

COENOLOGICAL COMPARISONS OF SOME STANDS OF TEMPERATE GRASSLAND ASSOCIATIONS IN HUNGARY

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(Received 10 January 2005; accepted 30 March 2005)

Coenological results of six areas of several temperate grassland associations compared are taken in communities of, *Asplenio septentrionali-Melicetum ciliatae*, *Cleistogeni-Festucetum sulcatae*, *Festucetum vaginatae*, *Potentillo-Festucetum pseudodalmaticae*, *Salvio nemorosae-Festucetum rupicolae*, and *Seslerietum heuflerianae-hungaricae* associations. All of these stands of the associations are in protected areas, but these sample areas are close to endangered zones. We tried to refer to their function in ecophysiological respect of these grasslands.

Key words: cluster analysis, ecological parameters, multivariate analysis, ordination, temperate grasslands

INTRODUCTION

The open and closed grasslands, the cliff vegetation has an important role in the original vegetation of Hungary. Many-shaped communities developed in accordance with variable base stone in the Carpathian Basin after the last glacial period. Despite the ancient climate changes caused flora changes just the refuges of these grassland communities of the mountain guarded special species from the previous flora or the special microclimate and the habitat have an endemic plant from common species made.

The remaking of nature of great quantity just these communities developed on sand or loess base stone have completely forced back or nowadays these stands have strongly changed.

Temperate grasslands cover large areas of the Earth's vegetation (Coup-land 1992), and they are locate in one of the regions where the impact of global

climate change is predicted to be high (Campbell *et al.* 2000). The temperate grassland surface has large and increasing areas with arid climate. Even in the middle of Europe, Hungary has wide variety of temperate grasslands from nutrient rich loess grasslands to temperate semidesert sand grasslands in areas where the relatively low and unevenly distributed yearly precipitation results the temperate semidesert conditions (Fekete *et al.* 1988, Zólyomi and Fekete 1994).

Even though temperate grasslands are widely distributed vegetation type in Central and Eastern Europe characterisation of their carbon budget, CO₂ exchange (photosynthetic and respiration activity) and their role in the global carbon cycling has started in details only recently. This requires deeper knowledge of their botanical compositional and coenological characteristics. The European climate in the 21st century is likely to be warmer, with drier summers, wetter winters and more variable patterns of rainfall and temperature. The major cause of this climatic change is the increasing concentration of atmospheric CO₂ (Houghton *et al.* 1990). However, very little is known about the long-term responses of Eastern European temperate grassland vegetation to elevated atmospheric CO₂ concentrations (Tuba *et al.* 1996a, 1998c). This also requires updated botanical and coenological datasets on all kind of temperate grasslands.

For the investigation of the role of the grasslands in the global carbon cycle, we need to know the effect of the local present-day climatic conditions on the ecophysiological processes, which are also influenced by the successional stages and degradation (Fekete *et al.* 1988, Nagy *et al.* 1994, 1998, Szente *et al.* 1996). Yet, little is known about the CO₂ exchange characteristics and carbon cycling of the temperate grasslands and especially their long-term responses to elevated atmospheric CO₂ concentrations (Tuba *et al.* 1998c, 2003a, Nagy *et al.* 1997b, Szente *et al.* 1998). Although data from Central East European temperate grasslands are especially sparse, relatively lot of information is available on Hungarian temperate grasslands and therefore it is not a surprise that the Hungarian temperate grasslands are integrated objects of the European scale EUR and D framework projects (Larcher 1995, Tuba *et al.* 1996b, 1998c).

The temperate loess and sandy grassland were the objects of the very first spatial scale dependence ecophysiological (CO₂ gas exchange rates) measurements which were carried out by chamber-series measurements. The variability of grassland CO₂-assimilation rates showed clear spatial scale-dependence. The lowest variability (Fóti *et al.* 2002) of the vegetation's photosynthesis showed up at the small-middle scales (60–120 cm in diameter) (Czóbel *et al.* 2002, 2005). The results are suggesting the existence of a synphysiological unit what can be considered as a kind of synphysiological unit with characteristic size for each grassland.

The temperate loess and semidesert sand grasslands were the objects of the initial field fumigation experiments with long-term elevated air CO₂ concentrations on Central East European temperate grasslands (Tuba *et al.* 1993, 1996b, 1998a, Kóbor *et al.* 2000, Nagy *et al.* 1997a, 2002), which experiments are still running at the Global Climate Change and Vegetation Long-term Field Experimental Research Station at Gödöllő (Plant Ecological Research Group of Hungarian Academy of Sciences, Department of Botany and Plant Physiology, Szent István University) (Tuba 2004, Szerdahelyi *et al.* 2004a, b).

The Central and Eastern European net ecosystem CO₂ exchange (NEE) measurements were launched above this semidesert temperate grassland in 2001 (Tuba *et al.* 2003b, Balogh *et al.* 2002). Research on poikilohydric desiccation plants and vegetation under elevated air CO₂ concentrations was also initiated (Tuba *et al.* 1998b, 2003a).

In mountains the open or closed associations developed on limestone or dolomite were/are exposed to less activity of destruction of industry or agriculture, just then these special species composition answer more sensitively for the effects of the environment.

First we have just chosen these objects for our investigations, these dolomite, limestone and silicate grasslands react on the otherwise hardly perceivable disturbance immediately increasing number of weeds and decreasing species number. The last decade made the methods more effective and refined, so beside the classical coenological characterisation we have to give quick and effective solution for the conservationists. Last but not least original stands we have no found at all like were/could have been in the 1950s and 1960s. This time was the heroic age of vegetation mapping and the coenology in Hungary. Later several new statistical methods could be used (Zólyomi and Précsényi 1964, Zólyomi *et al.* 1967). These methods could work with completed data of the Hungarian flora list (Simon 2000), the relative ecological parameters for the Hungarian flora (Borhidi 1995) and the Hungarian flora database (Horváth *et al.* 1995) and the new nomenclature of the associations (Borhidi 2003).

The aims of investigations were to study the inner regularity of these associations, statistical evaluation and species composition relationship to the profile of the relative ecological parameters.

MATERIAL

Sample areas were the next: 1) Stand of *Potentillo-Festucetum pseudodalmaticae* of andesite in Vadállókővek; 2) xerophilous loess grassland of *Salvia nemorosae-Festucetum rupicolae* close to Isaszeg; 3) the stands of *Festucetum vaginatae* in Tece-legelő; 4) the stands of *Cleistogeni-Festucetum sulcatae* in Mt

Pilis; 5) the open (*Asplenio septentrionali-Melicetum ciliatae*) and closed (*Seslerietum heuflerianae-hungaricae*) stands of gabbro stone near Szarvas-kő.

Potentillo-Festucetum pseudodalmaticae association

The sample plots of stands of *Potentillo-Festucetum pseudodalmaticae* Májovsky 1955 was carried out in the Visegrádi Mts. close to the Vadállókő. The samples were chosen on the NW slope (5–10°) about 450 m. The surroundings of the sample area was a middle aged oak forest (*Quercetum petraeae-cerris* association). The first sample area was taken up a place on the Vadállókő. Comprehensive work published only the forests of this region (Horánszky 1964). The changing of andesite grasslands were investigated previously (Török 1989). Degradational processes of similar stands were studied in Gerecse Mts. (Török and Podani 1982). At the area of the Duna–Ipoly National Park, in the vicinity of Buda Mts the point-mapping of protected plants were taken (Csontos and Lőkös 1992).

Salvio nemorosae-Festucetum rupicolae association

The study site is situated in the Gödöllő Hills, in the vicinity of villages Isaszeg and Kerepes (latitude 47° 31' N, longitude 19° 22' E, about 20 km to SE of Budapest at 230 m a. s. l.) where typical and continuous stands of the *Salvio nemorosae-Festucetum rupicolae* association Zólyomi ex Soó 1964 were chosen. In this area the annual precipitation is 601 mm, the average annual temperature is 9.1 °C, the medium daily maximum and minimum temperatures are 14.1 °C and 4.1 °C (Kakas 1969). This flora spectrum contains several steppe species typical of the Central Hungarian Mountain Range (Zólyomi and Fekete 1994). The coenological survey was carried out in July, 2001 (see Table 2).

Festucetum vaginatae association

The *Festucetum vaginatae* Rapaics ex Soó 1929 emend. Borhidi 1996 association is one of the most spread endemic associations on sandy and calcareous soil in the Carpathian Basin. First data came from Rapaics (1923), exact description was given by Soó (1929). This association was divided three types. Detailed description of the *Festucetum vaginatae* association was given by Fekete *et al.* (1976). In this paper we tried to have the subassociations correspond to spots of synphysiological measures made.

Sample plots were taken close to village Vácrátót in *Festucetum vaginatae* association. In this area the sandy grassland stands occupying typical posi-

Table 1
Festucetum vaginatae association (Tece)

Species/Samples	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
Bryophytes, lichens	5	2	5	10	25	40	40	25	50	25	20	15	15	10	1	5	0.5	0.5	2	10	2	1	0.5	5	15
<i>Arenaria serpyllifolia</i>				0.5				0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5				0.5	0.5	0.5				0.5
<i>Berteroa incana</i>															0.5										
<i>Botriochloa ischaemum</i>	5	25	2	20	10	2	1		0.5	1	1				0.5	0.5	0.5	0.5	2	0.5	5		0.5	0.5	0.5
<i>Bromus squarrosus</i>		0.5	0.5	0.5	0.5	0.5	0.5		0.5						0.5				0.5	0.5		0.5	0.5		
<i>Carex liparicarpus</i>														0.5		50						50	20		0.5
<i>Centaurea micranthos</i>									0.5					0.5	0.5	0.5							0.5		
<i>Crepis rheoadifolia</i>	0.5			0.5			0.5		0.5			0.5		0.5	0.5	0.5	0.5					0.5			
<i>Dianthus pontederæ</i>																									
<i>Equisetum hiemale</i>																				0.5	10				
<i>Erigeron canadensis</i>		0.5				0.5													0.5	0.5					
<i>Eryngium campestre</i>																									0.5
<i>Erysimum odoratum</i>	1	0.5	0.5		0.5		0.5		0.5			0.5		0.5	0.5	0.5	0.5	0.5	0.5	0.5					0.5
<i>Euphorbia cyparissias</i>																	0.5	0.5							0.5
<i>Euphorbia seguieriana</i>			0.5		0.5		0.5	1	0.5					0.5	0.5										
<i>Festuca domini</i>			0.5					0.5		0.5						0.5	0.5								0.5
<i>Festuca vaginata</i>	65	40	40	30	10	30	40	30	20	30	10	40	40	50	90	80	15	60	25	20	20	20	50	60	50
<i>Fumana procumbens</i>									0.5	0.5	0.5														
<i>Galium verum</i>																	0.5	0.5							0.5
<i>Linaria genistifolia</i>																									
<i>Matricaria maritima</i>						0.5			0.5																
<i>Medicago minima</i>	0.5	0.5	0.5	0.5		0.5	0.5				0.5			0.5	0.5	0.5	0.5	0.5	0.5		0.5				0.5
<i>Minuartia verna</i>					0.5			0.5	0.5	5	0.5	0.5		0.5	0.5	0.5	0.5		0.5	0.5					0.5
<i>Onosma arenaria</i>																									
<i>Plantago indica</i>	2	25	5	1	2	0.5	0.5	1	1	10				0.5	0.5				10	1	0.5				
<i>Poa bulbosa</i>								0.5																	0.5
<i>Polygonum aviculare</i> agg.	0.5			0.5			0.5																		
<i>Potentilla arenaria</i>				2		15		2		25							0.5	0.5	5	20	10	10	15	10	
<i>Potentilla argentea</i>																						0.5			0.5
<i>Rumex acetosella</i>		0.5							0.5												5		25	10	
<i>Sedum sexangulare</i>																									5
<i>Silene conica</i>	0.5	0.5										0.5	0.5												
<i>Silene otites</i>								20	0.5	0.5															

Table 1 (continued)

