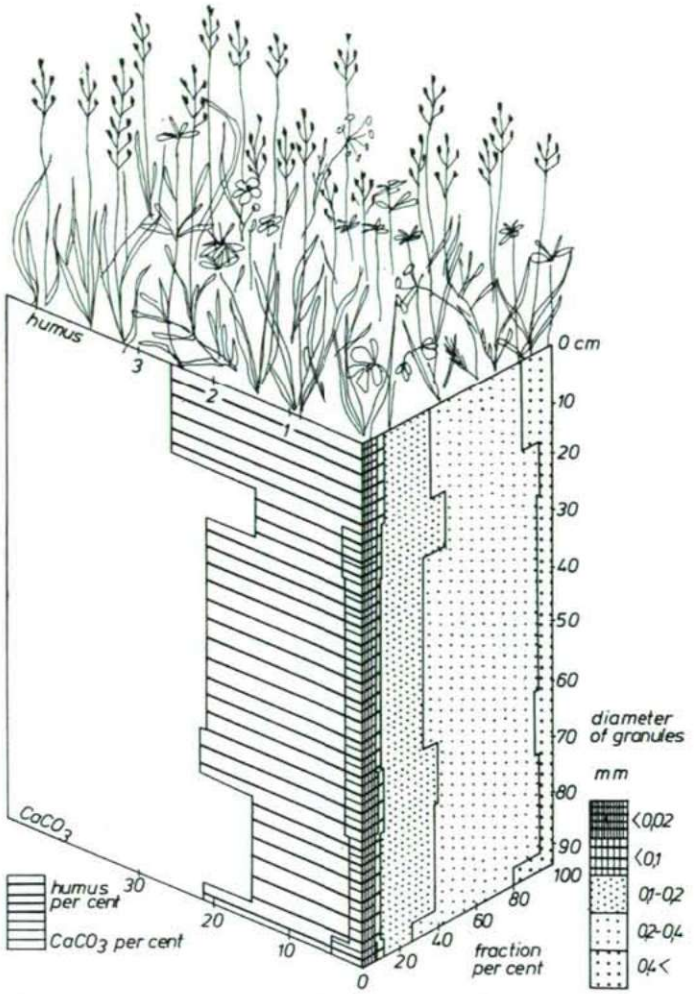


Fig. 6. Soil profile with high humus contents of a *Festuca pseudovina* stand.

