

STUDIES OF VEGETATION DYNAMICS ON THE ROCK GRASSLANDS IN CSÍKI-HEGYEK (BUDAÖRS, HUNGARY)

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Based on 20 phytosociological relevés studied during a five-year period, changes of vegetation of dolomite grasslands have been investigated. The following characteristics were analysed: phytogeographical area (floral element), phytosociological character, social behaviour type, degree of naturalness and indicator value of the nitrogen preference. Degradation of the grasslands has been documented and certified. With 9 tables and 1 figure.

Key words: dolomite grasslands, ecological indicator values, phytosociology, social behaviour types, vegetation dynamics

INTRODUCTION

Dolomite as parent material occurs in large areas of the Hungarian Central Mountains. Physical and chemical characteristics of this bedrock are expressed in the peculiar geomorphological appearance of the dolomite hills; these characteristics have a strong influence on the flora and vegetation (ZÓLYOMI 1942).

Early description and characterisation of rock grassland vegetation were made by ZÓLYOMI (1936, 1966). Vegetation of the Pannonian dolomite hills has been in focus of interest of botanists for a long time. Dolomite vegetation of Balaton Upland was analysed phytosociologically by DEBRECZY (1966, 1973). Vegetation mapping of the Odvas-hegy and its grassland vegetation was investigated (DOBOLYI et al. 1991). Variability, compositional diversity and fine-scale spatial patterns of dolomite grasslands were studied (KUN 1996, BARTHA et al. 1998, KUN et al. 2002), numerical analysis of dolomite rock grassland was carried out (PODANI 1998). The recently accepted classification of dolomite plant communities is given in BORHIDI (1996) and BORHIDI and SÁNTA (1999).

One of the largest dolomite-dominated areas of Hungary is Csíki-hegyek, found in the southern part of Buda Mts (9 km SW of Budapest). The main bedrock of this area is Triassic diplopore dolomite. Since the surroundings of Csíki-hegyek have been inhabited for hundreds of years, the present state of vegetation is determined by consequences of human activity.

Description of the supposed original plant cover is given in ZÓLYOMI (1958). The most important plant communities of Csíki-hegyek were 1) xerotherm oak forests (closed thermophilous oak woodlands), 2) mixed relict oak woodlands on

rocks (*Fago-Ornetum*), 3) pubescent oak scrub woodlands, 4) "rock steppes", 5) open and closed dolomite rock grasslands. These, except for *Fago-Ornetum*, can still be found in Csíki-hegyek, although in most cases not on their original places, not in the original extent and not in their original state. The most important manifestation of human activity is that forests have been cut for several hundreds of years and the cut-over areas were pastured intensively.

Pasturing caused intensive erosion and initiated the development of secondary rock grasslands and rock steppes. In present days, first of all, very intensive tourism is the most prominent human pressure, which results in significant changes of the vegetation. Trampling causes decrease of vegetation diversity and growing surfaces of devastated areas. The continuous degradation of dolomite grasslands has been observed for a long time, but neither in Csíki-hegyek, nor in other dolomite regions of Hungary has been studied up to date.

In spite of its degraded and secondary state, Csíki-hegyek is a particularly valuable and strictly protected territory of the Buda Mts Landscape Protection Area. The number of protected plant species living here is over 50, and some of them are Carpathian and Pannonian endemic ones.

Botanical study and vegetation mapping of this area were carried out in 1996 done on commission of the Buda Mts Landscape Protection Area (DOBOLYI 1996). As part of the study, anthropogenic change of dolomite grasslands has also been investigated. Observations of botanists and the local nature protection staff show that these grasslands exhibit slow degradation, in other words, they are not in an equilibrium state. Better knowledge of these processes is essential for nature conservation. The aim of my investigation was to follow the procession of vegetation dynamics, that is, to provide an exact documentation and monitoring of temporal changes of vegetation.

I used the method of fixed phytosociological relevés, which in my view provides the most exact data about vegetation dynamic processes in a short period of time. As for the investigated vegetation types, rock grasslands, rock steppes and their transitional stands were chosen because of their natural merits and because they are particularly sensitive to environmental changes and degradation effects. (According to multivariate analyses dolomite rock grasslands and rock steppes do not segregate sharply (PODANI 1998)).

The following four sites were subject of the investigation: Odvas-hegy (47°28'5"N, 18°56'53"E), Szekrényes-hegy (47°28'34"N, 18°56'14"E), Farkas-hegy (47°28'24"N, 18°56'28"E) and Kő-hegy (47°27'53"N, 18°57'22"E). At these sites there are large, homogeneous grassland areas of natural condition but change of their vegetation is expected or possible. The exact localities of the relevés were

marked on the field in such a way that they could be found and re-investigated any time in the future.

The changes of vegetation were analysed and reported for the Authority of the Duna-Ipoly National Park after five years in 2001 (DOBOLYI 2001).

MATERIAL AND METHODS

Sampling was carried out so that visibly undisturbed open rock grasslands and dolomite slope steppes be represented. The relevés were taken from 2 m × 2 m quadrates. The cover values of the species were transformed to the scale 1 to 9 (MAAREL 1979). The scientific names of the species were taken from HORVÁTH et al. (1995).