Species/Samples	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
<i>Stipa borysthénica</i>													0.5												
<i>Thymus praecox</i>									0.5					0.5	2	0.5									
<i>Trifolium arvense</i>																0.5			0.5	0.5	0.5				0.5
<i>Veronica spicata</i>																									
Species/Samples	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
Bryophytes, lichens	15	20	25	5	1	0.5	0.5	5	1	0.5	0.5	20	2	10	2	10	20	30	5	15					20
<i>Arenaria serpyllifolia</i>	0.5				0.5	0.5				0.5	0.5	0.5				0.5									
<i>Berteroa incana</i>																									
<i>Botriochloa ischaemum</i>	0.5	0.5	0.5	0.5			0.5				0.5	0.5													20
<i>Bromus squarrosus</i>							0.5												0.5		0.5	0.5			0.5
<i>Carex liparicarpos</i>																									
<i>Centaurea micranthos</i>	0.5	0.5	0.5	0.5	0.5		0.5	0.5				0.5		0.5											
<i>Crepis rhoeadifolia</i>			0.5	0.5	0.5						0.5							0.5	0.5	0.5	0.5	0.5	0.5		
<i>Dianthus pontederac</i>							0.5																		
<i>Equisetum hiemale</i>																									
<i>Erigeron canadensis</i>						0.5	0.5	0.5											0.5		0.5	0.5			0.5
<i>Eryngium campestre</i>																									
<i>Erysimum odoratum</i>		0.5	0.5					0.5	0.5	0.5	0.5			0.5	0.5	0.5					0.5	0.5			0.5
<i>Euphorbia cyparissias</i>																									
<i>Euphorbia seguieriana</i>	0.5							0.5	0.5	0.5		0.5		0.5					0.5	0.5	0.5				0.5
<i>Festuca domini</i>																									
<i>Festuca vaginata</i>	40	50	40	60	50	40	40	30	50	25	80	60	60	50	75	80	90	25	90	30	25	50	25	70	30
<i>Fumana procumbens</i>	5						5				10	10									5		0.5	2	
<i>Galium verum</i>																									
<i>Linaria genistifolia</i>		0.5										0.5													
<i>Matricaria maritima</i>											0.5														
<i>Medicago minima</i>	0.5	0.5		0.5					0.5	0.5		0.5		0.5	0.5	0.5	0.5	0.5							
<i>Minuartia verna</i>	0.5				0.5	0.5				0.5		0.5				0.5									
<i>Onosma arenaria</i>	0.5	0.5	0.5																	0.5					
<i>Plantago indica</i>	0.5		0.5					0.5																	
<i>Poa bulbosa</i>							0.5	0.5	0.5	0.5															
<i>Polygonum aviculare</i> agg.														0.5											

Table 1 (continued)

Species/Samples	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
<i>Potentilla arenaria</i>														5					0.5	40					
<i>Potentilla argentea</i>																									
<i>Rumex acetosella</i>			0.5																						0.5
<i>Sedum sexangulare</i>																									
<i>Silene conica</i>										0.5									0.5						0.5
<i>Silene otites</i>		0.5		0.5	0.5																				
<i>Stipa borysthénica</i>					15	20	25	10		5	0.5	0.5	0.5	0.5						0.5					0.5
<i>Thymus praecox</i>				0.5	0.5	0.5			20	25												2			
<i>Trifolium arvense</i>																									
<i>Veronica spicata</i>																									

ons in the vicinity of Vácrátót in Tece-legelő formerly might be a pasture (see Table 1).

Cleistogeni-Festucetum sulcatae association

The sample area lays in the Pilis Mts along the edge of the plateau of Mt Pilis. The richness in species composition of the open and closed grassland called our attention to the stands of *Cleistogeni-Festucetum sulcatae* Zólyomi 1958 association. The sample plots are chosen in the protected area (biosphere reservation) of Duna-Ipoly National Park.

Asplenio septentrionali-Melicetum ciliatae, Seslerietum heuflerianae-hungaricae associations

The sample area were chosen at the southern part of Bükk National Park developed on gabbro basic stone including several rare species, namely *Woodsia ilvensis* and *Sesleria heufleriana*. The coenological investigations were carried in the habitat of *Woodsia* in the stands of *Asplenio septentrionali-Melicetum ciliatae* (Soó 1940) Máthé et Kovács 1964 and *Seslerietum heuflerianae-hungaricae* Zólyomi (1936) 1966 associations.

METHODS

The size of all sample plots were 2 m × 2 m in all records. The species lists and their percentage cover values were recorded in seventy-five randomly selected quadrats in open grassland stand at Vadállókövek. The date of surveying was in July 1999.

The next area was contributed with Bálint Zólyomi’s unpublished data (mscr.) of Gödöllő Hills were investigated in the end of

Table 2
Salvia-Festucetum rupicolae association

Species/Samples	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
<i>Achillea collina</i>	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Achillea pannonica</i>	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Adonis vernalis</i>	0	0	0	0	0	0	10	0	2	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Agrimonia eupatoria</i>	10	0	0	0.1	0	0	0	0	0.1	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Agropyron caninum</i>	0	0	5	0	0	0	0	0.1	0.1	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50
<i>Agropyron repens</i>	0	0	0	0	0.1	0	5	5	1	0	0.1	0.1	0.1	0	0	0.1	0	0	0.1	0	0	0	0	0	0
<i>Allium sphaerocephalum</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Anthericum ramosum</i>	0.1	0	0	0	0	15	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Asperula cynanchica</i>	2	0	0	0	0	2	2	0.1	2	5	0.1	5	0	0	0	0.1	0	0	0	0	0	5	0	5	0
<i>Astragalus onobrychis</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Bromus sterilis</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Campanula rotundifolia</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0
<i>Carduus nutans</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Carex humilis</i>	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	25	0	0	0	0	0	0	0
<i>Centaurea sadleriana</i>	0	0	0	1	0	0.1	0	2	1	5	0.1	0	0	0	0.1	0	0	0	0	0	0.1	0	0.1	0.1	0
<i>Chrysopogon gryllus</i>	0	0	30	30	20	0.1	0	15	0.1	0	0	0	30	20	0.1	1	20	25	20	10	5	0.1	40	0.1	0
<i>Crataegus monogyna</i>	0	5	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0.1	0	0	0	0	0	0	0
<i>Cuscuta sp.</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Cytisus austriacus</i>	5	25	30	10	70	25	20	25	10	10	10	40	5	20	0.1	30	25	20	20	10	0.1	0.1	3	20	10
<i>Dactylis glomerata</i>	5	0.1	2	0.1	20	20	5	3	0.1	0.1	0.1	0.1	0	0	0.1	0	0	0	0.1	0	0	0	0	0	0.1
<i>Descurainia sophia</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Dianthus pontederæ</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Dorycnium germanicum</i>	20	15	5	15	5	2	10	5	15	5	2	0	10	0	15	0	5	0	0.1	15	15	20	40	25	15
<i>Erigeron canadensis</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Eryngium campestre</i>	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.1	0	0	0	0	0	0	0	0.1	0	0	0
<i>Euphorbia cyparissias</i>	0.1	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Euphorbia pannonica</i>	0.1	0	0	20	0	0	5	10	15	0	0	0	0	0	0.1	0.1	0	0	0.1	0	0	10	0	0.1	0.1
<i>Falcaria vulgaris</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1
<i>Festuca rupicola</i>	20	45	5	15	10	20	15	25	20	30	40	45	50	15	30	20	40	25	25	50	40	30	10	30	15
<i>Filipendula vulgaris</i>	0.1	0.1	5	0.1	0.1	0	0	5	0.1	5	0.1	0	5	15	2	25	3	5	2	0	15	20	0	5	0
<i>Galium verum</i>	0	0.1	0	0.1	0	5	0	2	2	0	0	0.1	0	0	0.1	0	0.1	0	0	1	0	0	0.1	0	0.1
<i>Helictotrichon pubescens</i>	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0.1	0	0	0	0	0.1	0

Table 2 (continued)

Species/Samples	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
<i>Hypericum perforatum</i>	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0
<i>Isatis tinctoria</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Knautia arvensis</i>	0.1	0	0	0	0	0	0	0	0	0	0.1	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0
<i>Koeleria cristata</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Lactuca quercina</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Lactuca serriola</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Medicago falcata</i>	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0
<i>Melandrium album</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Melica ciliata</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Minuartia verna</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0
<i>Muscari comosum</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0
<i>Myosotis stricta</i>	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Nonoa pulla</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Onobrychis viciaefolia</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0.1	0	0	0	0	0	0	0
<i>Phleum phleoides</i>	0.1	10	0	0.1	0.1	0	0.1	0.1	0.1	0	0.1	0	0.1	0.25	0.1	0.1	0.1	0.1	0.1	0	0	0	0	0.1	0
<i>Plantago media</i>	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0
<i>Poa pratensis</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Prunus spinosa</i>	0.1	0.1	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Ranunculus acris</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Reseda lutea</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Salvia nemoralis</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Sanguisorba minor</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Seseli varium</i>	0.1	0	0	0	0	0.6	5	5	2	0	15	0	0.1	0	0	5	0	0	0.1	0	0	0	0.1	0.1	0
<i>Silene otites</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Stipa capillata</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Stipa dasyphylla</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Teucrium chamaedrys</i>	5	2	5	5	5	2	10	2	5	5	2	5	1	0	20	1	5	2	1	1	5	1	10	0	0.1
<i>Thalictrum pseudominus</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0
<i>Turritis glabra</i>	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Viola arvensis</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 2 (continued)

Species/Samples	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
<i>Achillea collina</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0
<i>Achillea pannonica</i>	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Adonis vernalis</i>	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Agrimonia eupatoria</i>	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Agropyron caninum</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Agropyron repens</i>	0	0	0	0.1	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0.1	2	1	2	0.1	0
<i>Allium sphaerocephalum</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0
<i>Anthericum ranosum</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Asperula cynanchica</i>	0	0	0	0	0	0	0	0	0	0	2	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0
<i>Astragalus onobrychis</i>	0	0	0	0	0	0	0	0	0.1	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Bromus sterilis</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0
<i>Campanula rotundifolia</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Carduus nutans</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Carex humilis</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Centaurea sadleriana</i>	0	0.1	0	0	0	0	0.1	0	0	0	0.1	0	5	2	5	0	0	0	1	0	0	0	0	0	0
<i>Chrysopogon gryllus</i>	0	0.1	0.1	0	0	0	0	0	0.30	40	30	0	20	25	40	40	40	30	20	5	0.1	0.1	0	0	0
<i>Crataegus monogyna</i>	0	0	0	0	0.1	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Cuscuta sp.</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Cytisus austriacus</i>	10	5	0.1	25	30	20	10	10	25	10	0.1	30	25	15	0.1	25	30	25	40	15	20	5	25	30	5
<i>Dactylis glomerata</i>	0	0	0	0	0	0	0	1	0.1	0	1	0.1	0.1	0	0	0	0.1	2	0	0	0	0	0	0	0.1
<i>Descurainia sophia</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0
<i>Dianthus pontederæ</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.1	0	0	0	0	0	0	0	0	0
<i>Dorycnium germanicum</i>	10	5	20	5	10	20	10	15	15	0	20	40	25	5	10	0	0	0	5	5	5	5	0	0	0
<i>Erigeron canadensis</i>	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0
<i>Eryngium campestre</i>	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0.1	0	0	0	0.1	0	0	0	0.1	0
<i>Euphorbia cyparissias</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Euphorbia pannonica</i>	5	5	10	0	0	15	0	10	0	5	0	0	0.1	0	0	0	15	0	0	0	0	0	0	0	0.1
<i>Falcaria vulgaris</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Festuca rupicola</i>	60	70	75	70	40	40	40	60	30	40	40	25	25	40	30	65	50	30	40	50	40	40	50	50	50
<i>Filipendula vulgaris</i>	10	0	0.1	5	0.1	10	10	15	0.1	0.1	2	5	0.1	10	10	10	15	10	10	15	5	0	30	0	0
<i>Galium verum</i>	0	0	0.1	0	0	0	0	0	0	0	0.1	0	0	0.1	0.1	0.1	0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0
<i>Helictotrichon pubescens</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Hypericum perforatum</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 2 (continued)