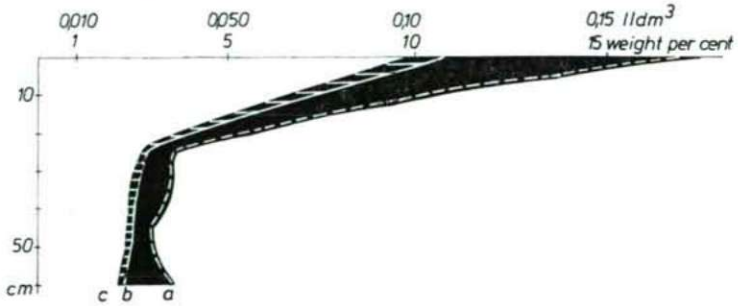
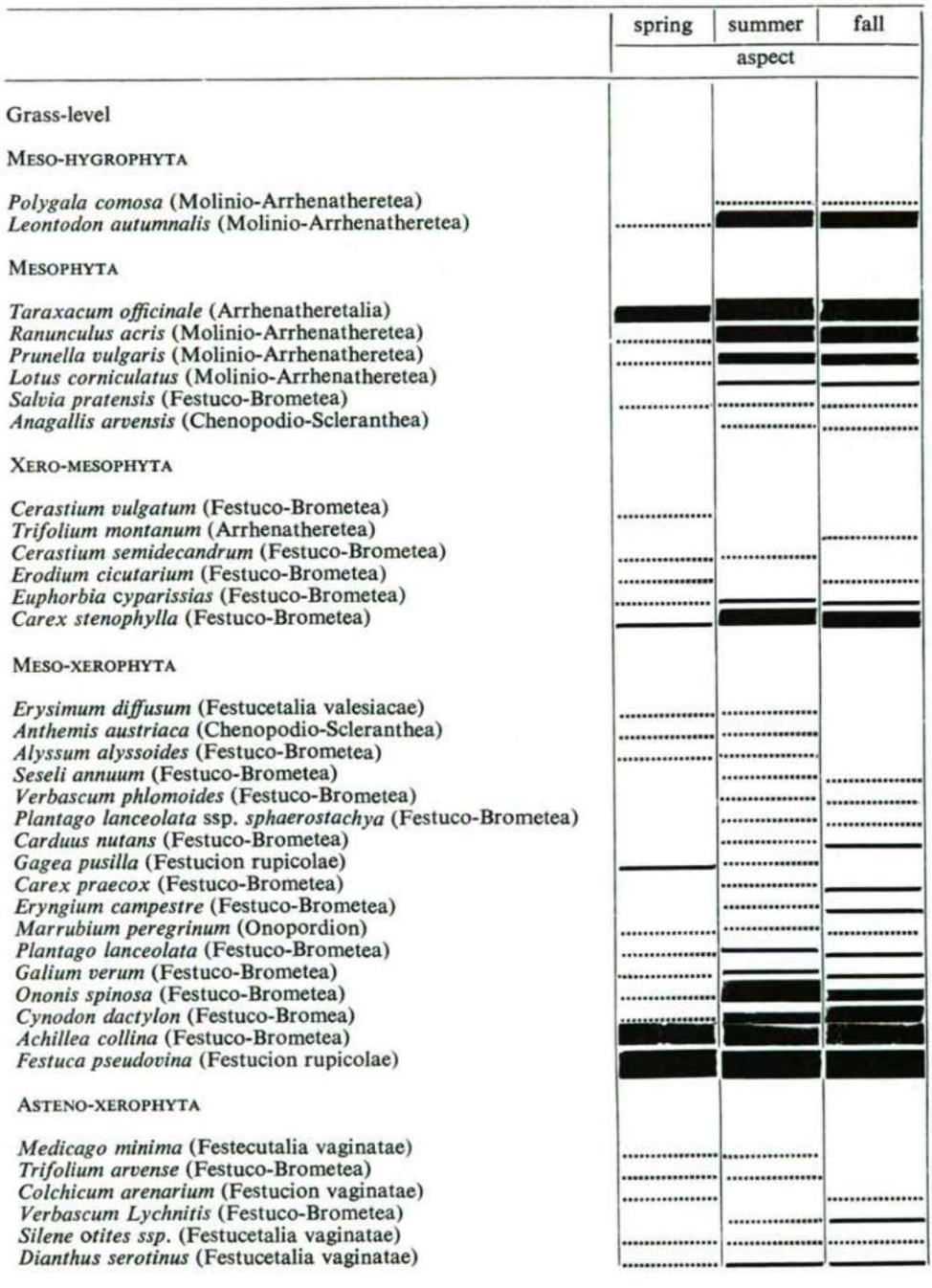


Fig. 7. Dynamics of soil humidity of the profile of Fig. 6. in fall meagre of precipitation.