In 2001 the phytosociological relevés were repeated on the same places and with the same method as the one applied in 1996. The evaluation of the four investigated sites was based on the following species characteristics: phytogeographical area (floral element, HORVÁTH et al. 1995), phytosociological character, social behaviour type, degree of naturalness and indicator value of the nitrogen preference (BORHIDI 1993).

The values of features characterising the sites have been calculated according to percentage pro rata of plant mass, that is the sum of the transformed cover values concerning one feature has been expressed in percentage of sum of all cover values of all species.

The average naturalness value of the sites was calculated with the following formula:

$$\overline{NV} = \frac{\sum_{sp} \left(\sum_{relevé} M \times NV \right)}{\sum M}$$

where $\overline{NV}$ = average naturalness value of the site; NV = naturalness value of the species (BORHIDI 1993); M = cover value of the species (MAAREL 1979); $\sum_{relevé} M$ = summarising according to the relevés (sum of the cover values of one species); $\sum_{sp}$ = summarising according to the species; $\sum M$ = sum of total cover values of the site.

RESULTS

The cover values and the additional data of the relevés are given in Tables 1 to 5. The floral composition and dominance of the species changed in a small degree in the interval between 1996 and 2001. Part of the changes can be explained by random processes (natural fluctuation), and partly by degradation. The fact and the tendencies of the degradation processes can be established and analysed by the statistical evaluation of the relevés.

Table 1. Cover values of the species in the relevés 1 to 5 (Odvas-hegy) A= 1996; B= 2001.

	No. of relevés									
	1		2		3		4		5	
	A	B	A	B	A	B	A	B	A	B
<i>Acinos arvensis</i> (Lam.) Dandy	2	1	1	1	1	–	1	–	1	1
<i>Agropyron intermedium</i> Host	–	–	–	–	4	–	–	–	–	–
<i>Agropyron repens</i> (L.) P. B.	–	–	–	–	–	1	–	–	–	–
<i>Allium flavum</i> L.	2	1	1	1	2	1	1	–	1	–
<i>Alyssum montanum</i> L.	3	1	3	1	3	1	1	1	2	1
<i>Anthyllis vulneraria</i> L.	2	–	–	–	–	–	–	–	1	–
<i>Arabis auriculata</i> Lam.	–	–	–	1	–	–	–	–	–	–
<i>Asperula cynanchica</i> L.	1	–	1	1	–	–	–	–	1	–
<i>Asplenium ruta-muraria</i> L.	–	–	1	1	–	–	–	–	–	–
<i>Aster linosyris</i> (L.) Bernh.	–	1	1	–	1	1	4	2	–	–
<i>Astragalus vesicarius</i> L. subsp. <i>albidus</i> (W. et K.) Br.-Bl.	–	–	–	–	3	1	–	–	3	2
<i>Bothriochloa ischaemum</i> (L.) Keng	–	3	–	4	–	3	–	–	–	–
<i>Carex humilis</i> Leyss.	–	3	–	1	–	–	–	–	3	4
<i>Carex liparicarpus</i> Gaud.	3	4	2	3	4	6	2	2	5	5
<i>Centaurea micranthos</i> S. G. Gmel.	–	–	1	2	1	–	2	1	2	1
<i>Centaurea sadlerana</i> Janka	4	3	1	2	–	–	–	–	–	–
<i>Chamaecytisus austriacus</i> (L.) Link	3	2	2	2	–	–	–	–	–	–
<i>Chrysopogon gryllus</i> (Torn.) Trin.	5	4	4	–	–	–	6	5	–	–
<i>Dianthus pontederiae</i> Kern.	1	–	1	1	–	–	1	1	–	1
<i>Dorycnium germanicum</i> (Gremli) Rikli	3	3	1	2	–	–	–	–	–	–
<i>Draba lasiocarpa</i> Roch.	1	–	1	2	–	–	–	–	–	–
<i>Erysimum diffusum</i> Ehrh.	3	–	1	1	1	–	1	1	2	–
<i>Euphorbia cyparissias</i> L.	–	–	–	1	3	1	–	–	5	3
<i>Euphorbia seguierana</i> Necker	3	1	–	–	–	–	–	1	–	–
<i>Festuca pallens</i> Host	2	2	2	3	4	2	–	1	1	1
<i>Festuca rupicola</i> Heuff.	–	–	–	–	2	2	–	6	–	2
<i>Festuca valesiaca</i> Schleich.	–	–	–	–	–	4	–	5	–	–
<i>Fumana procumbens</i> (Dun.) Gren. et Godr.	–	–	2	1	–	–	–	–	–	–
<i>Globularia punctata</i> Lap.	–	1	–	1	2	1	–	1	–	1
<i>Helianthemum canum</i> (L.) Baumg.	2	–	–	2	2	–	2	3	3	1
<i>Helianthemum nummularium</i> (L.) Mill.	–	2	–	1	–	–	–	–	–	1
<i>Helianthemum ovatum</i> (Viv.) Dun.	–	–	1	1	–	–	–	–	–	–
<i>Hippocrepis comosa</i> L.	–	–	–	1	–	–	–	–	–	–
<i>Holosteum umbellatum</i> L.	–	–	–	3	–	–	–	–	–	1
<i>Hypericum elegans</i> Stephan	1	1	1	2	–	–	–	–	–	–
<i>Inula ensifolia</i> L.	–	–	1	–	–	–	3	3	–	–
<i>Iris pumila</i> L.	–	–	–	–	1	1	1	2	–	–
<i>Jovibarba hirta</i> (L.) Opiz	1	1	2	2	1	1	1	1	–	–
<i>Jurinea mollis</i> (L.) Rchb.	–	–	–	–	–	–	1	–	–	–
<i>Koeleria cristata</i> (L.) Pers.	–	1	–	–	2	1	1	4	1	1
<i>Linum tenuifolium</i> L.	2	–	–	–	–	–	1	–	1	1
<i>Lithospermum arvense</i> L.	–	–	–	–	–	–	–	1	–	–
<i>Medicago prostrata</i> Jacq.	–	–	–	–	3	1	–	–	–	–
<i>Minuartia setacea</i> (Thuill.) Hay.	3	2	1	2	1	1	3	–	1	–