Species/Samples	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
<i>Isatis tinctoria</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	20
<i>Knautia arvensis</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Koeleria cristata</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1
<i>Lactuca quercina</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Lactuca serriola</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Medicago falcata</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Melandrium album</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0.1	0.1
<i>Melica ciliata</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Minuartia verna</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Muscari comosum</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0
<i>Myosotis stricta</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Nonea pullla</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Onobrychis viciifolia</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Phleum phleoides</i>	0	0	0	0.1	0	0	0	0.1	0	0	0	0	0.1	0	0.1	0	0	0	5	0	0	0	0	0	0
<i>Plantago media</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1
<i>Poa pratensis</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Prunus spinosa</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Ranunculus acris</i>	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Reseda lutea</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Salvia nemoralis</i>	0.1	0.1	0.1	5	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
<i>Sanguisorba minor</i>	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Seseli varium</i>	0	0	0	0.1	2	0	5	0	0	0	0	0	0	0	0	0	0	0.1	0	0.1	5	0	0	0	0.1
<i>Silene otites</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0
<i>Stipa capillata</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Stipa dasphylla</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Teucrium chamaedrys</i>	10	10	2	5	5	5	10	10	0.1	0	5	0.1	0	10	0.1	5	5	0	0	5	10	5	10	0	0
<i>Thalictrum pseudominus</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Turritis glabra</i>	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Viola arvensis</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.1	0.1	0	0

Table 2 (continued)

Species/Samples	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
<i>Achillea collina</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Achillea pannonica</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Adonis vernalis</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Agrimonia eupatoria</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Agropyron caninum</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0
<i>Agropyron repens</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Allium sphaerocephalum</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Anthericum ramosum</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Asperula cynanchica</i>	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Astragalus onobrychis</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Bromus sterilis</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Campanula rotundifolia</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Carduus nutans</i>	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Carex humilis</i>	0	0	0.1	0	0	0	0	0	0	0	0	10	5	0	0	10	10	0	0	0	0	0	0	0	0.1
<i>Centaurea sadleriana</i>	0	0	0	0	0	0	0	0	0.1	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0
<i>Chrysopogon gryllus</i>	0	5	10	5	0	10	0	0	0	0	0	0	1	0.1	10	10	60	10	40	10	0	0	0	5	0
<i>Crataegus monogyna</i>	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Cuscuta sp.</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0
<i>Cytisus austriacus</i>	25	15	20	10	25	40	5	5	2	10	40	20	25	25	20	10	20	5	15	10	5	15	30	40	25
<i>Dactylis glomerata</i>	0	0	0.1	0	0	0.1	0	0.1	0	0	0	0.1	0	0	0.1	0	0	0.1	0	0	0	0.1	0	0	0
<i>Descurainia sophia</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Dianthus pottederae</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Dorycnium germanicum</i>	0	10	15	5	10	0	2	0	0	0	10	0	5	25	5	0	0	5	5	2	5	0	10	10	15
<i>Erigeron canadensis</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Eryngium campestre</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0.1	0	0	0
<i>Euphorbia cyparissias</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Euphorbia pannonica</i>	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	1	0.1
<i>Falcaria vulgaris</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Festuca rupicola</i>	40	30	50	40	30	25	0	20	0.1	45	25	20	20	25	30	10	25	15	60	25	40	50	40	0	50
<i>Filipendula vulgaris</i>	2	10	15	10	0	5	5	0	0.1	20	15	20	0	15	0	5	0	0.1	0	5	10	15	0	20	10
<i>Galium verum</i>	0	3	0	0	0	0	0	0.1	0	0	0	0	0.1	0.1	0	0	0	0.1	0	0	0	0.1	0	0	0
<i>Helictotrichon pubescens</i>	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0
<i>Hypericum perforatum</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0
<i>Isatis tinctoria</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 2 (continued)

Species/Samples	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
<i>Knautia arvensis</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Koeleria cristata</i>	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Lactuca quercina</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0
<i>Lactuca serriola</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1
<i>Medicago falcata</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Melandrium album</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Melica ciliata</i>	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Minuartia verna</i>	0.1	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0.1	0	0	0	0	0	0
<i>Muscari comosum</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Myosotis stricta</i>	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1
<i>Nonea pulla</i>	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Onobrychis viciaefolia</i>	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0
<i>Phleum phleoides</i>	0.1	0	0.1	0	0	0	0.1	0	0	0.1	0	0	0	0	0	0.1	0	0	0	0	0.1	0	0.1	0	0
<i>Plantago media</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Poa pratensis</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Prunus spinosa</i>	0.1	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0
<i>Ranunculus acris</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Reseda lutea</i>	0	0.1	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
<i>Salvia nemoralis</i>	0	0	0	0	0	0	0.1	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Sanguisorba minor</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Seseli varium</i>	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0
<i>Silene otites</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Stipa capillata</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	0
<i>Stipa dasycphylla</i>	0	0	30	30	30	25	60	70	90	25	0	0	0	0	30	10	30	0	0	0	0	25	20	25	10
<i>Teucrium chamaedrys</i>	5	2	5	12	0	0	0	0	0	0	10	0	0	0	0	5	3	0.1	0.1	0.1	2	0	0.1	0.1	0
<i>Thalictrum pseudominus</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0
<i>Turritis glabra</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Viola arvensis</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

the 1950s. This manuscript has got under favour Prof. Dr Gábor Fekete. The plots have been placed in a typical and a continuous stand of Tece-legelő. We tried to set up plots in that area represents this association, namely rich in species and different in physiognomy. Fifty quadrats were recorded there. The date of surveying was on 10 July 2001.

Species composition, distribution of floral elements, ecological parameters and nature preservation rank categories were analysed of the 100 sample plots of *Cleistogeni-Festucetum sulcatae* association at 8 sample areas in the range of the Pilis Mts on Mt Pilis. The date of surveying was in July 1988 and in 1989.

In the Bükk Mts, at the upper third of Szarvas-kő 39 sample plots were chosen. The date of surveying was in 1985. The cover values were estimated in percent. The directions of samples were NW and NNW, the angle of inclination varied in 60–70°.

The next relative ecological parameters of the species composition were detected of all sample plots as follows: relative temperature requirement (TB), relative water requirement (WB), relative nitrogen requirement (NB), continentality values (KB) and social behaviour types (SOC). For statistical evaluation the several ecological characters of species carried from the Hungarian flora database (Horváth *et al.* 1995). The values of ecological indicator numbers of species (Borhidi 1995) are given in percentage pro rata.

The species compositions of the sample plots were submitted to cluster analysis, using SYN-TAX 5.0 programs with percentage differences-index (Podani 1993, 1994) trying to explain coenological meaning the forming groups. A hierarchical (cluster analysis) and a non-hierarchical (Pcoa) analysis are given. The nature conservation ranks (NCR) (Simon 1988) are given in 10 categories separated in two groups. Proportion of first group (U = unique, KV = strictly protected, V = protected, E = native species, K = accessorial species,

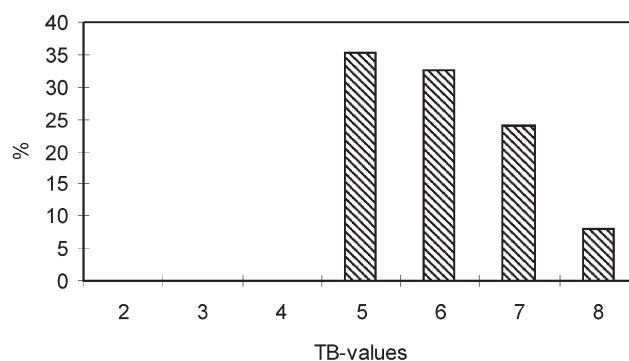


Fig. 1. Distribution of TB values of sample plots of Vadálló-kövek

TP = nature pioneers) reflects natural conditions, proportion of the second group indicates the degree of degradation (TZ = disturbance tolerant native species, A = adventive, G = cultivated species, GY = weeds) comparing to the Hungarian average. The categories of simplified flora element spectrum of Hungary (FL) contain the main groups completing with relationship of Pannonian viewpoint. This kind of simplification was suitable for analysis.

RESULTS

Potentillo-Festucetum pseudodalmaticae association

Dominant species: *Festuca pseudodalmatica*. Characteristic species: *Achillea nobilis*, *Anthericum ramosum*, *Dianthus armeria*, *Euphorbia cyparissias*, *Festuca pallens*, *Melica ciliata*, *M. uniflora*, *Petrorhagia prolifera*, *Potentilla arenaria*, *Seseli osseum*, *Stachys recta*, *Stipa stenophylla*, *Teucrium chamaedrys*, *Thymus pulegioides*, *Trifolium arvense*.

Distribution of the floral elements has two main peaks. Most of the species (40%) have a sub-Mediterranean character. Other part of the flora list (30%) are character of European or Eurasian character. The rate of adventive species has relatively low quantity. The rate of cosmopolitan elements is about 10%. The quantity of the Pontic, Balkan and Pannonian species reach the 10%. This rate is higher compared to typical plots. The distribution of the life forms show the overweight of the hemicryptophytes. This character with the geophytes reaches the 80%. The quantity of the phanerophytes and chamaephytes are considerable (17%). The therophytes are in the sample plots only in very few quantities, just the hemitherophytes appear with low rate (< 5%). This marks the integrity of the sample area.

According to the distribution of coenological characters the Festucetalia valesiacae were found in the highest quantity (55%). The elements of the Festuco-Bromea reach the 10%. The rest characters immigrated from the near oak forest (21%) and a meadow (6%). The rate of indifferent species (< 5%) shows the intact conditions of the area.

Distribution of the temperature requirement (TB) shows (Fig. 1) the dominance of the moderately xerophilous species (65%). Diagram of the soil pH (RB) shows a characteristic profile of the slightly acidic type of the erubase soils (45%). The most of the rest of species occur on dolomite and limestone ground, too. The maximum values of the water supply (WB) unambiguously show (Fig. 2) the mass of the middle xerophytes (70%). Distribution of the nature conservation rank categories have a high rate of protected species explained *Stipa* species. The rarity of weeds and disturbance tolerant species is

remarkable. Distribution of nitrogen supply (NB) shows the low nitrogen requirement in more than half of the species (71%). The rate of the high nitrogen supply is less than 7%. This kind of diagram is frequent in dry habitats of temperate grassland.

In the dendrogram 5 larger and 7 smaller groups generated at 0.5 probability value (Fig. 3). One kind of the larger groups consists the more closed association fragments with more species (*Spiraea media*, *Inula hirta*, *Teucrium chamaedrys* and *Thymus* sp.) and the other kind of groups contains the sample plots of mainly characterising of *Stipa stenophylla* without chamaephytes.

The separated sample plots of the others are the fragments of *Asplenio septentrionali-Melicetum* association. There are only few species in these plots. Besides some moss and lichen synusia in some places are some tufts of *Bromus japonicus*, *Euphorbia cyparissias* and other spring therophytes occur. The closed spots of chamaephytes are rich in species of *Potentillo-Festucetum pseudodalmaticae* association mean the more constant and more intact stand, so the spots of mosaic with *Stipa* tufts construct opener stands. In these spots the invasion of weeds from time to time could be observed and here the degradation processes go off quickly.

Salvia nemorosae-Festucetum rupicolae association

Dominant species with decreasing cover values were: *Festuca rupicola*, *Stipa dasyphylla*. Characteristic species: *Adonis vernalis*, *Agropyron caninum*, *A. repens*, *Anthericum ramosum*, *Asperula cynanchica*, *Carex humilis*, *Centaurea saddle-riana*, *Chrysopogon gryllus*, *Cytisus austriacus*, *Dactylis glomerata*, *Dorycnium germanicum*, *Euphorbia pannonica*, *Falcaria vulgaris*, *Filipendula vulgaris*, *Galium verum*, *Helictotrichon pubescens*, *Hypericum perforatum*, *Isatis tinctoria*, *Phleum phleoides*, *Salvia nemoralis*, *Seseli osseum*, *Teucrium chamaedrys*.