Table 4. Potentillo-Festucetum pseudovinae dannbiale



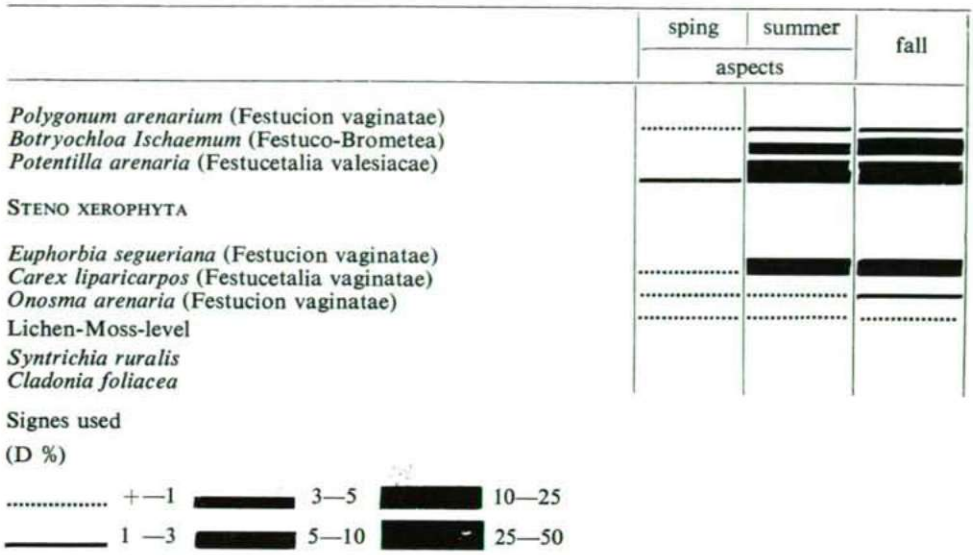


Table 5. Grouping the stand according to the number of species

	sumber of species		percent		number of species		per-cent
Molinio-Arrhenatheretea	5			mhg	2		
Arrhenatheretalia	1	7	15.9			8	18.2
Arrhenatheretea	1			m	6		
Festucion valesiacae							
Festucion rupicolae	2						
		5	11.3	xm	6		
Festucetalia valesiacae	3						
						24	54.6
Festuco-Brometea							
Festuco-Bromea	25	25	56.9	mx	18		
Onopordion							
Chenopodio-Scleranthea							
Festucetalia vaginatae	3		15.9	ax	9		
		7				12	27.2
Festucion vaginatae	4			sx	3		

xerophyta are permanently dominant from the spring aspect (over 50 per cent). The composing species are mostly the *Festucion rupicolae, Festucetalia valesiacae* and *Festuco-Brometea* species. Number of species and connections with the hydro-ecological groups are seen in Tables 5. and 6.

It is striking also, however, that some asteno-xerophyta and steno-xerophyta remain in this stand if only threadwise. It may be supposed that they come from the

Table 6. Distribution of the species of *Potentillo-Festucetum pseudovioae* into ceno-systematic and hydro-ecologic groups according to dominancy in the three aspects

	spring	summer	fall		spring	summer	fall
	aspect				aspect		
Mol.-Arrhenatheretea	1.5	7.0	6.5	mhg	0.5	2.5	2.5
Arrhenatheretalia	3.0	5.0	5.5				
Arrhenatheretea	0.5			m	4.5	10.5	10.0
Festucion valesiacae	0.5		0.5	xm	3.5	3.5	4.0
Festucion rupicolae	41.0	40.5	40.0				
Festucetalia valesiacae	20.5	10.5	10.0	mx	53.0	59.5	60.0
Festuco-Brometea	15.0	24.0	23.5				
Festuco-Bromea	0.5	2.0	5.0				
Onopordion + Chen.-Scler.	1.0	1.5	1.0				
Festucetalia vaginatae	1.0	1.5	1.5	ax	24.0	16.5	18.0
Festucion vaginatae	2.5	4.0	5.0	st	1.5	3.0	3.5

neighbouring *Festucetum vaginatae* stands which are sometimes mosaic-like inserted. The favourable ecological characters and humus content of the sandy soil exclude the possibility of the survival of less competitive *Festucetalia* species of the steno-xerophyta group.

Seasonal dynamics of the phytomass production was also investigated (KÖRMÖCZI et al., 1980).

Lolio-Potentilletum anserinae (Rpcs. 27) KNAPP 46

This association occurs in small spots on deeper sites between the hills. Due to subsiding the water table this association gradually becomes dry and considerable changes occur in its species composition.

Soil-ecology. Organic matter is 4 per cent in the zone of the roots and even at 80 cm it is neraly 1 per cent. In contrast to the soil deficient in lime of the former two stands here in the layer A more than 16 per cent and in the deeper layers nearly 32 per cent $CaCO_3$ can be demonstrated. Lime was most probably eluviated from the soil of the ridges accumulated here (Fig. 8).

In the mechanical analysis the loam-clay fraction was considerably higher than in the former stands. The high clay-content below 70 cm is the consequence of lime accumulation.

In Figure 9. the water content in the soil profile expressed as dry weight per cent, as wet weight per cent and as volume per cent (l/dm^3) demonstrates the situation of water supply in the fall scanty of rain falls. The sharp decrease fo humidity in the zone of the roots may be connected with the intensive transpiration of the plants. However, water moving from the underground table has a favourable effect.