Table 1 (continued)

	No. of relevés									
	1		2		3		4		5	
	A	B	A	B	A	B	A	B	A	B
<i>Muscari racemosum</i> (L.) Mill.	–	–	–	–	–	1	–	1	–	1
<i>Onosma visianii</i> Clem.	–	–	–	–	–	–	–	–	1	–
<i>Ornithogalum comosum</i> L.	3	1	2	–	2	1	1	3	3	2
<i>Orphantha lutea</i> (L.) Kern.	1	–	1	1	–	–	–	–	–	–
<i>Paronychia cephalotes</i> (M. B.) Bess.	–	–	–	–	–	–	–	1	–	–
<i>Petrorhagia prolifera</i> (L.) Ball et Heyw.	–	–	–	1	–	–	–	–	–	–
<i>Poa badensis</i> Haenke	–	–	–	–	–	–	–	–	1	1
<i>Poa bulbosa</i> L.	–	5	–	6	–	3	–	5	–	6
<i>Potentilla arenaria</i> Borkh.	1	1	2	2	4	4	2	3	–	1
<i>Reseda lutea</i> L.	–	–	3	1	–	–	–	–	–	–
<i>Sanguisorba minor</i> Scop.	5	2	6	5	6	5	5	3	6	3
<i>Scabiosa canescens</i> W. et K.	–	–	–	1	–	–	–	–	–	–
<i>Scabiosa ochroleuca</i> L.	–	–	3	–	–	–	1	–	–	–
<i>Scorzonera austriaca</i> Willd.	1	–	2	1	–	–	2	3	1	2
<i>Seseli leucospermum</i> W. et K.	3	3	3	3	–	–	1	1	1	–
<i>Seseli osseum</i> Cr.	–	–	–	1	–	–	–	–	–	–
<i>Silene otites</i> (L.) Wibel	3	1	–	–	–	1	2	–	1	1
<i>Stachys recta</i> L.	1	1	3	2	3	3	1	1	1	4
<i>Stipa capillata</i> L.	–	–	–	–	–	–	6	–	5	–
<i>Stipa eriocalis</i> Borb.	3	4	4	3	2	–	3	5	5	6
<i>Taraxacum laevigatum</i> (Willd.) DC.	–	–	–	–	–	–	–	1	–	–
<i>Teucrium chamaedrys</i> L.	–	–	–	–	–	–	4	5	–	–
<i>Teucrium montanum</i> L.	2	3	3	2	3	2	3	2	2	1
<i>Thymus praecox</i> Opiz	3	3	3	2	3	6	3	2	2	1
<i>Trinia glauca</i> (L.) Dum.	–	1	–	1	–	1	–	1	–	–
<i>Veronica spicata</i> L.	–	1	2	–	–	–	2	3	–	–
<i>Vinca herbacea</i> W. et K.	–	1	1	1	1	1	–	1	–	–
<i>Vincetoxicum pannonicum</i> (Borhidi) Holub	1	1	4	4	1	1	3	3	2	2

Table 2. Cover values of the species in the relevés 6 to 10 (Szekrényes-hegy) A=1996, B=2001.

	No. of relevés									
	6		7		8		9		10	
	A	B	A	B	A	B	A	B	A	B
<i>Acinos arvensis</i> (Lam.) Dandy	–	–	1	–	2	1	–	–	2	1
<i>Allium moschatum</i> L.	–	1	–	–	1	1	–	–	–	–
<i>Allium sphaerocephalon</i> L.	–	–	–	1	–	–	–	–	–	–
<i>Alyssum montanum</i> L.	–	–	1	1	–	1	–	–	–	1
<i>Alyssum tortuosum</i> W. et K.	2	–	2	–	1	–	–	–	–	–
<i>Anthyllis vulneraria</i> L.	3	1	2	–	–	–	1	1	–	–
<i>Asperula cynanchica</i> L.	–	1	–	–	–	1	1	1	–	–
<i>Astragalus vesicarius</i> L. subsp. <i>albidus</i> (W. et K.) Br.-Bl.	–	–	–	–	4	2	2	1	–	–
<i>Campanula sibirica</i> L.	–	–	–	–	–	–	1	–	–	–

Table 2 (continued)