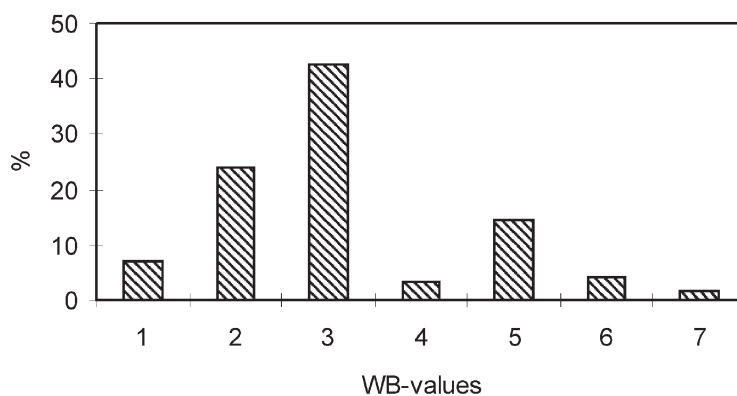


Fig. 2. Distribution of WB values of sample plots of Vadálló-kövek

The dendrogram of the sample plots can be seen in Figure 4. Using the percentage difference-index there are 7 well-organised groups at 0.58 similarity value. The first group (sample plots 1–37) is characterised by the dominance of *Carex humilis*, *Chrysopogon gryllus*, *Chamaecytisus austriacus*, *Dorycnium germanicum*, *Teucrium chamaedrys* and the presence of *Phleum phleoides*,

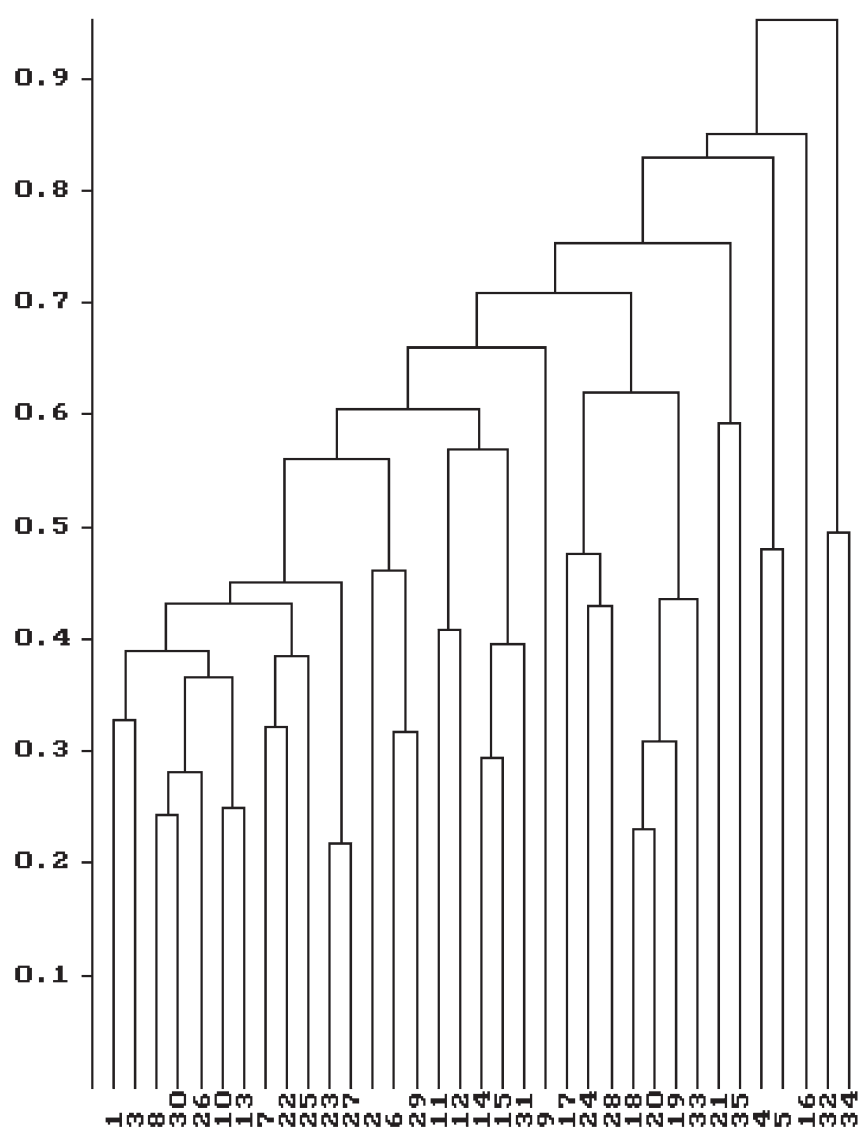


Fig. 3. Dendrogram of the sample plots of Vadálló-kövek

Filipendula vulgaris (*Carex* dominated type). This fragment has three levels: the tall grasses (50–70 cm), the hemicryptophyte and chamaephyte species (30–50 cm) and the therophytes (5–15 cm). The levels have compact stand.

The *Chrysopogon gryllus* is almost absent from the second group (samples 2–50), and there is less *Chamaecytisus austriacus*, *Phleum phleoides*, *Filipendula vulgaris*, *Dorycnium germanicum*, *Teucrium chamaedrys*, too, however the dominance of *Festuca rupicola* is more pronounced, and the denominative species of this association, *Salvia nemorosa* is also present (*Cytisus* dominated type). This fragment is compact, too, but smaller (50 cm) than the *Carex humilis* dominated type.

The third group (3–68) (*Stipa* dominated type) is characterised by lower cover values of *Stipa dasyphylla*, *Chrysopogon gryllus*, *Chamaecytisus austriacus*, *Dactylis glomerata*, *Festuca rupicola*, *Filipendula vulgaris*, *Helictotrichon pubescens*, *Phleum phleoides*, *Teucrium chamaedrys*. The four other groups are different from each other in species composition and cover values, but are coupled by the presence of *Stipa dasyphylla*. This fragment not so compact, it comprised

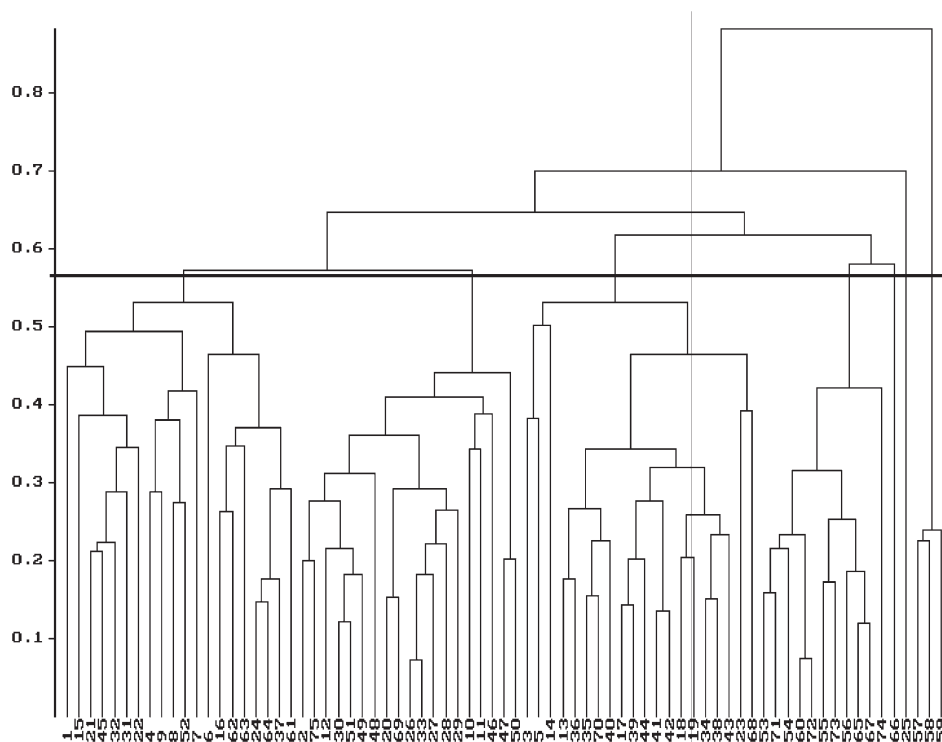


Fig. 4. Dendrogram of the sample plots of *Salvia nemorosa*-*Festuca rupicola* stand

loose and tall grass spots (50–70 cm) and smaller other hemicryptophyte and chamaephyte species 30–40 cm).

The principal coordinates analysis (PCoA) shows 3 loose groups of sample plots (Fig. 5), identical with the three types found by cluster analysis. The rest of sample plots contain rare species making them diverse and mosaic-like, not typical to *festucetosum rupicolae* subassociation.

Analysing several classical coenological attributes the investigated area and the three grassland types can be characterised as follows. The distribution of temperature indicator values (TB) shows two peaks, similarly to the continentality diagram's two maximum values. The proportion of mesophilous and xerophyte species is more than 55%. The high frequency of these species is characteristic for both open and closed grassland communities.

The distribution of relative humidity indicator values (WB) shows a normal Poisson-form. Its maximum value is due to the high frequency of xero-tolerant plants. The diagram is asymmetric in the case of xeromorph habitats.

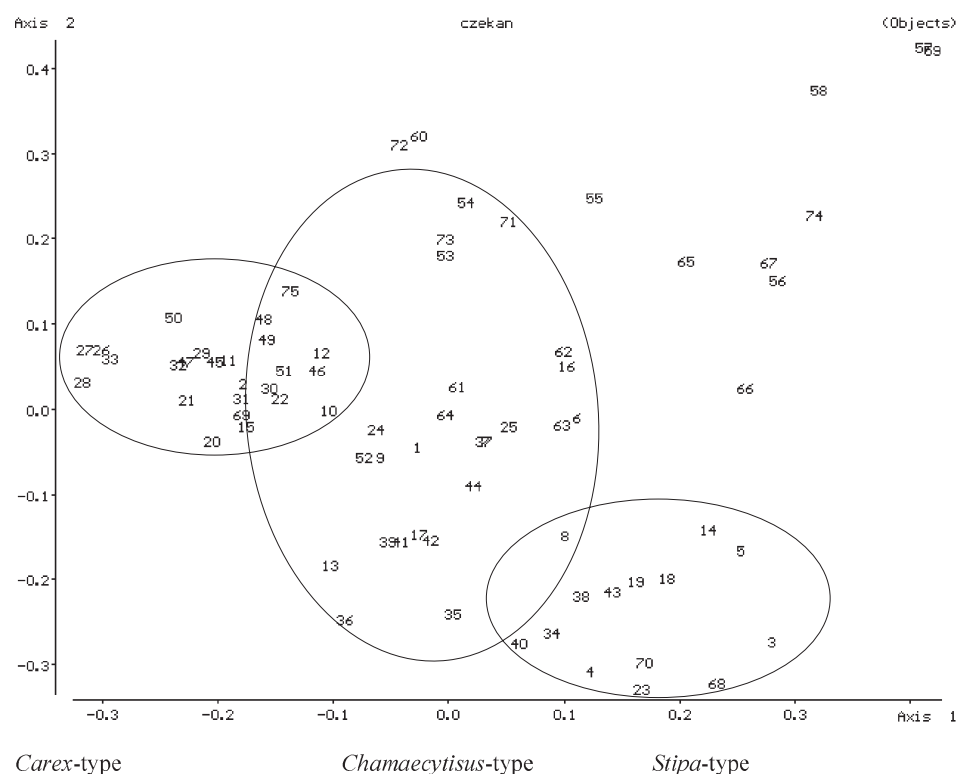


Fig. 5. Result of the ordination method of the sample plots of *Salvia nemorosa*-*Festucetum rupicolae* stand

The distribution of soil acidity values (RB) sign the high frequency of basiphilous species in the area's three types. 10% of them are lime indicator species and do not occur in acidic habitats (*Carex humilis*, *Chamaecytisus austriacus*, *Thalictrum pseudominus*).