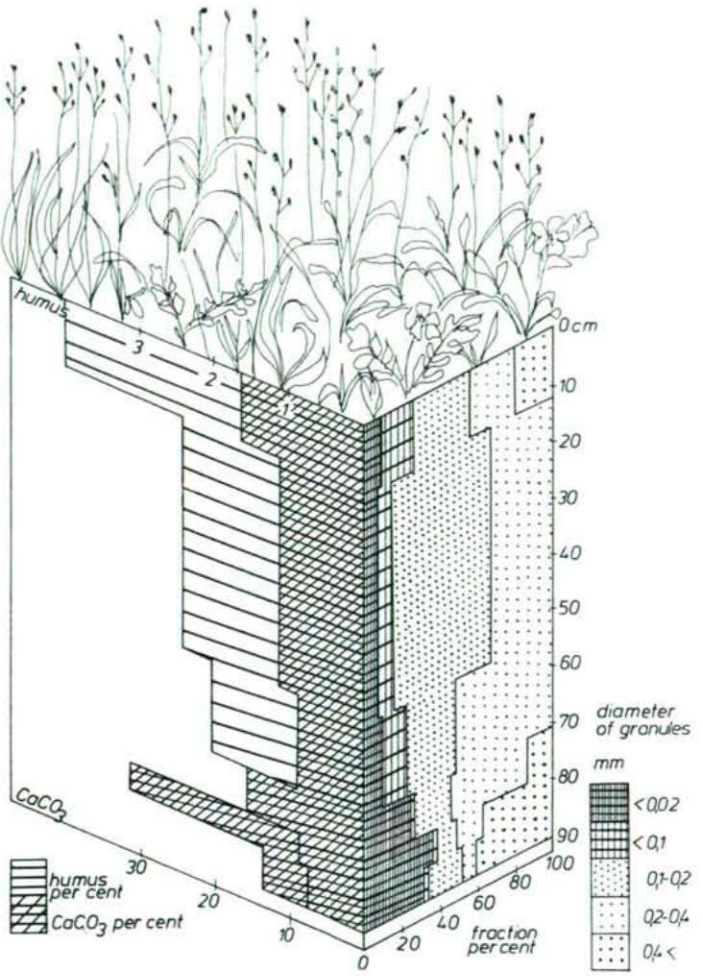


Fig. 8. Characters of the limey sand with a humus layer in the depth of *Lolio-Potentilletum anserinae*.

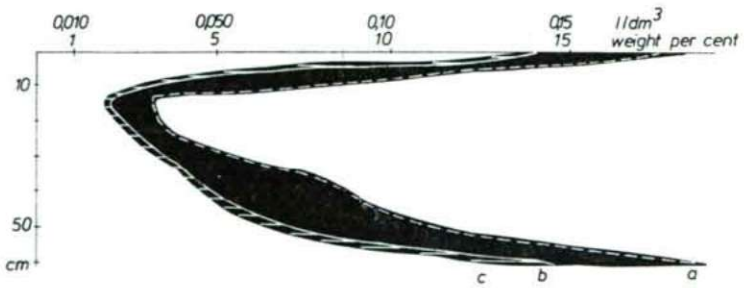


Fig. 9. Dynamics of soil humidity as expressed in weight per volume (a), in per cent of dry weight (b) and per cent of wet weight (c) in the humid sandy pasture during the fall.