	No. of relevés									
	6		7		8		9		10	
	A	B	A	B	A	B	A	B	A	B
<i>Carex humilis</i> Leyss.	—	—	—	—	—	—	2	2	—	—
<i>Carex liparicarpus</i> Gaud.	4	3	5	5	4	4	2	3	2	3
<i>Cuscuta epithymum</i> (L.) Nath.	—	—	—	—	—	1	—	—	—	—
<i>Dianthus plumarius</i> L. subsp. <i>regis-stephani</i> (Rapaics) Baksay	1	2	3	—	3	1	2	—	3	1
<i>Draba lasiocarpa</i> Roch.	1	—	—	—	1	—	2	2	1	1
<i>Erysimum diffusum</i> Ehrh.	—	—	1	—	—	—	—	—	—	—
<i>Euphorbia cyparissias</i> L.	1	1	4	1	1	2	—	—	—	—
<i>Euphorbia seguierana</i> Necker	1	1	2	1	1	1	1	—	—	—
<i>Festuca pallens</i> Host	3	2	1	3	3	1	3	3	3	3
<i>Fumana procumbens</i> (Dun.) Gren. et Godr.	—	—	—	—	1	1	3	3	1	1
<i>Globularia punctata</i> Lap.	3	3	3	1	2	—	—	—	1	1
<i>Helianthemum canum</i> (L.) Baumg.	—	3	—	4	3	3	3	4	1	2
<i>Helianthemum nummularium</i> (L.) Mill.	—	—	—	3	—	—	—	1	—	—
<i>Jovibarba hirta</i> (L.) Opiz	1	1	1	1	1	1	1	1	1	1
<i>Koeleria cristata</i> (L.) Pers.	—	—	—	—	—	—	—	1	—	—
<i>Linum tenuifolium</i> L.	1	1	1	—	1	1	1	—	1	1
<i>Minuartia setacea</i> (Thuill.) Hay.	1	1	—	1	2	1	—	1	2	1
<i>Minuartia verna</i> (L.) Hiern	3	—	4	—	1	—	1	—	1	—
<i>Muscari racemosum</i> (L.) Mill.	—	—	—	—	—	—	—	—	—	1
<i>Onosma visianii</i> Clem.	1	1	1	—	2	1	1	3	2	3
<i>Orphantha lutea</i> (L.) Kern.	1	1	1	2	1	3	1	1	—	—
<i>Paronychia cephalotes</i> (M. B.) Bess.	—	—	—	—	1	—	—	—	—	—
<i>Poa badensis</i> Haenke	1	—	1	—	—	—	1	1	1	1
<i>Poa bulbosa</i> L.	—	3	—	3	—	4	—	2	—	2
<i>Potentilla arenaria</i> Borkh.	3	2	3	3	4	4	3	3	—	3
<i>Reseda lutea</i> L.	—	—	—	—	—	—	—	1	—	—
<i>Sanguisorba minor</i> Scop.	4	3	3	4	4	4	3	3	4	5
<i>Saxifraga tridactylites</i> L.	—	1	—	—	—	1	—	1	—	—
<i>Scabiosa canescens</i> W. et K.	3	3	3	3	2	3	—	—	—	—
<i>Scorzonera austriaca</i> Willd.	1	1	—	—	1	1	—	—	—	1
<i>Sedum album</i> L.	—	—	—	—	1	1	—	1	—	—
<i>Seseli leucospermum</i> W. et K.	5	4	3	4	4	3	5	5	4	4
<i>Silene otites</i> (L.) Wibel	2	1	—	2	—	1	—	—	—	—
<i>Stachys recta</i> L.	—	—	1	—	—	—	—	—	—	—
<i>Stipa eriocalis</i> Borb.	2	2	3	3	3	3	2	4	2	1
<i>Teucrium montanum</i> L.	2	3	—	2	2	3	4	1	1	—
<i>Thalictrum minus</i> L. subsp. <i>pseudominus</i> (Borb.) Soó	—	—	—	—	—	—	1	—	—	—
<i>Thesium linophyllum</i> L.	—	—	—	—	1	1	—	—	—	—
<i>Thymus praecox</i> Opiz	2	2	3	5	5	5	3	1	—	2
<i>Veronica spicata</i> L.	—	—	—	1	—	—	—	—	—	—

Table 3. Cover values of the species in the relevés 11 to 15 (Farkas-hegy) A=1996, B=2001.