According to the distribution of relative nitrogen indicator values (NB) half of the species are characteristic of habitats very poor in nitrogen, 10% of them live in places extremely poor in nitrogen or in dry places (*Seseli osseum*, *Minuartia verna*, *Phleum phleoides*).

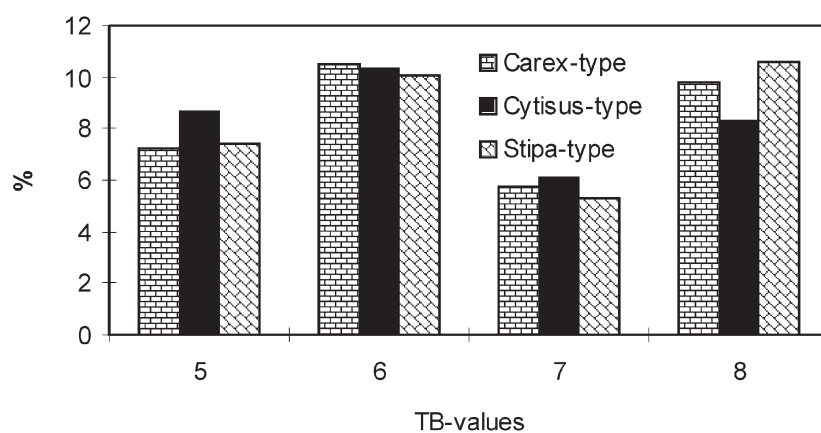


Fig. 6a. Distribution of the TB values of three types of the *Salvio nemorosae-Festucetum rupicolae* stand

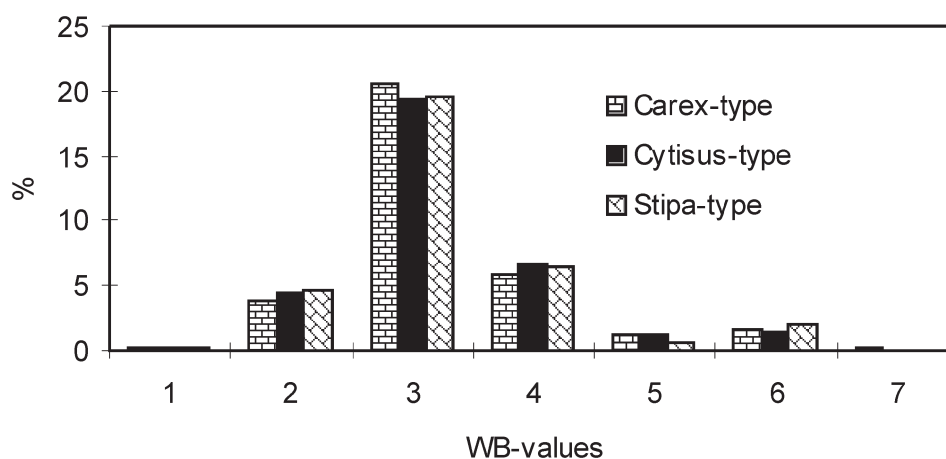


Fig. 6b. Distribution of the WB values of three types of the *Salvio nemorosae-Festucetum rupicolae* stand

In terms of temperature (TB), water (WB) and soil (RB) requirements the distribution and the maximum of values are similar in the three types. The tendency of the distribution of nitrogen requirement (NB) is similar to the others, but the rate of *Stipa* type is higher at the maximum value (9%), that at the *Chamaecytisus* type (Fig. 6).

Distribution of relative light indicator values (LB) shows high ratio of light plants (45%), full light plants of open habitats (20%) and shadow tolerant ones (32%). There are only few typical shadow plants.

The distribution of plants according to degree of continentality shows two peaks (Fig. 7). The first maximum corresponds to the suboceanic species, mainly CE but expanding to the East (*Bromus sterilis*, *Teucrium chamaedrys*, *Galium verum*, *Agrimonia eupatoria*), the second maximum shows the continental-subcontinental species spread in East Europe (*Festuca rupicola*, *Isatis tinctoria*, *Silene otites*). The difference between the maximum values of light requirement (LB) and nitrogen requirement (NB) of the *Stipa* and *Chamaecytisus* type is nearly the same (8%). The values of continentality (KB) are markedly different being 10% higher in the *Chamaecytisus* type, than in the *Stipa* type. This *Stipa* dominated group of plots is the most uniformly distributed out of the three types.

The distribution of categories of nature conservation values (Simon 1988) shows native species are the most frequent (60%), native accessorial species are less abundant (20%). The proportion of disturbance tolerant native species is low (10%), as the proportion of weeds, cultivated plants and adventive species too (less than 4%). There is however considerable quantity of strictly pro-

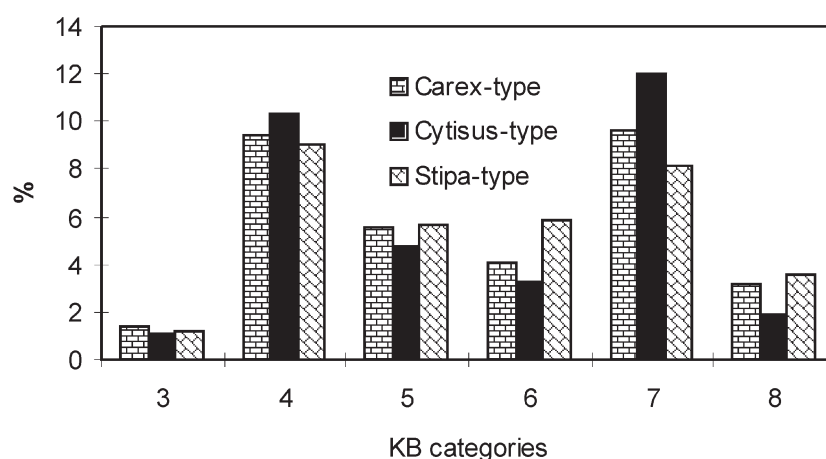


Fig. 7. Distribution of the continentality categories of three types of the *Salvia nemorosa*-*Festucetum rupicolae* stand

tected and protected species of Hungary (8%), like *Adonis vernalis*, *Centaurea sadleriana*, *Stipa dasyphylla*, *Thalictrum pseudominus*.

According to distribution of floral elements (FL) the share by the Eurasian elements is the highest (27%), the sub-Mediterranean and the Pontic-Pannonian elements (e.g. *Chamaecytisus austriacus*, *Isatis tinctoria*) are present in considerable quantity (together 28%) and there is a smaller quantity (10%) of the Pannonian (*Dianthus pontederiae*) and the Pannonian-Balkan elements (*Euphorbia pannonica*). The proportion of cosmopolitan species is less than 5% (*Koeleria cristata*), and the rate of adventive species is low (1.5%, e.g. *Erigeron canadensis*, *Onobrychis viciifolia*). This shows that this area is more or less intact. The distribution of the floral elements shows that the *Stipa* type has the highest quantity of Eurasian, continental and sub-Mediterranean elements, in contrast to the *Carex* type that almost have the lowest levels of these. The *Chamaecytisus* type has the highest quantity of European and Pontic-Pannonian elements.

Distribution of social behaviour types (SOC) is shown in Figure 8. Generalists (G) and the competitors (C) give half of the species. The cover by natural pioneers (NP) (*Myosotis stricta*) and specialists (S) (e.g. *Adonis vernalis*, *Thalictrum pseudominus*) is remarkable, too (together 26%). There are few (15%) disturbance tolerant (DT) species (e.g. *Achillea collina*, *Agrimonia eupatoria*, *Galium verum*). The quantity of weeds (W), alien competitors (AC) and ruderal competitors (RC) is insignificant (e.g. *Viola arvensis*, *Descurainia sophia*), less than 4.5%.

The distribution according to the coenosystematic categories shows the group of indifferent species is comprised of several xerophilous species (e.g.

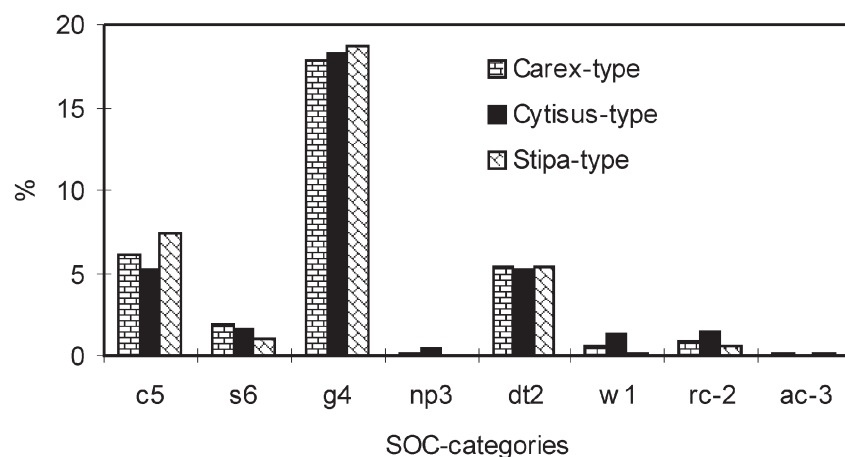


Fig. 8. Distribution of the SOC values of three types of the *Salvio nemorosae-Festucetum rupicolae* stand

Hypericum perforatum, *Melandrium album*) and species occurring due to anthropogenic disturbance (*Erigeron canadensis*), with a share of 14%. Presence of forest elements shows the bushy character of this area. The rest are the elements of grassland associations (80% of all). The distributions of the social behaviour type (SOC) and of the nature conservation rank categories (NCR) are similar in the three types.

The rate of monocotyledons/dicotyledons/Fabaceae shows that the quantity of Fabaceae species is double in the *Stipa* dominated type than the two other groups (*Carex*, *Chamaecytisus*). Effects of a warmer and drier climate may favour the spread of species from the *Chamaecytisus* and the *Stipa* types.

Contribution of distribution of the relative parameters of sample plots of Isaszeg and manuscript of Bálint Zólyomi shows several differences between the sample areas. According to social behaviour types (SOC) the rate of competitors (c5) and generalists (g4) are about the double than at the sample area of own of Isaszeg. Just then the rate of specialists (s6), disturbance tolerants (dt2) and natural pioneers (np3) are half of the detected data of Zólyomi (Fig. 9). Diagram of the water supply (WB) shows a kind of normal distribution of the categories of the species of Isaszeg, so the contribution data sheet of Zólyomi is more xerophilous. Contribution of the distribution according to the continentality categories (KB) the species of the sample area of Isaszeg form a twin peaks, so the previous data shows a normal distribution (Fig. 10).