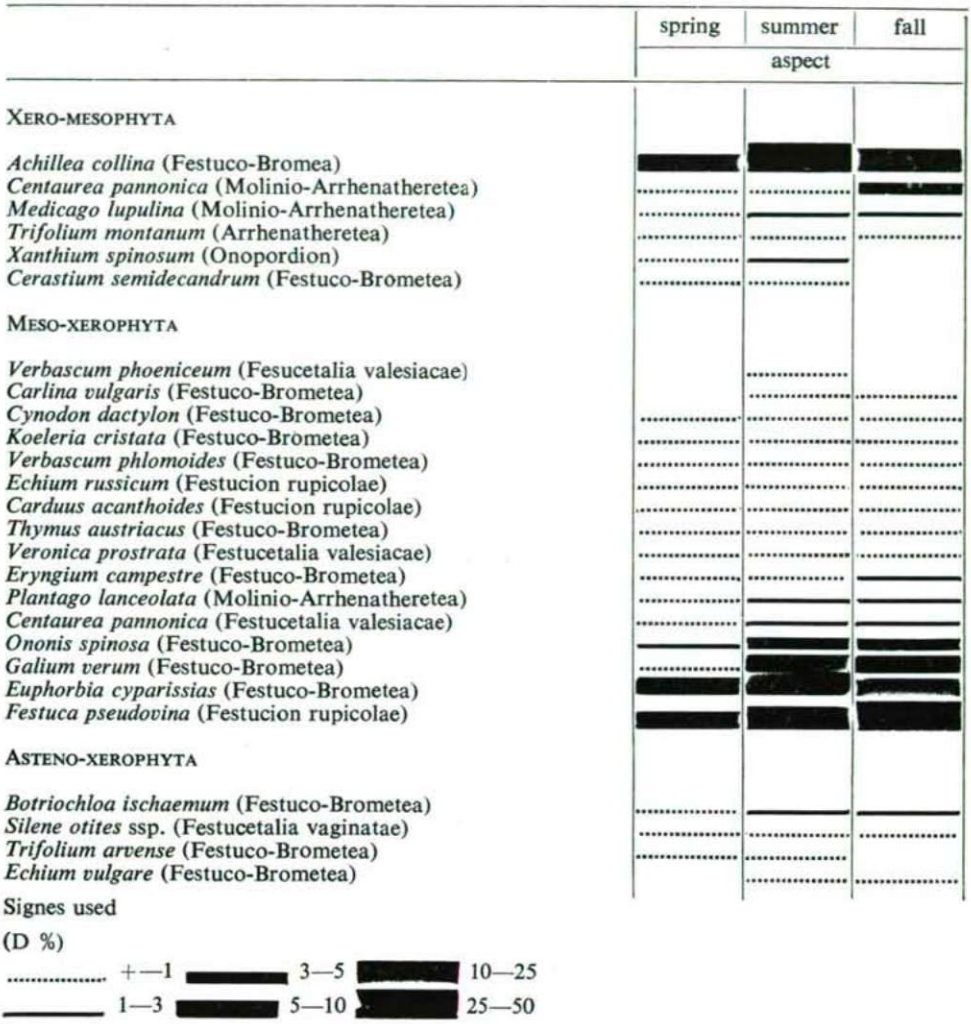
Analysing the phytocenoses some conclusions can be drawned concerning the genesis of the stand. Some helo-hygrophyta character species of the marsh-meadows as *Serratula tinctoria, Molinia coerulea, Mentha aquatica* can attain 8—10 per cent dominancy in the summer and in the fall. In first line to the more favourable soil-ecological properties can be attributed the close correlation between the number of species and dominancy of species belonging to the different sub-groups of the hygrophyta and species groups inside the *Molinio-Arrhenatheretea.*

Prevailing of species with wider ecological adaptability (frequently considered as indifferent species) from the *Festuco-Bromea* may be contributed to grazing and trodding, as in the former stands. It is to be pointed out, however, that the xero-mesophyta and meso-xerophyta are represented with a high number of species, but except some of them (e.g. *Festuca pseudovina, Achillea collina, Ononis spinosa, Euphorbia cyparissias, Galium verum* etc.) they occur only threadwise or with a very low dominancy (Tables 7, 8, and 9).

Results concerning phytomass production of *Lolio-Potentilletum anserinae* KNAPP 46 are also published (KÖRMÖCZI et al., 1980).