	No. of relevés									
	11		12		13		14		15	
	A	B	A	B	A	B	A	B	A	B
<i>Acinos arvensis</i> (Lam.) Dandy	–	–	–	–	1	1	1	1	–	–
<i>Allium moschatum</i> L.	–	–	–	–	1	1	1	2	–	–
<i>Alyssum montanum</i> L.	–	–	1	1	1	2	–	–	–	–
<i>Alyssum tortuosum</i> W. et K.	3	1	2	1	4	1	3	1	3	1
<i>Anthericum ramosum</i> L.	1	1	–	–	–	–	–	1	–	1
<i>Asperula cynanchica</i> L.	–	1	–	–	–	1	–	–	–	1
<i>Biscutella laevigata</i> L.	–	–	–	–	–	–	–	–	1	–
<i>Bothriochloa ischaemum</i> (L.) Keng	–	–	–	–	–	–	–	4	–	–
<i>Carex humilis</i> Leyss.	3	4	3	2	2	4	3	3	–	1
<i>Carex liparicarpos</i> Gaud.	–	–	–	–	–	–	4	–	3	4
<i>Centaurea micranthos</i> S. G. Gmel.	–	–	1	–	1	1	–	–	–	–
<i>Chrysopogon gryllus</i> (Torn.) Trin.	–	–	–	–	–	1	1	3	–	–
<i>Cuscuta epithymum</i> (L.) Nath.	–	–	–	–	–	2	–	–	–	–
<i>Dianthus plumarius</i> L. subsp. <i>regis-stephani</i> (Rapaics)										
Baksay	1	1	2	2	–	–	2	1	2	1
<i>Draba lasiocarpa</i> Roch.	–	–	–	–	–	–	–	–	1	–
<i>Euphorbia seguierana</i> Necker	–	–	2	1	–	–	–	–	1	1
<i>Festuca pallens</i> Host	4	1	6	3	5	4	4	3	4	3
<i>Festuca rupicola</i> Heuff.	–	–	–	–	1	–	–	–	–	–
<i>Festuca valesiaca</i> Schleich.	–	–	–	–	–	1	–	–	–	–
<i>Fumana procumbens</i> (Dun.) Gren. et Godr.	–	2	–	1	1	–	3	2	1	3
<i>Galium glaucum</i> L.	–	–	–	–	1	–	–	–	–	–
<i>Galium verum</i> L.	–	–	–	–	–	1	–	–	–	–
<i>Globularia punctata</i> Lap.	1	2	3	2	3	3	2	2	2	1
<i>Helianthemum canum</i> (L.) Baumg.	1	3	5	2	6	3	3	1	3	–
<i>Helianthemum nummularium</i> (L.) Mill.	–	3	–	5	–	6	–	3	–	4
<i>Helianthemum ovatum</i> (Viv.) Dun.	3	–	–	–	–	–	–	–	–	–
<i>Hippocrepis comosa</i> L.	–	–	3	5	–	–	2	2	–	–
<i>Jovibarba hirta</i> (L.) Opiz	1	1	–	–	4	3	3	3	1	1
<i>Jurinea mollis</i> (L.) Rchb.	–	–	1	–	–	–	–	–	–	–
<i>Koeleria cristata</i> (L.) Pers.	–	–	2	1	3	3	1	1	–	–
<i>Medicago prostrata</i> Jacq.	–	–	–	–	4	4	–	–	–	–
<i>Minuartia setacea</i> (Thuill.) Hay.	1	1	2	1	2	3	1	1	3	2
<i>Minuartia verna</i> (L.) Hiern	1	–	1	–	2	–	1	–	1	–
<i>Muscari racemosum</i> (L.) Mill.	–	–	–	–	1	2	–	–	–	–
<i>Orphantha lutea</i> (L.) Kern.	–	1	–	–	–	2	–	3	–	1
<i>Paronychia cephalotes</i> (M. B.) Bess.	2	1	3	1	3	2	3	3	2	1
<i>Poa badensis</i> Haenke	–	–	1	1	2	1	1	–	1	1
<i>Poa bulbosa</i> L.	–	–	–	–	–	2	–	1	–	–
<i>Potentilla arenaria</i> Borkh.	4	2	6	7	4	5	4	3	3	3
<i>Sanguisorba minor</i> Scop.	1	1	3	1	3	1	4	2	–	2
<i>Scabiosa canescens</i> W. et K.	–	–	–	4	–	–	–	1	–	1
<i>Scorzonera austriaca</i> Willd.	1	1	1	–	–	–	–	–	1	–
<i>Sedum album</i> L.	–	–	–	–	–	–	–	–	1	1

Table 3 (continued)

	No. of relevés									
	11		12		13		14		15	
	A	B	A	B	A	B	A	B	A	B
<i>Stipa capillata</i> L.	–	–	–	–	–	3	–	–	–	–
<i>Stipa eriocalis</i> Borb.	3	2	1	3	1	–	1	–	1	2
<i>Taraxacum laevigatum</i> (Willd.) DC.	–	–	–	–	1	–	–	–	–	–
<i>Teucrium chamaedrys</i> L.	–	–	–	–	3	–	–	–	–	–
<i>Teucrium montanum</i> L.	4	5	1	5	4	5	4	5	4	4
<i>Thymus praecox</i> Opiz	4	4	5	5	3	4	4	3	4	3
<i>Veronica spicata</i> L.	–	–	4	5	4	3	3	2	1	1

Table 4. Cover values of the species in the relevés 16 to 20 (Kő-hegy) A=1996, B=2001.