Festucetum vaginatae association

This flora spectrum is poor in characteristic species and contains several ruderal weed species. On the base of the dendrogram of 50 sample plots gener-

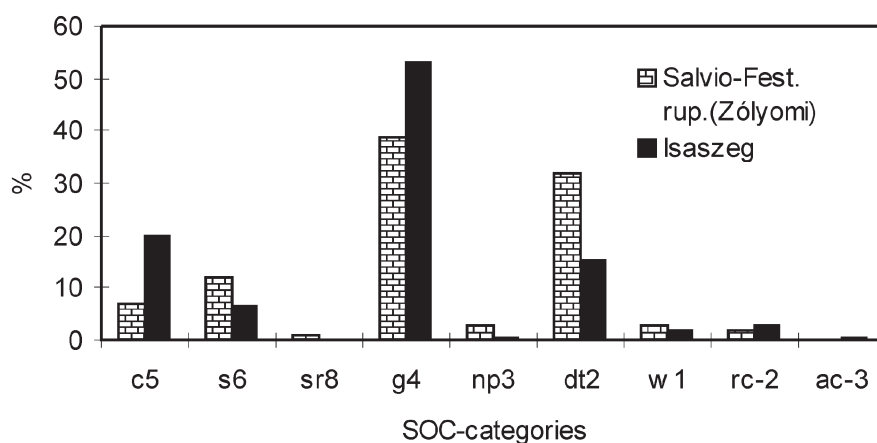


Fig. 9. Distribution of the SOC values of two *Salvia nemorosa*-*Festucetum rupicola* stand

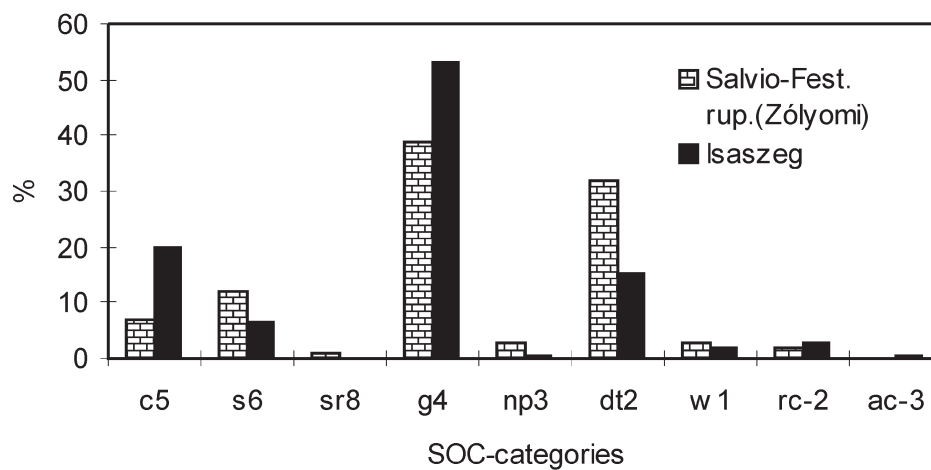


Fig. 10. Distribution of the continental categories of two *Salvia nemorosa*-*Festucetum rupicolae* stand

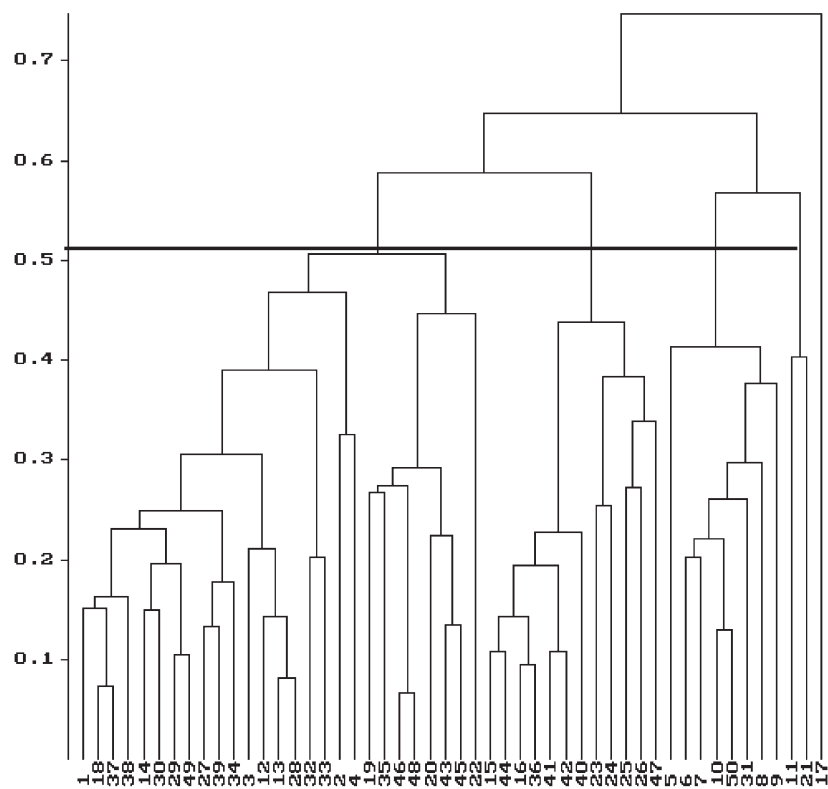


Fig. 11. Dendrogram of the sample plots of the *Festucetum vaginatae* stand

ated by percentage difference index in probability values of 0.52 three groups (types) were separated (Fig. 11). The three groups are the forms of the *Festucetum vaginatae* association differ from the cover values of the species first of all. This area is poor in species, the sample plots differ from each others in dominance values of *Festuca vaginata*. The first type (sample plots 1–22) has lower cover values (open type), mainly with *Festuca vaginata*, *Botriochloa ischaemum* and with low cover values of *Festuca domini* and *Bromus squarrosus* and appear some specimens of *Potentilla arenaria* and *Fumana procumbens*, too. Beside the *Festuca* tufts the presence of the xerophyte moss-lichen synusia is expressive. These sample plots comprise the *Festucetum vaginatae fumanetosum* subassociation.

The second type (sample plots 15–47) has higher cover values with more tufts of *Festuca vaginata* (closed type). The sum of cover values is significantly higher. This subassociation is the *Festucetum vaginatae typicum*. The third type (sample plots 5–9) has low cover values of *Festuca vaginata* (*Stipa* type), but appear a stand of *Stipa borysthena* (with *Plantago indica*). This subassociation is the *Festucetum vaginatae stipetosum*.

The distributions of several ecological parameters of the three types of dendrogram are given below. The graph of distribution of temperature (TB) indicator values according to the three types of species composition can be seen in Figure 12. The maximum values of all types correspond with thermophilous forest or woodland belt, so the first type has the highest value. It differs from double maximum of loess grassland graphs. The presence of mesophilous and xerophyte species are more than 70%. The high rate of these species are so characteristic for open or closed grass communities. The *Stipa borysthena* dominated type has maximum values of lower categories. The graph of distribution of relative humidity indicator values (WB) shows a normal bell-shaped form (Fig. 13). The maximum values added from xero-indicators

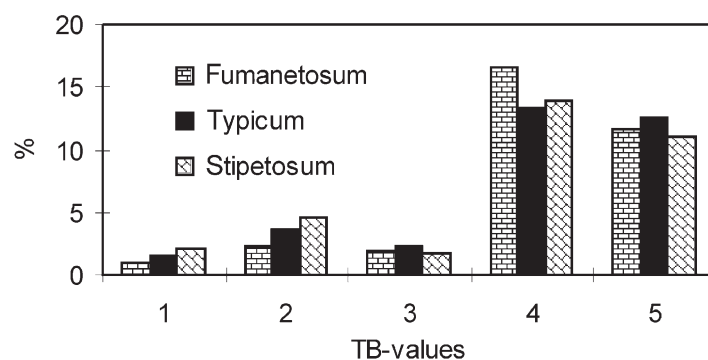


Fig. 12. Distribution of the TB values of the three subassociations

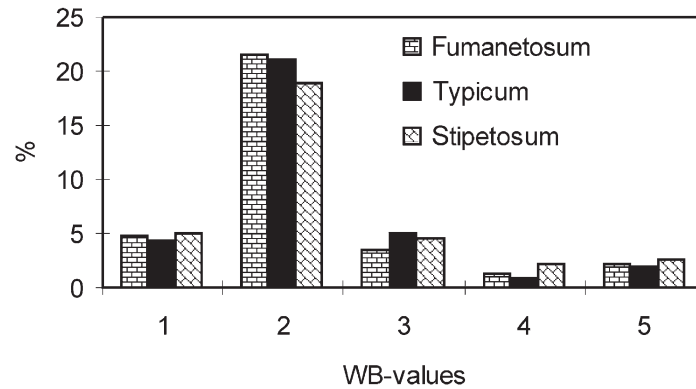


Fig. 13. Distribution of the WB values of the three subassociations

on habitats with long dry period in all of three types (60% of the species). The diagram is asymmetric for xeromorph habitats. The highest value has the open type. Consequently the higher values of higher categories corresponds to *Stipa* type. The highest points represent the mass of basiphilous species. 4.5% of them expressively Ca indicator species and not occurring in acidic habitat (*Carex humilis*, *Fumana procumbens*, *Thymus praecox*). The diagram is asymmetric for basiphilous characters.

Distribution of relative nitrogen indicator values can be seen in Figure 14. The half of the species composition occur in habitats of very poor in nitrogen, more than 30% live in places of extremely poor in nitrogen or in dry places (*Fumana procumbens*, *Minuartia verna*, *Festuca vaginata*, *F. domini*). The open type has the highest value. It similar to other types, but *Stipa* type shows a kind of disturbance. The second (closed) type is between the open and *Stipa borysthenica* type.

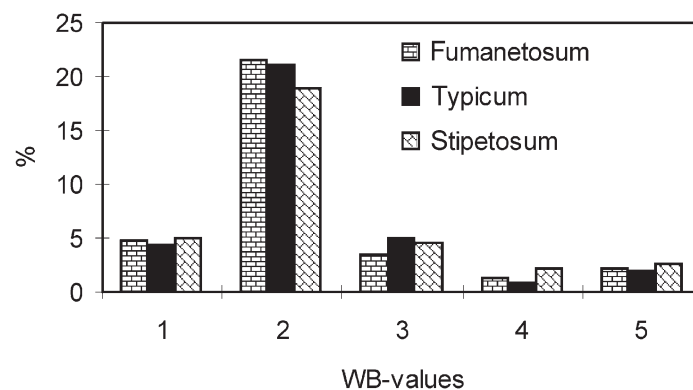


Fig. 14. Distribution of the NB values of the three subassociations

Distribution of relative light indicator values in most quantities are the full light plants (73%), the light plants of open habitats (25%), the half-light plants mostly living in full light, but shadow tolerant (1.7%).

The distribution of plants according to degree of continentality of the general climate can be seen in Figure 15. The diagram only has one peak contrast with double maximum of loess grassland. The maximum shows the continental-subcontinental species, main area in East Europe (*Festuca rupicola*, *Minuartia verna*, *Centaurea micranthos*, *Bromus squarrosus*). There are no pregnant differences in the distribution of three types. The other categories have considerably values of continentality. There are one expressive continental species, too (*Stipa borysthena*).

In the distribution of categories of nature conservation values (Simon 1988). Most quantities are the disturbance tolerant native species (28%), the native accessorial species (25%). The rate of native species predominating in plant communities is low (3.2%). The rate of weeds, cultivated plants and adventive species is few (10.1%), but there are in more quantity of the strictly protected and the protected species in Hungary (16%). These are: *Stipa sabulosa*, *Festuca domini*, *F. vaginata*, *Fumana procumbens*.

According to the diagram of floral elements the highest quantities of open and closed types have the Pontic-Mediterranean elements, e.g. *Euphorbia seguieriana*, *Botriochloa ischaemum* (together the three types 16.9%), there are in meaningful quantities (13.4%) the Pannonian (*Dianthus pontederiae*, *Festuca vaginata*, *F. vaginata* subsp. *domini*) and the Pontic elements (*Centaurea micranthos*, *Crepis rhoeadifolia*).

The rate of cosmopolitan species are less than 1% (*Polygonum aviculare* agg.), so the rate of adventive species are few (3.1%), e.g. *Conyza canadensis*.

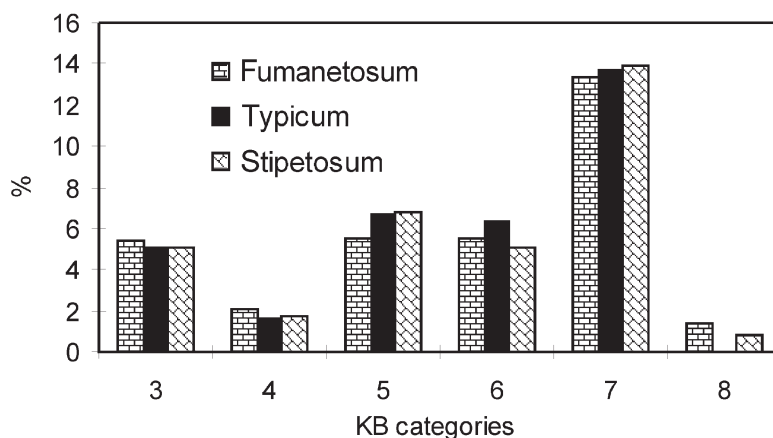


Fig. 15. Distribution of the categories of continentality of the three subassociations

The distribution of the floral elements (FL) shows that *Stipa borysthena* type has the highest level of Eurasian and circumpolar elements. This contrasts with the elements of open and closed type that almost have the lowest levels of these elements.