Table 7. Lolio-Potentilletum anserioae

	spring	summer	fall
	aspect		
Grass-level			
HELO-HYGROPHYTA			
Serratula tinctoria (Molinio-Arrhenatheretea)		.....	.....
Mentha aquatica (Molinio-Arrhenatheretea)	———	■■■	■■■
Molinia coerulea (Molinion)	.....	■■■	■■■
HYGROPHYTA			
Potentilla anserina (Molinietalia)	■■■	■■■	■■■
Potentilla reptans (Molinio-Arrhenatheretea)	———	■■■	———
Carex distans (Molinio-Juncetea)	.....	.....	.....
MESO-HYGROPHYTA			
Festuca pratensis (Molinio-Arrhenatheretea)	.....	■■■	■■■
Poa trivialis (Molinio-Arrhenatheretea)	.....	.....	———
Tetragonolobus maritimus (Molinietalia)	.....	.....	.....
Althaea officinalis (Agropyro-Rumicion)	.....	.....	.....
Polygala comosa (Molinio-Arrhenatheretea)	.....	■■■	———
MESOPHYTA			
Prunella vulgaris (Molinio-Arrhenatheretea)	■■■	■■■	■■■
Lotus corniculatus (Molinio-Arrhenatheretea)	———	■■■	■■■
Ranunculus acris (Molinio-Arrhenatheretea)	.....	———	———
Lolium perenne (Plantaginetalia)	.....	.....	.....
Salvia pratensis (Festuco-Brometea)	.....	.....	.....
Taraxacum officinale (Molinio-Arrhenatheretea)	.....	.....	.....
Leontodon autumnalis (Molinio-Arrhenatheretea)		.....	.....



Molinio-Salicetum rosmarinifoliae
(MAGYAR 33) Soó 57 *festucetosum pseudovinae* (Soó 57) n.n.

In the area this association occurs only fragmentary on the deeper sites between the hills.

Inland drainage and long, intensive pasturing considerably modified the original ecosystem. Today, only the most resistant species of the marsh survived. On other places between the Danube and Tisza where (KOVÁCS, 1962) the soil-ecological characters are less favourable degradation leads to some subassociation of *Festucetum vaginatae*. In our study area a different change occured.

Table 8. Grouping the stand according to the number of species

	number of species		per-cent			number of species		per-cent
Molinio-Juncetea	1				hhg	3		
Molinion, Molinietalia	3	18	41.0		hg	3	18	41.0
Molinio-Arrhenatheretea	13				mhg	5		
Arrhenatheretea	1				m	7		
Festucion rupicolae	3	6	13.4		xm	6	22	50.0
Festucetalia valesiacae	3							
Festuco-Brometea	16	16	36.4		mx	16		
Onopordion, Plantaginetea	3	3	7.0					
Festucetalia vaginatae	1	1	2.2		ax	4	4	9.0

Table 9. Distribution of the species of *Lolio-Potentilletum anserinae* into ceno-systematic and hydro-ecologic groups according to dominancy in the three aspects

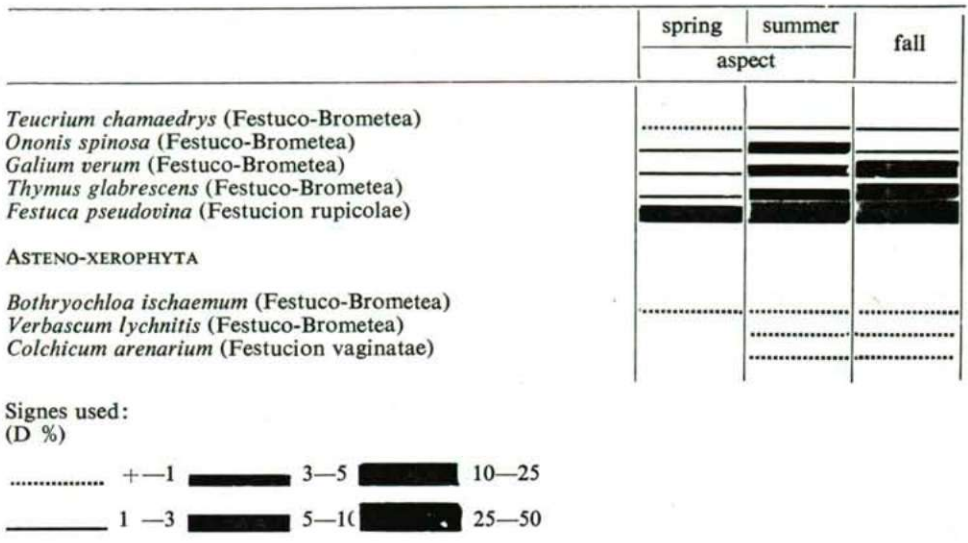
	spring	summer	fall		spring	summer	fall
	aspect				aspect		
Mol.-Juncetea	0.5	0.5	0.5	hhg	1.5	8.5	8.5
Molinion + Molinietalia	11.0	20.5	10.5				
Mol.-Arrhenatheretea	9.0	21.5	21.5	hg	11.5	17.5	6.5
Arrhenatheretea	0.5	0.5	0.5				
				mgh	2.5	6.5	6.0
Festucion rupicolae	21.0	26.0	31.0	xm	17.5	18.5	18.5
Festucetalia valesiacae	1.0	2.0	1.5				
Festuco-Brometea	12.5	25.0	28.5				
Festuco-Bromea				mx	28.5	41.0	45.0
Onopordion, Plantaginetea							
Agropyro-Rumicion	1.5	2.0	1.5				
Festucetalia vaginatae	0.5	0.5	0.5	ax	1.5	2.5	2.0