	No. of relevés									
	16		17		18		19		20	
	A	B	A	B	A	B	A	B	A	B
<i>Alyssum montanum</i> L.	1	1	–	–	–	1	1	1	1	1
<i>Anthericum ramosum</i> L.	–	–	–	1	–	2	–	1	–	–
<i>Anthyllis vulneraria</i> L.	1	–	1	1	1	1	3	1	1	–
<i>Asperula cynanchica</i> L.	–	–	–	1	–	–	–	1	–	–
<i>Aster linosyris</i> (L.) Bernh.	–	–	–	–	–	1	–	–	–	–
<i>Biscutella laevigata</i> L.	–	–	1	–	1	–	–	–	–	–
<i>Bromus pannonicus</i> Kummer et Sendtner	–	–	–	–	1	–	–	–	2	–
<i>Carex humilis</i> Leyss.	3	4	4	5	4	4	5	5	6	7
<i>Carex liparicarpus</i> Gaud.	–	1	–	–	–	–	–	–	–	–
<i>Centaurea sadlerana</i> Janka	–	1	–	–	–	1	1	1	2	1
<i>Chrysopogon gryllus</i> (Torn.) Trin.	4	4	–	–	1	2	–	–	–	–
<i>Dianthus plumarius</i> L. subsp. <i>regis-stephani</i> (Rapaics)	–	–	–	–	–	–	–	–	–	–
Baksay	–	–	–	–	–	–	4	2	3	1
<i>Draba lasiocarpa</i> Roch.	–	–	–	–	–	–	–	–	1	–
<i>Euphorbia cyparissias</i> L.	2	1	–	–	–	–	–	–	–	–
<i>Euphorbia seguierana</i> Necker	2	1	1	1	–	1	–	–	1	–
<i>Festuca pallens</i> Host	3	1	1	1	–	1	2	1	3	1
<i>Fumana procumbens</i> (Dun.) Gren. et Godr.	4	3	–	3	4	3	4	3	4	4
<i>Genista pilosa</i> L.	–	–	3	1	–	–	3	5	–	2
<i>Globularia punctata</i> Lap.	2	1	1	1	–	1	1	2	3	3
<i>Gypsophila fastigiata</i> L. subsp. <i>arenaria</i> (W. et K.) Dom.	–	–	–	–	–	–	–	2	–	–
<i>Helianthemum canum</i> (L.) Baumg.	3	4	4	4	3	4	4	4	4	3
<i>Helianthemum nummularium</i> (L.) Mill.	–	1	–	–	–	–	–	–	–	–
<i>Inula ensifolia</i> L.	–	–	1	1	1	1	2	1	2	1
<i>Jovibarba hirta</i> (L.) Opiz	1	1	–	1	–	–	–	–	–	–
<i>Jurinea mollis</i> (L.) Rchb.	1	–	1	–	1	–	1	1	–	–
<i>Koeleria cristata</i> (L.) Pers.	1	–	–	–	–	–	3	1	3	–
<i>Linum tenuifolium</i> L.	1	1	1	1	–	1	1	1	1	–
<i>Medicago prostrata</i> Jacq.	–	1	–	–	–	–	–	–	–	–
<i>Minuartia setacea</i> (Thuill.) Hay.	1	1	–	1	1	–	3	1	1	–

Table 4 (continued)

	No. of relevés									
	16		17		18		19		20	
	A	B	A	B	A	B	A	B	A	B
<i>Minuartia verna</i> (L.) Hiern	1	–	–	–	1	–	–	–	1	–
<i>Orphantha lutea</i> (L.) Kern.	–	1	–	1	–	1	–	–	1	–
<i>Poa badensis</i> Haenke	–	–	–	–	–	–	1	2	–	1
<i>Poa bulbosa</i> L.	–	–	–	–	–	–	–	1	–	–
<i>Polygonatum odoratum</i> (Mill.) Druce	–	–	–	–	–	–	1	1	–	–
<i>Potentilla arenaria</i> Borkh.	3	1	–	–	–	1	–	1	–	–
<i>Sanguisorba minor</i> Scop.	2	1	1	–	–	–	2	1	2	1
<i>Scabiosa canescens</i> W. et K.	–	–	–	–	–	1	–	3	–	5
<i>Scabiosa ochroleuca</i> L.	–	–	–	–	–	–	3	–	2	–
<i>Scorzonera austriaca</i> Willd.	1	1	2	1	1	1	1	–	3	1
<i>Seseli leucospermum</i> W. et K.	1	2	2	4	3	1	3	2	–	1
<i>Stipa eriocalis</i> Borb.	1	3	1	2	1	3	3	1	4	3
<i>Teucrium montanum</i> L.	3	3	4	3	4	4	3	3	–	3
<i>Thesium linophyllum</i> L.	1	–	–	–	–	–	–	–	1	1
<i>Thymus praecox</i> Opiz	2	4	1	3	2	3	3	3	2	2
<i>Veronica spicata</i> L.	–	–	–	–	–	–	1	1	1	1
<i>Vincetoxicum pannonicum</i> (Borhidi) Holub	1	1	1	1	1	1	1	1	2	1
<i>Viola rupestris</i> F. W. Schmidt	–	1	–	–	–	–	–	1	–	–

Table 5. Additional data of the relevés.