Figure 16 shows the distribution of the social behaviour types (SOC). The highest value in the natural pioneers (NP3) has the *Stipa* type, the second the open type. In the generalists (G4) highest the closed type. There are few (13.5%) disturbance tolerant species (*Galium verum*, *Rumex acetosella*). The quantities of weeds, alien competitors and ruderal competitors are insignificant (*Polygonum aviculare* agg., *Conyza canadensis*), less than 9%.

The species composition consists of 62 species (16 monocots, 46 dicots and 5 Fabaceae species). In the sample area the rates of cover values of monocot/dicot/Fabaceae species are: 45/34/22. The rate of monocot/dicot/Fabaceae shows that quantity of Fabaceae species is similar to the three types. The higher value of dicots of closed type signs the less quantity of *Festuca* tufts. Effects of a warmer and a drier climate spread of species of the *Medicago*, *Trifolium* and the *Stipa* types could be caused.

The result of principal coordinates analysis (PCoA) shows 3 loose, overlapping groups of sample plots are given in Figure 17. We have got three well-organised species compositions. The biggest circles include those plots, which form the open spots (*fumanetosum*). The other circle comprises the closed mosaics and spots (*typicum*). In these plots the species change very quickly, in spots the therophytes alternate with hemitherophytes and hemi-cryptophytes or therophytes alternate each other. These spots may degradable or other procession forward is in progress. For example the place of old tufts of

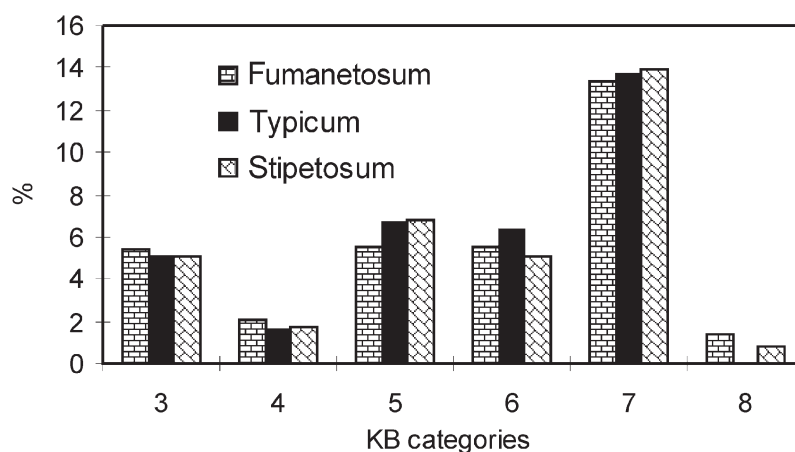


Fig. 16. Distribution of the categories of social behaviour types of the three subassociations

Festuca and/or *Bromus* invade therophyte species. In return for this the invading species press back the ephemeral therophytes. These elements are in moving, its dynamism differ from other two groups.

The rest of smallest circle shows that the third type of plots. These results harmonise the dendrogram, too.

Cleistogeni-Festucetum sulcatae association

The open sample plots of Klastrom-szirtek and the other sample plots of intact stands of Öreg-szirt organised separated groups. The plots Klastrom-szirtek slightly degraded opposite to the plots of Öreg-szirt. The two sample areas differ from each other in microrelief so the form and quantity of degradational processes are different and this process is well marked at the Klastrom-szirtek. At other sample areas the difference is not slight, the difference is low among the fragments.

Dominant species: *Festuca rupicola*. Characteristic species: *Achillea pannonica*, *Agropyron repens*, *Anthericum ramosum*, *Asperula cynanchica*, *Bromus erect-*

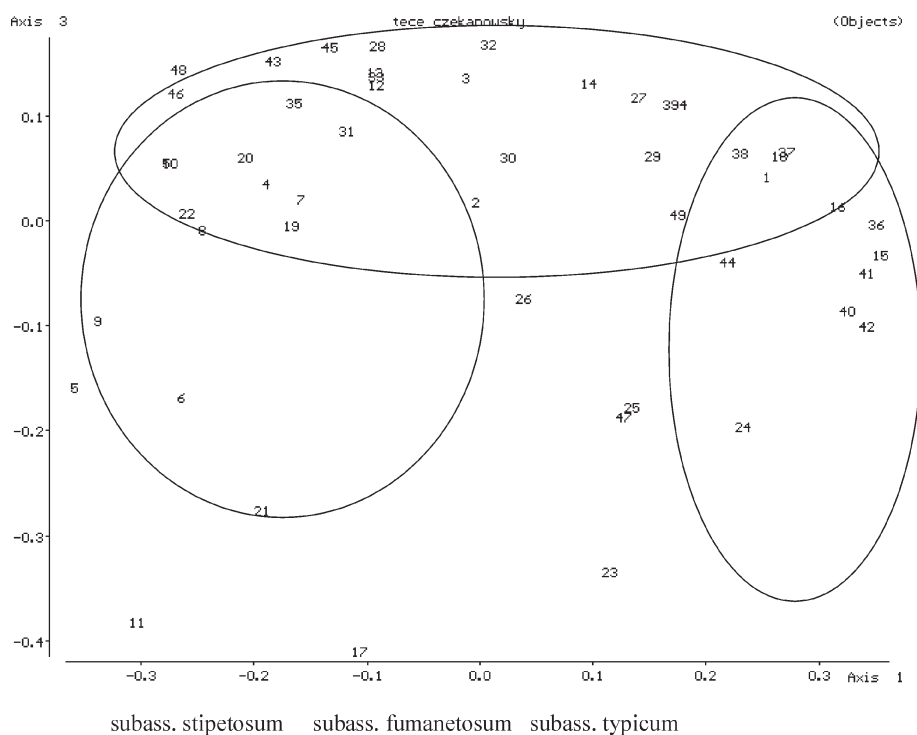


Fig. 17. Result of the ordination method of the sample plots of *Festucetum vaginatae*

tus, *B. japonicus*, *Erysimum odoratum*, *Festuca valesiaca*, *Koeleria cristata*, *Melica ciliata*, *Poa badensis*, *P. bulbosa*, *P. nemoralis*, *Potentilla arenaria*, *Sanguisorba minor*, *Sedum acre*, *S. album*, *S. sexangulare*, *Seseli osseum*, *Stachys recta*, *Stipa pulcherrima*, *Thymus praecox*, *T. serpyllum*, *Veronica austriaca*.

The results of cluster analysis apart from some sample plots of wedged in a group coincidence the diagram of ordination. The group is based on origination is the presence of dominant grasses and other hemitherophytes (e.g. *Melica ciliata*, *Festuca valesiaca*, *Potentilla arenaria*).

The association analysis separated the sample plots by two divisive species namely *Polypodium odoratum* and *Melica ciliata*. Strictly separation was detected because of *Polypodium* was like a fugitive species from the oak forest in the sample plots and the lack of *Melica ciliata* living only in open stands.

In the sample areas of Mt Pilis the rate of therophytes and hemitherophytes higher than other sample areas. In other groups the plots are more closed signing the less disturbing. The dynamism of therophytes and hemitherophytes considerably depend on the temporary condition of the spot and the surrounding area. These life form types have a decisive importance in the secondary successional processes. Distribution of life forms of the other groups more or less similar, the rate of Th and TH alternate in the groups. According to distribution of flora spectrum the rate of sub-Mediterranean elements are considerable. This spectrum is characterised by Pannonian (6.9%), Balkan (3.6%) and Pontic (3.4%) elements.

The continental elements occurred rarely in the sample area. The cosmopolitan and the circumpolar species are negligible except in one group. Distribution of coenocharacters shows the mass of grassland elements, but the Quercetea elements only appear in the group of close to forest of the Klastrom-szirtek. Distribution of the temperature requirements (TB) the sample area shows a thermophilous habitat (T6 and T7, Fig. 18). According to water

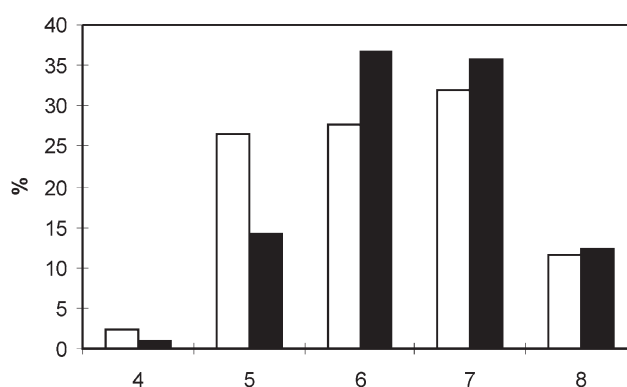


Fig. 18. Distribution of the TB values of Klastrom-szirtek (white) and Öreg-szirt (black)

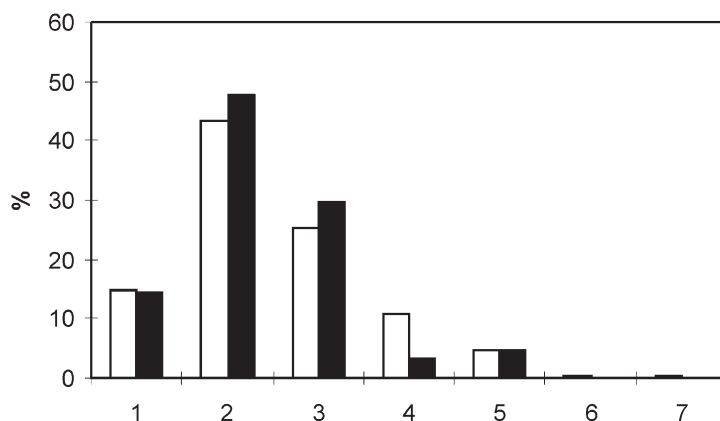


Fig. 19. Distribution of the TW values of Klastrom-szirtek (white) and Öreg-szirt (black)

supply (WB) the diagram shows a xero-indicator and a xero-tolerant habitat with a long-dry period (W2 and W3, Fig. 19). Distribution of nitrogen supply shows extremely poor or very poor habitat (N1 and N2). Diagram of the continentality categories (KB) has two peaks, namely at the suboceanic and at the subcontinental character (Fig. 20).

Asplenio septentrionali-Melicetum ciliatae, *Seslerietum heuflerianae-hungaricae* associations

The group of the sample plots of open grassland, i.e. *Asplenio septentrionali-Melicetum ciliatae* (dominant species: *Melica ciliata*; characteristic species:

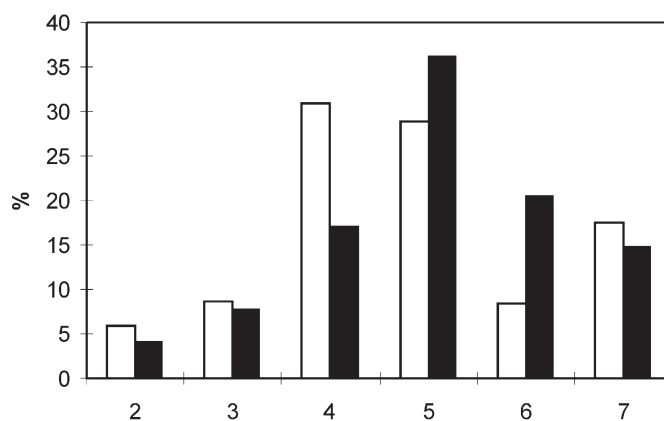


Fig. 20. Distribution of the continentality categories of Klastrom-szirtek (white) and Öreg-szirt (black)

Allium flavum, *Asplenium septentrionale*, *A. trichomanes*, *Cystopteris fragilis*, *Festuca pallens*, *Minuartia frutescens*, *Poa nemoralis*, *Potentilla arenaria*, *Saxifraga paniculata*, *Sempervivum hirtum*) separated from the group of the spots of the closed stands, i.e. *Seslerietum heuflerianae-hungaricae* (dominant species: *Sesleria heufleriana*; characteristic species: *Centaurea rhenana*, *Cotoneaster nigra*, *Cynanchum vincetoxicum*, *Dictamnus albus*, *Festuca pallens*, *Filipendula vulgaris*, *Genista pilosa*, *Iris variegata*, *Koeleria cristata*, *Scabiosa ochroleuca*, *Sedum acre*, *Seseli osseum*, *Thymus glabrescens*, *Veronica orchidea*).