The ecological circumstances are similar to that of the former stand it formes isles in it. Here can be observed with some per cent dominancy also *Schoenus nigricans*, character species of *Schoenetum nigricantis* (ALL. 22) W. KOCH 26 showing the genesis of the stand.

Although in the species spectrum occur some character species of the association and association group (e.g. *Molinia coerulea, Salix rosmarinifolia, Serratula tinctoria, Cirsium canum* etc.), the changed ecological factors are no longer favourable to the species of the different subgroups of the hygrophyta. The drying up site and intensive grazing favour the same meso-xerophyta species as in the case of *Lolio-Potentilletum anserinae*. So became numerous *Festuca pseudovina, Poa angustifolia, Ononis spinosa, Galium verum* — as in the former stand; they can be considered as differential species (Table 10).

It may be supposed that the regression and elimination of *Molinion, Molinietalia* and *Molinio-Arrhenatheretea* species show a change in the direction of some associa-

Table 10. Molinio-Salicetum rosmarinifoliae



tion of *Festucion rupicolae* or *Agropyro-Rumicion*. Good correlations were demonstrated also in the different aspects in number of species (Table 11) and dominancy (Table 12) between cenosystematic groups and hydro-ecologic groups of the relics of the marsh vegetation.

Table 11. Distribution of the species number of the stand into ceno-systematic and hydro-ecologic groups

	number of species		per cent		number of species		per cent
Eriophorion	1	3	7.1		hhg	5	11.7
Molinio-Juncetea	2						
Molinion, Molinietalia	5	5	12.2		hg	2	4.8
Molinio-Arrhenatheretea	3	4	9.6		mhg	4	9.6
Agropyro-Rumicion	1						
Arrhenatherion	2						
Arrhenatheretalia		3	7.1		m	6	14.3
Arrhenatheretea	1						
Festucion rupicolae	1						
Festucetalia valesiacae	4	5	11.6		xm	3	7.1
Festuco-Brometea							
Festuco-Bromea	16	19	45.3		mx	19	45.3
Onopordion, Plantaginetea	3						
Chenopodio-Scleranthea							
Festucion vaginatae	3	3	7.1		ax	3	7.1

Table 12. Distribution of the species of *Molinio-Salicetum rosmarinifoliae* into ceno-systematic and hydro-ecologic groups according to dominancy in the different aspects

	spring	summer	fall		spring	summer	fall	
	aspect				aspect			
Eriophorion								
Mol.-Juncetea	5.5	7.0	4.0		hhg	11.5	14.0	10.0
Molinion	7.0	10.0	10.0		hg	3.0	8.5	11.0
Molinietalia								
Mol.-Arrhenatheretea	4.5	9.0	14.5					
Agropyro-Rumicion	5.0	8.0	10.0		mhg	6.0	9.5	6.5
Arrhenatherion								
Arrhenatheretalia	0.5	3.0	5.0					
Arrhenatheretea	0.5	1.5	1.5		m	6.0	11.0	4.0
Festucetalia valesiacae								
Festucetalia rupicolae	23.5	21.0	28.0		xm	2.5	3.5	5.5
Festuco-Brometea								
Festuco-Bromea	14.5	19.0	24.0		mx	34.5	36.5	52.0
Onopordion, Plantaginetea	1.5	1.0	1.5					
Chenopodio-Scleranthea								
Festucion vaginatae	6.5	5.0	4.0		ax	1.5	2.0	2.5

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