No	Site	Date		Exposure	Angle of slope	Total cover (%)
		1996	2001			
1	Odvas-hegy	06.VII	08.VI	S	15°	65
2	Odvas-hegy	06.VII	14.VI	S	30°	60
3	Odvas-hegy	06.VII	08.VI	S	5°	60
4	Odvas-hegy	06.VII	15.VI	S	5°	80
5	Odvas-hegy	06.VII	08.VI	S	5°	75
6	Szekrényes-hegy	15.VI	04.VII	E	30°	40
7	Szekrényes-hegy	15.VI	04.VII	E	30°	50
8	Szekrényes-hegy	15.VI	04.VII	SE	30°	55
9	Szekrényes-hegy	15.VI	04.VII	E	40°	40
10	Szekrényes-hegy	15.VI	25.VI	E	30°	20
11	Farkas-hegy	27.V	15.VI	S	10°	35
12	Farkas-hegy	27.V	25.VI	E	5°	80
13	Farkas-hegy	27.V	25.VI	E	5°	70
14	Farkas-hegy	27.V	15.VI	SW	10°	50
15	Farkas-hegy	27.V	15.VI	SW	20°	40
16	Kő-hegy	08.VI	14.VI	S	30°	30
17	Kő-hegy	08.VI	14.VI	W	20°	25
18	Kő-hegy	08.VI	15.VI	W	25°	20
19	Kő-hegy	08.VI	15.VI	W	20°	50
20	Kő-hegy	08.VI	15.VI	NW	30°	60

Results of statistical analyses

The phytogeographical spectrum (areal types) of the four sites is given in Table 6. High natural value of the investigated grassland is proven by the high diversity of floral elements, and the relative high proportion of special floral elements (e.g. sub-Mediterranean, Pontic, Balkan and Sarmatian) and endemic species. The phytogeographical spectrum has changed only in a small extent in the time frame of the study. The most important change is that the proportion of the endemic species had decreased in the past five years. This fact is one sign of degradation.

The phytosociological composition of the sites is characteristic for the open dolomite rock grasslands and dolomite slope steppes and it shows only insignificant, small change (Table 7). Since there are no earlier phytosociological data of the studied sites, this change does not provide evidence for conclusive statement.

Distribution of the social behaviour type (based on the role the plant species play in the plant communities) is one of the most important basic characteristics of vegetation units. It is particularly suitable to express the natural value of the sites. Remarkable is the extremely high proportion of specialists (Table 8). Change of

Table 6. The phytogeographical spectrum of the sites (Ranking according to HORVÁTH et al. (1995) (expressed in percentage).

	Odvas-hegy		Szekrényes-hegy		Farkas-hegy		Kő-hegy	
	1996	2001	1996	2001	1996	2001	1996	2001
Alpin-Balkan	1.1	1.4	—	—	—	—	—	—
Atlantic-sub-Mediterranean	2.6	2.1	2.9	6.3	7.9	5.8	8.1	8.4
Balkan	3.1	2.0	—	—	—	—	—	—
Circumpolar	0.3	0.3	—	—	—	—	—	0.9
Eurasian	7.1	10.7	2.9	2.8	4.8	5.1	2.2	1.8
European	14.8	8.7	13.5	13.0	11.0	12.0	8.1	4.9
Illyrian, West Balkan	—	—	—	—	2.4	1.5	1.4	1.3
Carpathian endemic	0.6	0.6	2.1	1.2	0.3	—	0.5	—
Continental	4.3	4.9	4.5	3.5	10.0	7.3	13.5	12.9
Central European	5.7	4.9	10.7	10.6	10.3	11.2	9.0	15.1
Central European-Alpin	1.4	1.4	2.1	2.0	3.1	2.9	0.5	0.9
Cosmopolitan	1.1	2.0	—	0.4	2.1	1.8	3.1	0.4
Pannonian endemic	9.4	8.4	16.4	10.7	2.4	1.8	11.2	9.8
Pannonian-Balkan	0.6	—	2.9	3.2	0.3	—	1.8	0.4
Pontic-Pannonian	6.3	5.8	2.5	2.0	7.6	5.8	5.4	3.1
Pontic-sub-Mediterranean	18.5	15.9	13.9	14.2	4.5	9.4	4.0	6.2
Pontic	2.3	2.0	0.4	—	0.7	0.4	—	—
Sarmatian	2.6	3.2	5.3	5.9	7.2	7.3	1.4	1.3
Subatlantic	—	—	—	—	—	—	2.7	3.6
Sub-Mediterranean	18.5	18.7	20.1	18.9	25.2	26.8	27.4	28.4
Turanean (Aralo-Caspian)	—	7.2	—	5.5	—	1.1	—	0.4

Table 7. Distribution of phytosociological character on the sites (BORHIDI 1993) (expressed in percentage).

	Odvas-hegy		Szekrényes-hegy		Farkas-hegy		Kő-hegy	
	1996	2001	1996	2001	1996	2001	1996	2001
Secalietea	—	0.3	—	—	—	—	—	—
Onopordetalia	0.9	0.3	—	0.4	—	—	—	—
Sedo-Scleranthetea	1.7	0.9	2.5	1.6	1.0	1.1	—	—
Sedo-Scleranthetalia	—	7.2	—	5.5	—	1.1	—	0.4
Alysso-Sedion	—	—	—	1.2	—	—	—	—
Festuco-Brometea	36.9	32.6	23.4	26.4	24.1	27.5	21.1	16.0
Festucetalia valesiaceae	24.7	24.8	20.1	23.2	37.6	42.4	38.1	43.6
Festucion valesiaceae (incl. Festucion rupicolae)	3.7	3.1	—	—	—	—	—	—
Asplenio-Festucion pallentis	4.3	4.3	5.3	5.9	6.9	6.9	4.5	6.7
Bromo-Festucion pallentis	15.6	15.6	32.8	24.0	19.3	13.8	26.0	21.8
Festucetalia vaginatae	6.8	6.3	7.4	7.1	2.4	1.5	—	0.4
Festucion vaginatae	1.4	0.9	6.2	3.2	7.9	5.4	9.0	10.2
Quercetalia pubescentis- petraeae	—	—	—	—	—	—	0.5	0.4
Indifferent	4.0	3.8	2.5	1.6	0.7	0.4	0.9	0.4

the distribution indicates the degradation of the investigated sites very sensitively: proportion of the specialists has decreased in all of the four sites.