The rest of sample groups of the edge of the forest (*Spiraea media*, *Valeriana officinalis*, *Cornus mas*, *Cerasus mahaleb*) linked with these groups. The competition among these flowering plants is strong, although the *Woodsia ilvensis* plays a subordinate role in this competition compared to the flowering plants.

Almost all of the character species of the association group (*Asplenio-Festucion pallentis* Soó) occur in the sample plots. The distribution of the main floral elements in decreasing rate is the following: sub-Mediterranean (17%), Eurasian (12%), circumpolar (10%), Central European (9%). In our flora list the existence of Carpathian (7%), Balkan (4%) and Pontic (5%) elements is characteristic. According to coenocharacters the elements of *Asplenio-Festucion* (28%), *Festuco-Bromea* (22%), *Festucetalia valesiaca* (16%) and *Festucion vaginatae* (3%) dominate. In the sample area the forest species rarely occur in the grassland vegetation also. Distribution of the soil reaction (RB) shows the mass of the basiphilous species, but the other categories occur, too.

The diagram of the temperature requirement (TB) shows the maximum of thermophilous species (T6 and T7) (Fig. 21). The distribution of the water supply (WB) strongly indicates the dry habitat (Fig. 22). The categories of the

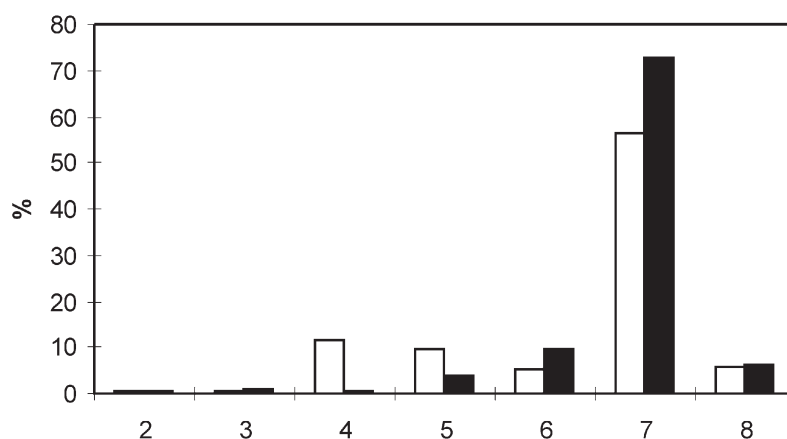


Fig. 21. Distribution of the TB values of the sample plots of *Woodsia ilvensis* (*Aspl. sept.-Mel. cil.* = white, *Sesl. heufl.-hung.* = black)

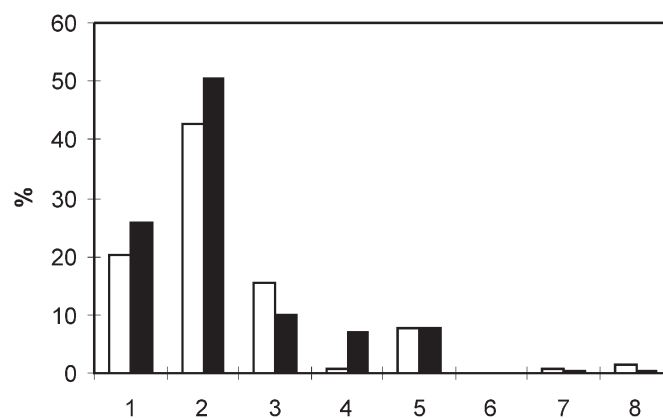


Fig. 22. Distribution of the WB values of the sample plots of *Woodsia ilvensis* (*Aspl. sept.-Mel. cil.* = white, *Sesl. heufl.-hung.* = black)

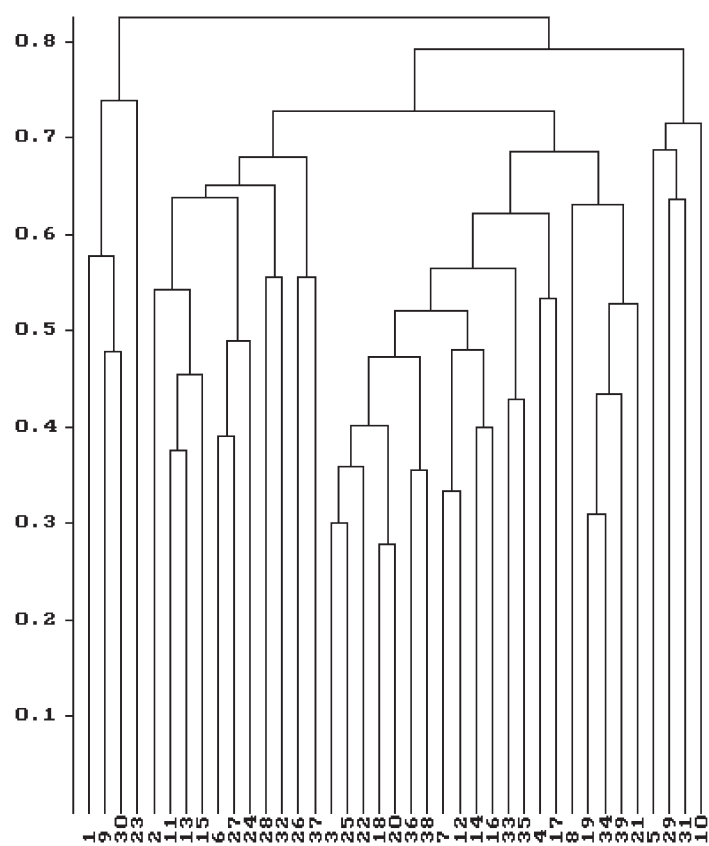


Fig. 23. Dendrogram of the sample plots of *Woodsia ilvensis*

xerophilous and xerotherm (W2 and W3) have the highest rate. This diagram is in connection with the distribution of the nitrogen values (NB) in dry habitats generally occur those species live in poor nitrogen supply (*Centaurea* spp., *Festuca pallens*, *Minuartia frutescens*, *Potentilla arenaria*, *Sedum* spp., *Sempervivum* spp., *Sesleria heufleriana*).

The result of the hierarchical classification (Fig. 23) gave several low members of groups of sample plots like have low difference of similarity values of each other. The ordination shows the separated groups of the sample plots of two associations (Fig. 24).

CONCLUSIONS

Potentillo-Festucetum pseudodalmaticae association

On the base of dendrogram the groups show a mosaic-like association fragments. Specially in these plots the species composition strictly depend on the exposition, the microrelief, the rate of soil and rocks, so the different of species composition of broken spots partly explained by degradational processes, too.

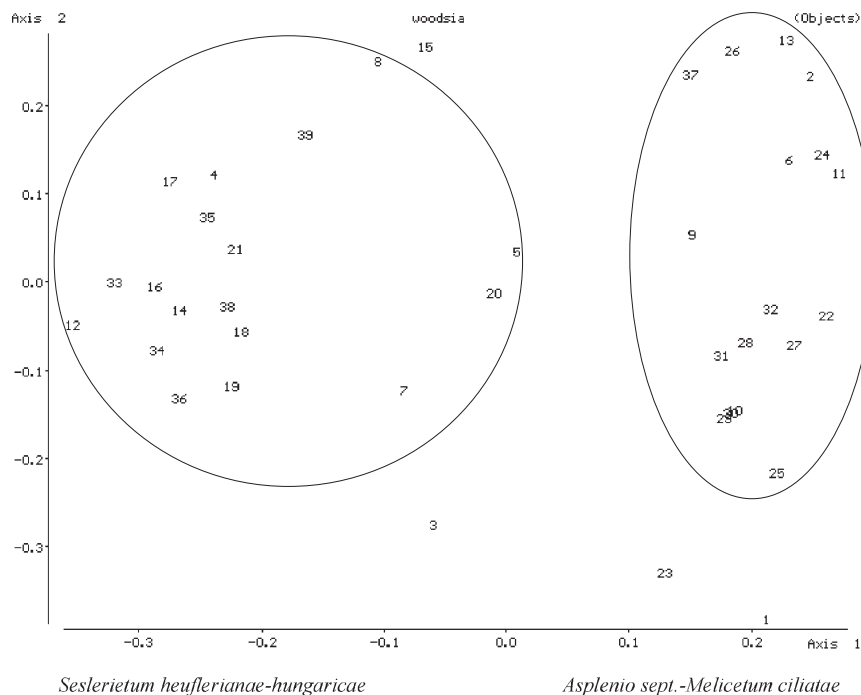


Fig. 24. Result of the ordination method of the sample plots of *Woodsia ilvensis*

Salvio nemorosae-Festucetum rupicolae association

In a typical stand we tried to denote plots representing this *Salvio nemorosae-Festucetum rupicolae* association. Statistical evaluation of several ecological characters of species was carried out together with a hierarchical cluster analysis. According to these analyses three groups dominated by *Carex humilis*, *Chamaecytisus austriacus* and *Stipa dasyphylla* of *festucetosum rupicolae* subassociation of a stand of *Salvio nemorosae-Festucetum rupicolae* association were separated.

Festucetum vaginatae association

In a typical stand we tried to set up plots which represents this *Festucetum vaginatae* association. Statistical evaluation of several ecological characters of species carried out and a hierarchical (cluster analysis) and a non-hierarchical (Pcoa) multivariate analysis were given. The three groups refer to *Festucetum vaginatae typicum* (closed type), *Festucetum vaginatae fumanetosum* (open type) and *Stipa sabulosa* of a stand of *Festucetum vaginatae stipetosum* subassociation are isolated by cluster analysis and principal coordinate analysis. These results harmonise the synphysiological measures, too.

Cleistogeni-Festucetum sulcatae association

It seems that used methods suitable for characterisation, showing the differences and investigation of the species composition of the sample areas of the rock grassland of Pilis Mts. Distribution of the relative ecological parameters harmonised others results of grassland. Result of cluster analysis and ordination correspond to each other. The examination of the sample areas could explain well with these methods. The sample groups correspond to the subassociations of the *Cleistogeni-Festucetum sulcatae* association (*festucetosum valesiaceae* and *stipetosum pulcherrimae*). On the base of the sample plots of the stands of *Cleistogeni-Festucetum sulcatae* association of Mt Pilis two frequent subassociation (*festucetosum valesiaceae* and *stipetosum pulcherrimae*) were detected. On the base of the distribution of the KB, WB and TB values the stands of all associations separated well, so we do not neglect the decisive importance of the species compositions being background of the abstraction of the diagrams. Partly it can be laid down as a fact of the distribution of the social behaviour types, too. The distribution of NB values is not (always) characteristic, this kind of diagram is locally evaluated.

We tried to show that the catching and following of the changing of this fragile balance of these stands are important point of view of nature conserva-

tion, too. Diversity of the highest degree of these stands (including their genetic diversity) and the unchanged survival is great value of the nature.

***Asplenio septentrionali-Melicetum ciliatae, Seslerietum heuflerianae-hungaricae* associations**

Living on the high slope of the Szarvas-kő, *Woodsia ilvensis* not only live in the rock clefts with other Crassulaceae species but occurs in the stands of the closed grassland as well. Some *Woodsia* specimens also detected there, but their optimal microhabitat is only the rock cleft. The *Woodsia ilvensis* is less competitive species with the aggressive spreading species, mainly the grasses (*Festuca pallens*, *Sesleria heufleriana*). This fern species in this habitat could not establish permanently at the border of the rock cliff association. The population is retired in the last century in its locality.

*

Acknowledgements – The financial support of the Hungarian Scientific Research Fund (OTKA T032586), the MEGARICH 4th and the GREENGRASS 5th EU Framework Research Projects are gratefully acknowledged. Special thanks to Prof. Dr Zoltán Tuba for the valuable suggestions to my work.

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