Since every social behaviour type has a naturalness value (BORHIDI 1993), value of the sites can be quantified by the average naturalness value. Figure 1 indicates that average naturalness value has decreased on all investigated sites. This is an exact evidence of degradation.

Table 8. Distribution of the social behaviour type on the sites (Borhidi 1993) (expressed in percentage) (NV = naturalness value).

Social behaviour type	NV	Odvas-hegy		Szekrényes-hegy		Farkas-hegy		Kő-hegy	
		1996	2001	1996	2001	1996	2001	1996	2001
Unique specialists	10	3.1	3.2	—	—	—	—	2.7	2.2
Specialists	6	22.2	21.3	44.3	33.1	31.7	24.6	35.4	35.1
Competitors	5	11.4	13.0	6.2	5.5	14.8	14.5	20.2	20.9
Generalists	4	53.4	46.7	44.3	51.2	51.7	56.9	40.8	40.9
Natural pioneers	3	4.0	8.9	2.9	8.3	1.0	2.2	—	0.4
Disturbance tolerants	2	5.1	5.5	2.5	1.6	0.7	1.8	0.9	0.4
Weeds	1	0.9	1.4	—	0.4	—	—	—	—
Change of average naturalness value		-0.10		-0.28		-0.18		-0.03	

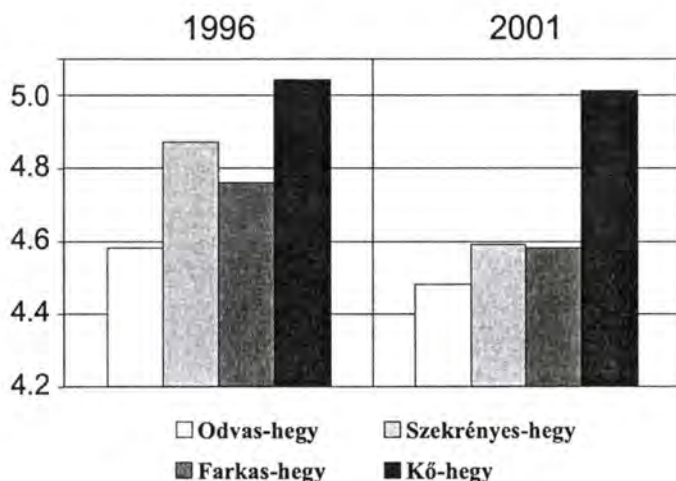
Table 9. Distribution of the nitrogen preference categories on the sites (BORHIDI 1993) (expressed in percentage).

Nitrogen preference categories	Odvas-hegy		Szekrényes-hegy		Farkas-hegy		Kő-hegy	
	1996	2001	1996	2001	1996	2001	1996	2001
1	50.3	49.0	71.7	71.3	74.5	70.7	58.7	61.8
2	37.5	37.1	18.0	20.47	18.6	17.0	23.3	16.4
3	10.5	11.8	7.8	7.1	6.6	11.2	14.9	18.7
4	1.7	1.6	2.5	1.2	0.3	1.1	3.1	3.1
5	–	0.5	–	–	–	–	–	–
6–9	–	–	–	–	–	–	–	–

One potential kind of degradation is spreading of nitrophilous weeds in several vegetation types and distribution of the nitrogen preference categories can indicate nitrogen pollution of the environment. In our case low nitrogen preference is significant on the four sites. In Farkas-hegy the proportion of the higher nitrogen preference categories have been increasing in a small extent (Table 9).

DISCUSSION

Although we have no early data about the original vegetation of Csíki-hegyek, the main vegetation types could be: pubescent oak scrub woodlands, rock steppes, open and closed rock grasslands (ZÓLYOMI 1958). Most of the woods were cut several hundred years ago and the dolomite hills were pastured intensively. Proportion of the grasslands has increased in time, and their structure has

**Fig. 1.** Average naturalness value of the sites.

changed and stabilised (secondary rock steppes and grasslands). Today the main tendencies of change of vegetation are the spontaneous spreading of (mostly native) shrubs and degradation caused by the growing tourism.

Results of this study have pointed out first of all the main trends and degrees of site degradation. Some evidence of the latter in botanical terms:

- decreasing proportion of specialists,
- decreasing average naturalness values,
- increasing proportion of the higher nitrogen preference categories (in Farkas-hegy).

In spite of the undesirable processes the studied sites are valuable and deserve protection. Some facts justifying the extremely high natural value of these rock grasslands:

- high number of plant species,
- high proportion of special floral elements and endemic species,
- high proportion of specialists,
- high average naturalness values,
- low proportion of weeds (including nitrophilous ones).

In the interest of protection of natural values of the investigated sites (and their surrounding areas) a reasonable controlling and limitation of tourism seem to be necessary and unavoidable.

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